

FY2015 Specialty Crop

Block Grant Program – Farm Bill

Idaho State Department of Agriculture

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A Web-Enabled Site Suitability and Visualization Tool to Support Idaho's Growing Wine Industry

Subrecipient

Boise State University (BSU)

Project Summary

The overarching objectives of this project were threefold: (1) to compile a set of climate indices through review of appropriate literature and interaction with growers in the Snake River American Viticultural Area (SR-AVA) that are used to inform decision-making related to wine grape production, (2) to use an existing state-of-the-art regional database of weather for the years 1986-2017 that the Snake River American Viticultural Area to calculate the identified climate indices through space and time, and (3) to develop a web-based, interactive visualization tool that allows growers and anyone with access the ability to see spatial and temporal patterns in these key measures of climate. Additionally, a complementary suite of activities collected ground-based terrestrial laser scanning (TLS) data from a number of vineyards in the SR-AVA to facilitate improved site-level characterization of key parameters like topographic slope, aspect, and, potentially, soil characteristics. The rationale for this project was to provide access to a dataset of high scientific quality to existing and future producers of wine grapes (and other specialty crops) in order to help inform their planning and operational practices. To ensure success it was, therefore, necessary to understand (1) what attributes and indices of climate and weather are used by growers in their decision-making process, and (2) how to use the advanced climatological dataset to calculate these indices through space and time.

Project Approach

The project used a state-of-the-art climate dataset previously developed by the PI at Boise State University with support from NASA and the National Science Foundation. The dataset was developed using a regional model capable of simulating land-atmosphere conditions at spatial resolutions that explicitly permit convection (e.g., < 4 km) and sub-diurnal temporal resolutions, the Weather Research and Forecasting (WRF) model. In the SR-AVA it is particularly important to capture climate variables at substantially higher spatial resolutions than other available climate products because the area has spans a large elevation range and is associated with significant topographic complexity that influences the distribution of key variables like precipitation and temperature. It is also important to capture sub-diurnal fluctuations in weather and climate because Idaho's continental and desert climate are associated with potentially rapid fluctuations that cannot be captured by daily summary data.

The dataset is composed of two spatial domains/ an outer domain that captures the entire Snake River Basin at a spatial resolution of 3km and a nested, inner domain that captures the SR-AVA and Boise River Basins at spatial resolutions of 1km. In both cases, output from the model is available at 1 hr temporal resolutions. WE ran the model for a continuous period spanning October 1, 1986 through September 30, 2017. This encompasses 30 years of water data. Because the model simulates the entire land-atmosphere column, the dataset is exceptionally large (more than 300 TB). Hence a significant portion of this project involved data reduction and sub-setting of key variables.

Over the course of the first project year, we conducted a thorough literature review and interviews with a number of vineyard operators in the Sunnyslope region of the SR-AVA to ascertain what facets of climate and weather were important for making planning and operational decisions. Based on this literature review and engagement with key stakeholders, we found that the climate factors of interest to growers could be grouped into two subsets. The first included climate metrics and indices that are commonly related to the favorability of a location or year for growing grapes. An example climate index in this category are the growing degree days (GDD), which capture the accumulation of atmospheric heat content above some threshold value. Historical estimates of GDD are frequently used to assess the favorability of growing conditions at a particular location and make decisions about grape varieties likely to succeed at that location. The other category of climate indicators include those that capture potentially damaging weather conditions. These include the day of first frost event during a given growing season, a “frost” being defined as a continuous period of below-freezing air temperatures lasting at least 5 hours. The day of first frost is an important determinant of when harvest and any winter vine maintenance activities should be complete. Our literature review and interviews were used to develop a list of high-priority indices that would be obtained throughout space and time for the SR-AVA from the regional database. For all indices that we computed and visualized, these datasets represent the highest-resolution data available to support growers in Southwest Idaho.

Having obtained a prioritized list of climate indices, we developed a web-based visualization tool that allows users to interactively explore these key indices throughout the SR-AVA and during all years captured by the climate database. The functionality allows users to see region-wide trends in variables, zoom in to see patterns in finer spatial detail, and develop plots of historical years at an individual site-level. Our visualization tool is developed using an R Shiny server that was deployed on Boise State’s network. The R Shiny framework allows users to view both geospatial and time series data interactively with minimal configuration required by the developers. Importantly, the available geospatial visualization utilities allow a suite of base layers (maps) that provide meaningful spatial context for users. These base layers provide visualization of key geospatial attributes like roads and highways, waterways, National Forests, and other signposts to orient the viewer. These are displayed in a hierarchical fashion, meaning that the base layers refine in their scale as the user zooms in. A critically important facet of this R Shiny platform is that it is extensible and easily reconfigurable. Hence, as we develop new datasets, find new climate indices, and perform additional analyses, we can add content in the future. As such, the R Shiny platform represents an important piece of software infrastructure that will continue to be developed and use to communicate important data to end-users. The URL for the web-viewer is http://bwc.boisestate.edu/sample-apps/test_app/ and the website will go live on approximately December 15 (although screen captures are provided below).

Goals and Outcomes Achieved:

Determined a set of indices that are important for decision-making. These include growing degree days, day of first frost, and a variety of others.

Developed a set of high-priority climate indicators to further develop into spatiotemporal visualizations that are now served on a web-based platform.

Use a high-quality scientific climate dataset to compute these climate indicators for the SR-AVA region.

Develop and deploy an interactive visualization platform that allows end-users to explore these climate indices for the SR-AVA region, both in space for a particular growing season and at a point for multiple growing seasons (see screen captures below).

Collect and interpret ground-based TLS data characterizing topographic characteristics at several vineyards and post these data to the Idaho Lidar Consortium data portal.

Measurable Outcomes Achieved:

1 research scientist supported

2 graduate students at Boise State University supported

2 TLS datasets uploaded to the Idaho Lidar Consortium data portal

1 interactive climate data exploration web portal created (http://bwc.boisestate.edu/sample-apps/test_app/)

1 MS thesis, partially supported by this project, in development

2 publications for submission to peer-reviewed journals, in development

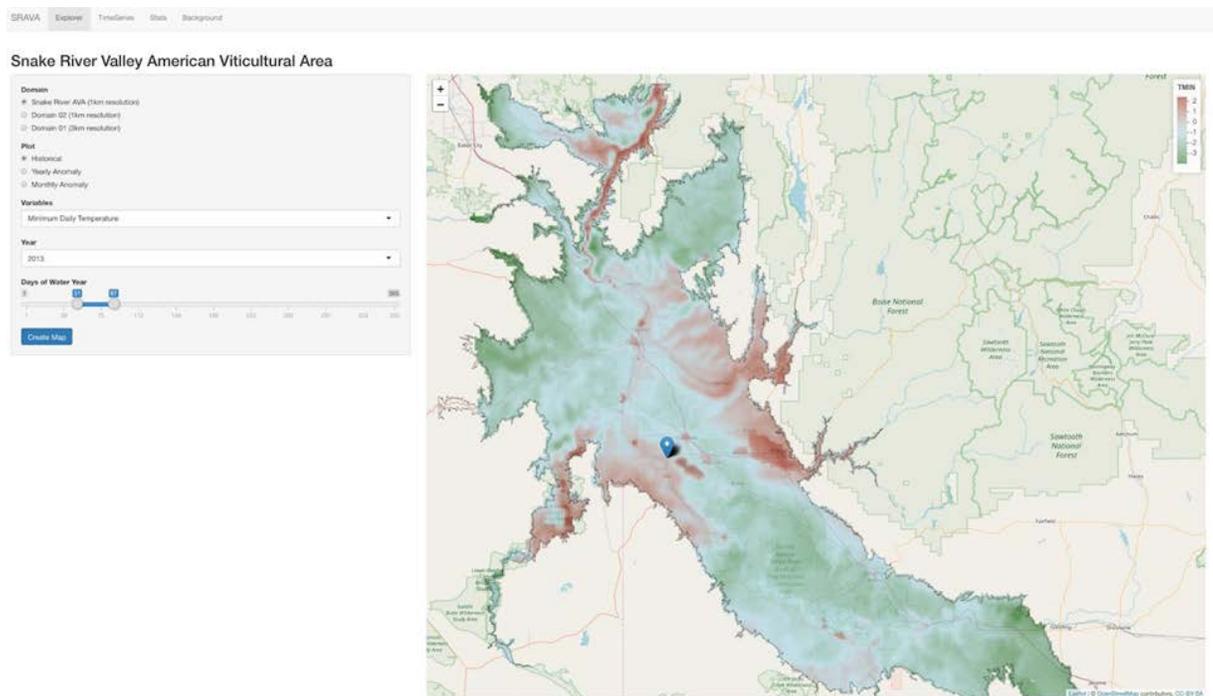


Figure 1: The spatial distribution of minimum daily air temperature between day 51 and 87 of water year 2013, overlain upon base geospatial layers to orient users.

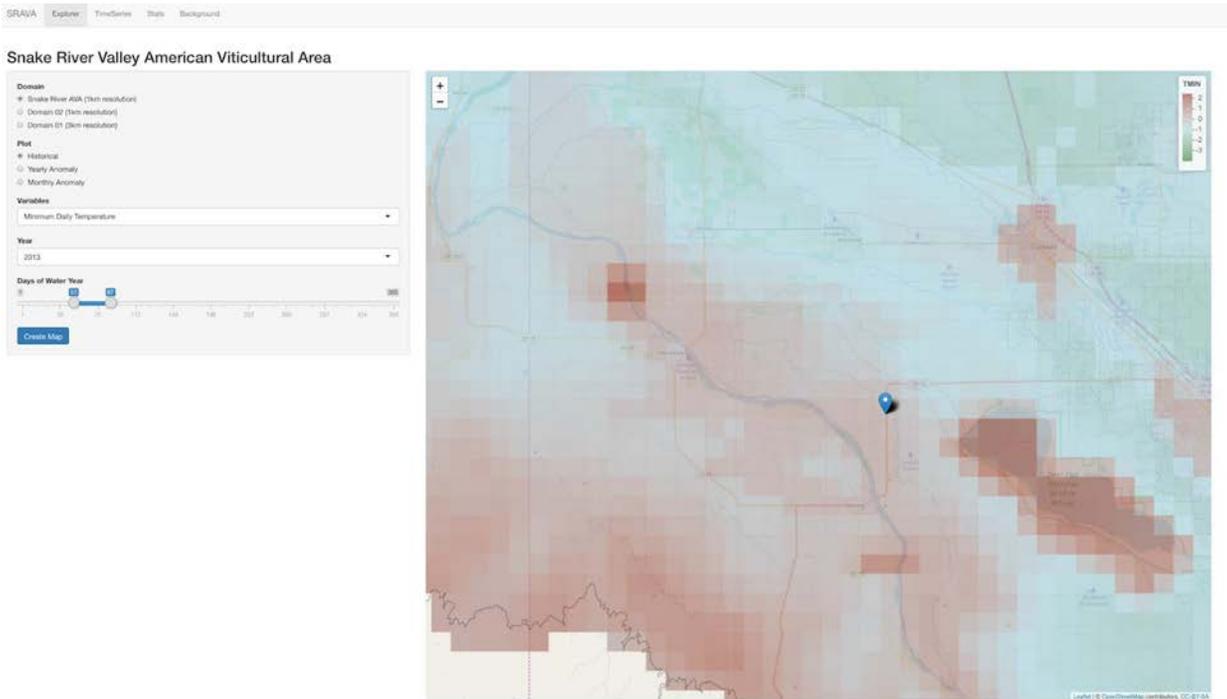


Figure 2: A zoomed in view of the same data from Figure 1, illustrating refinement of baselayers and showing correspondence between the atmospheric model and key landscape features (i.e., higher minimum air temperatures observed over Lake Lowell).



Figure 3: For an individual point, corresponding approximately to the Sunnyslope region, a time series total precipitation during four individual years.

Beneficiaries:

This project resulted in partial support for one research scientist, and two graduate students in the Department of Geosciences at Boise State. One of these graduate students is developing a Master’s thesis that will seek to understand large-scale seasonal and sub-seasonal climate patterns most likely to give rise to potentially grape-damaging events in southwest Idaho.

The project benefited the PI, Co-PI and their research groups by providing opportunities to develop connections and collaborations with growers within the SR-AVA as well as other key stakeholders, include the Idaho State Wine Commission.

The project benefits existing wine grape growers in the SR-AVA by providing an interactive visualization site that allows them to explore and visualize 31 years of historical weather conditions at their vineyards. This will help them potentially identify both potential varieties that may succeed at their vineyards, as well the historical temporal occurrence of hazardous events such as frost. They can view these data both as spatial maps, as well as time series data.

The project benefits potential wine grape growers potentially developing new or expanding operations in the SR-AVA by providing them the same capabilities as existing growers for as-yet undeveloped sites. This tool can be used to help them identify locations with potentially favorable climate profiles that represent opportunities for new sites and new varieties.

The project also benefits growers of other specialty crops and agriculturalists, in general, by providing these visualization capabilities. Although GDD and dates of first frost are useful for growing wine grapes, these and other indices for which we have developed visualizations are useful for a broad variety of crops, specialty and otherwise.

Lessons Learned

During the course of the project we developed good working relationships with a number of wine producers, key wine industry stakeholders, and other agriculture-oriented individuals and entities in the region. We will seek to leverage these new relationships into collaborations to extend and enhance our web-based tool. Specifically, we are planning to showcase the web-portal to the Idaho State Wine Commission and develop discussions about future projects and directions that might better support growers of specialty crops in Idaho. We will correspondingly use the outcome of these and other discussions to develop new ideas for future Specialty Crop Block Grant solicitations.

Although the TLS datasets provide very highly detailed data about individual vineyards, the difference in spatial and temporal scales between the TLS scans and the climate dataset proved too difficult to leverage them together in any significant way. In future work we will seek new pathways in which Lidar data can potentially be better used for site characterization at regional scales. Airborne lidar datasets that may be being produced by some government agencies like FEMA may prove useful in this regard.

Using the R Shiny platform proved to be a highly successful choice for this project. The framework is relatively easy to setup and install, provides users significant flexibility in configuring visualization portals, and can be extended and modified easily in the future. Although the R Shiny tools are commercial, they are open source. With the help of Research Computing at Boise State we were able to deploy an independent R Shiny server at no cost to the project. Moreover, the URL chosen is persistent and can be used for its purpose in perpetuity. Hence, this proved to be a developer- and user-friendly and inexpensive tool to enable the success of the project.

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Lewis-Clark Valley AVA Launch

Subrecipient

Clearwater Economic Development Association (CEDA)

Project Summary

The purpose of this project was to increase the awareness of the Lewis-Clark Valley American Viticultural Area (LCV AVA)- Idaho's newest designated AVA. The elements of this project were to launch a strategic and targeted promotion of the LCV AVA through the creation of a marketing plan for the AVA; and implementation of the marketing plan to introduce the LCV AVA grape growers and vintners to potential markets.

Historically, the center and infancy of the Northwest wine industry was the Lewiston-Clarkston region- wine grapes have been farmed commercially in the Lewis-Clark Valley since at least 1871 and the first winery opened in the late 1870s; prohibition led to the industry's demise. This project was developed to become the catalyst for the reemerging wine industry cluster developing in north-central Idaho.

With the 2016 designation of the LCV AVA, the Lewis-Clark Valley growers and vintners of north-central Idaho hope to restore the region to what it was at the beginning of the 20th century – a primary and well-respected, premier grape growing region of the United States. The 306,658 acre LCV AVA encompasses parts of the Idaho counties of Nez Perce and Clearwater and the Washington counties of Asotin, Garfield, and Whitman.

For growth to occur, the industry stakeholders (at the time of application - four bonded wineries and fifteen vineyards) needed to develop a cohesive brand, and implement a successful marketing campaign that would increase awareness for both consumers and potential vineyard developers. At the time of application there were twelve (12) commercial vineyards and three (3) bonded wineries within in the LCV AVA Idaho portions of the AVA boundaries. Three (3) vineyards and one (1) bonded winery were located within the Washington portions of the AVA boundaries.

The most significant need of the emerging LCV AVA was to increase the number of vineyards and/or the acreage of grapes grown meet the demand for grapes grown within the LCV AVA. Addressing this industry cluster gap would allow vintners to bottle and sell more wine labeled as an AVA produced wine. An AVA designation on a wine label allows vintners and wine consumers to attribute a given quality, reputation, or other characteristics to the geographical origin of the AVA; often increasing demand and price points of AVA labeled wine.

Project Approach

The project was initiated by developing a Marketing Committee which oversaw all activities. Members of the committee were Coco Umiker (Clearwater Canyon Cellars & Umiker Vineyard); Melissa Sanborn (Colter's Creek Winery and Vineyard); Lynn DeVleming (Basalt Cellars & DeVleming Vineyard); Michelle Peters (Visit Lewis Clark Valley Tourism Association); Debbie Baker (Valley Vision Economic Development); and, Deb Smith (Clearwater Economic Development Association). The Marketing Committee executed procurement activities; worked with the selected Contractor, Northwest Media, to develop a marketing plan, brand, logo, and website.

The Marketing Committee worked with the contractor during three meetings and emails to develop a recognizable brand to identify the unique attributes of the Lewis-Clark Valley AVA. Through a comprehensive vetting process the

committee selected three logos. The logos are used in all marketing materials, event display materials, and communication.

The Marketing Committee also worked with the contractor in the development of the Lewis-Clark Wine Alliance website, www.lewisclarkwine.com and a Facebook page. (NOTE: ISDA Specialty Crop Block Grant funds were not used in the development of the website, website development was funded through a contribution by the city of Clarkston, WA.) A valuable website element important to this project is the "Contact" button which allows an interested party to request general information, visitor information, opportunities to advertise, and/or learn more about the organization. This tab has been used by three parties interested in vineyard development; two educators interested in teaching materials and several advertising requests. Responses were provided to all inquiries and follow-up conversations have ensued. The Wine Alliance will continue to offer information and support as requested.

Print and online ads were designed and placed in the following publications:

- Wine Press Northwest
- Northwest Travel Magazine
- Horizon Air Magazine
- Idaho State Travel Guide
- Washington State Travel Guide
- North Central Idaho Travel Guide
- Visit Lewis Clark Valley Visitor Guide
- Idaho Wine Commission Tour Brochure
- Lewiston Tribune Annual Manual
- Inland Summer Guide

Three billboards were used to alert wine lovers about the new AVA. Billboards were placed near the entrance of the Spokane airport (Spokane, WA), at a high traffic intersection in Walla Walla, WA; and at the entrance of Lewiston on Highway 12.

The Marketing Committee planned and executed an event during this project that was intended to increase awareness and interest in vineyard development. Over 20 representatives, including real estate agents and bankers, attended by invitation, the November 20, 2015 "Developing the Emerging Wine Industry Seminar" presented by vineyard and winery of the LCV AVA wine industry. The intent of this event was to familiarize realtors and lenders with the specifics of the AVA such as boundaries, elevation restriction, and basic requirements for development. This event has created a relationship with the local realtor trade association.

Member of the Wine Alliance Marketing Committee joined with the Clearwater Economic Development Association (CEDA) Annual Meeting Committee to plan and execute the official 'launch' of the Lewis- Clark Valley AVA. CEDA's annual meeting, held April 20, 2016, was opened to the wine industry supporters, wine club members, industry stakeholders and the general public where over 400 turned out to learn more about the pending AVA designation and what it would mean to the regional wine industry, to meet the winemakers, and to taste the award winning wines made from AVA grapes. The event received media coverage and was attended by Idaho and Washington Congressional representatives.

The AVA Launch generated the interest of wine journalist and media writers. The Wine Alliance capitalized on the publicity and joined with the Idaho Wine Commission, the Idaho Department of Tourism, Idaho Preferred, and Visit Lewis-Clark Valley to host seven wine writers who toured North and North Central Idaho in late June 2016. The participants were treated to a jet-boat trip into Hells Canyon and then visits to three of the six wineries within the Lewis-

Clark Valley AVA. Several articles and blogs about the Lewis-Clark AVA have published since the media tour, including an editorial in Forbes Magazine titled "The Newest Real Estate Investment in Wine? Here a Tip!" This article names the newly designated Lewis-Clark Valley AVA as one of the top three places in the world, and the NUMBER ONE place in the United States, to invest in vineyard properties.

The media spotlight drew international attention and on December 21, 2016 a wine exporting representative met with members of the Lewis-Clark Valley AVA. The meeting included discussion on export regulations, shipping requirements, and potential interest. Initial interest will be small, possibly two to three pallets per year. Two Lewis-Clark AVA wineries have explored this opportunity and are working directly with the exporter.

To create local and regional interest, the Lewis-Clark Wine Alliance participated in several events during this grant period.

The Lewis-Clark Wine Alliance served it local wines at Barge Fest, Held July 8, 2017 in downtown Lewiston. Over 400 people attended the music festival.

The Lewis-Clark Wine Alliance shared a booth with Visit Lewis Clark Valley to promote LCV AVA wines at Vintage Spokane (Spokane, WA) held July 23, 2017. Vintage Spokane is the region's largest summer wine and food event, attracting almost 800 attendees.

The Lewis-Clark Wine Alliance served samples of LCV AVA wines to 170 attendees of the Idaho Conference on Recreation and Tourism, October 17, 2017 which was held in Coeur d'Alene, ID.

LCV AVA wines were featured at the Beautiful Downtown Lewiston's 7th Annual Art Walk.

This project has been greatly enhanced by the partnership between the Lewis-Clark Valley Wine Alliance and Visit Lewis Clark Valley (the local tourism bureau). Visit Lewis Clark Valley is charged with marketing the Lewiston, ID and Clarkston, WA region and has been able to bring additional funds to the table which has been used to leverage Idaho Specialty Crop Block Grant funds. The two organizations have been sharing cost and space in print media advertising in publications such as Northwest Travel Magazine, Horizon Air Magazine, Washington State Travel Guide, and the Idaho State Travel Guide. Visit Lewis Clark Valley has been instrumental in securing tourism marketing funding from the City of Clarkston, WA and Asotin County in Washington. These funds demonstrate the support of the Washington stakeholders and partners in the bi-state Lewis-Clark Valley AVA region.

Also critical to this project was the involvement, and support, of the vineyard owners and vintners of the LCV AVA. They contributed time, expertise, and product to the activities related to and complimentary to this project.

Goals and Outcomes Achieved

The goals of this project were:

- 1.) Goal: Increase tons of grapes produced/sold, acreage planted
Target: By 2017, increase production of grapes sold/acreage planted by a minimum of five (5) percent

Benchmark: 2014 production/acreage planted

Performance Measure: Derived from yearly specialty crop commission assessment reports; LCVWA members yearly reporting

Result: The 2014 benchmark of acreage of grapes planted was 76.10 acres reported by LCV AVA vineyard owners. As of November 2017, LCV AVA vineyard owners report there are 121.5 acres of grapes planted within the LCV AVA boundaries. This indicates a 59.6% increase in vineyard acreage during this project period.

2.) Goal: Growth of new vineyards and vintners within the LCV AVA

Target: By 2018 the LCV AVA will include two (2) new vineyards and one (1) new winery
Benchmark: Number of vineyards and wineries within the LCV AVA at the time of designation
Performance Measure: Alcohol Beverage and Control license permits, TIB, ID and WA States Department of Agriculture

Result: At the time of application there were three Idaho wineries and one Washington winery bonded within the LCV AVA and twelve Idaho vineyards and three Washington vineyards. At the completion of this project there are currently seven bonded wineries in Idaho - an increase of 133%. Two new vineyards have come online; one is less than five acres and the second is over 15 acres.

3.) Goal: Changes in wine tourism spending and lodging revenues

Target: By 2017, increase wine tourism spending through increased wine tourism within the AVA by five (5) percent

Benchmark: 2015 on-site wine sales within the LCV AVA, number of 2015 guided wine tours

Performance Measure: 2016 & 2017 wine sales within the AVA, 2016 & 2017 winery visits, 2016 & 2017 guided wine tours

Result: Through review of their guestbook registrations, LCV AVA wineries have reported increased visitors in 2016 and 2017. Three wineries reported visitors from the Spokane area that became familiar with the LCV AVA through our participation at Vintage Spokane (June 2017). A new wine tour company opened in early 2017 and has provided over 50 wine tours since its inception. Recently, the tour operator submitted a proposal to the American Empress Cruise line which docks in Clarkston, Washington weekly through tourism season and may soon be providing guided wine tours for their passengers. Washington State University Foundation offers two wine tours per year for WSU alumni visiting the campus for football games and/or parent's weekend. Nez Perce County (ID) lodging tax collections increase \$240,000 in 2016 over 2015 (2017 data unavailable) and Asotin County (WA) lodging sales were 9.43% higher than 2015. Hoteliers report anecdotally that those increases, in part, can be contributed to travelers staying in the Lewis-Clark Valley for wine related experiences. Wine sales were not recorded for this project in 2015 due to the delay in award. CEDA will submit 2016 - 2017 sales comparisons in January 2018.

The activities that were implemented to achieve the above goals were the development of the brand, the implementation of the marketing plan, the use of web and social media, print ad placement and public outreach.

The overall project goal was to increase the volume of wine grapes grown within the LCV AVA. Although the short-term (2-year) indicators reveal that that goal has been achieved, we still do not have the tonnage of grapes needed by the LCV AVA wineries to meet their capacity or allow for growth.

This project will lead to long-term benefits that were unable to be measured or come to fruition during the grant duration. The Lewis-Clark Wine Alliance believes the following opportunities will contribute to the development of vineyards and increases in the production of wine:

LCV Wine Alliance recently provided technical assistance to the Nez Perce Tribe which has completed a value-added agriculture feasibility study. Initial results indicate that the development of vineyards and wineries are favorable, due in part to the Tribe's land ownership and water-rights within the LCV AVA. The Tribe is currently investigating this opportunity and anticipates moving forward in the fall of 2017 with the development of a five -ten acre vineyard.

At this time there will be seven cruise boats docking at the Port of Clarkston (Clarkston, WA) which is adjacent to downtown Lewiston, ID for the 2018 season. All have offshore excursion options to visit attractions in the immediate Lewiston area, including downtown Lewiston. The Lewis-Clark Wine Alliance, the Idaho Department of Tourism, Idaho Wine Commission, and Visit Lewis Clark Valley have been promoting the LCV AVA wines and have proposed serving wines on the boats prior to landing in the Lewis-Clark Valley and/or offering wine makers dinners when in port. A wine tour operator has submitted a proposal to provide wine tours to four LCV AVA wineries -that tour option could be offered as early as the 2018 season. Alaska Airlines offers a "Wines Fly Free" program from both the Lewiston and Boise airports; LCV AVA wineries, Lewis Clark Wine Alliance and Visit Lewis Clark Valley have been promoting this program and believe that cruise boat passengers will take advantage of this opportunity of flying into the LCV AVA area.

CEDA has been working with an entrepreneur who recently purchased a building in downtown Lewiston and plans to open a wine bar/tasting room in the fall of 2018. This retail and tasting room will not only attract locals and tourists, the Wine Bar is anticipated to introduce LCV AVA wines to the cruise boat passengers visiting downtown Lewiston.

LCV Wine Alliance has provided technical assistance to a land owner outside of the AVA boundaries. The land owner has recently completed soil testing and based upon results anticipates planting 1- 5 acres in the Kamiah, ID area. The land owner will use this vineyard as a test plot and if viable will propose extension of the current AVA boundaries by 2021. The extension of the LCV AVA boundaries will increase the available acreage for vineyard development.

Five of the six estate wineries within the LCV AVA indicate they will be increasing vineyard acreage in 2018/2019 to meet demand for estate wines.

Beneficiaries

The primary beneficiaries of this project are the current LCV AVA winery owners. Increased awareness has increased demand of LCV AVA bottled wines, increased winery memberships, and tasting room visits which lead to on-site sales. Vineyard owners have benefited through increased demand for LCV AVA grapes.

Industry support partners such as CHS Primeland, an agriculture retail cooperative, have benefited through this program. Marketing of LCV AVA wines and vineyards has led Primeland to work with LCV AVA industry stakeholders and now offer items such as vines, stakes, herbicides/pesticides, etc., as well as offer retail sales of LCV AVA wines in their Lewiston store.

The tourism industry has benefited from this project through the increased awareness of the Lewis-Clark AVA and its wines. Hotels have reported increased lodging by wine visitors, there are now wine tours offered in the LCA AVA, and area restaurants have reported increased demand for local wines - which many are now offering (the Gallery in

Grangeville, ID now carries LCA AVA wines due to demand!). One Hells Canyon jet boat operator is now offering a "Lewis-Clark Valley AVA Wine Tour" where guests will enjoy local wines paired with locally produced foods.

Lessons Learned

This project has met its primary goal to increase the awareness of the LCV-AVA and the wines produced within its boundaries. Consumers, wineries, and potential vineyard developers have been impacted by the marketing campaign and report increased awareness due to print and web ad placement. A data driven marketing campaign has resulted in a growing social media following, targeted outreach, and brand awareness. We have been pleased with the wineries reporting increased visitors from the Spokane, WA area after the LCV AVA has ran an ad campaign or participated in an event in Spokane.

Critical to the success of this project is the partnerships and collaboration with Visit Lewis Clark Valley, Idaho Tourism, and the Idaho Wine Commission. All partners provided cooperative marketing and public relation funds that allowed the LCV Wine Alliance to leverage and extended the reach of the Idaho State Department of Agriculture Specialty Crop Block Grant funds. Through the collaborative efforts of these partners we received international media attention, had a full page ad in the Alaska Air In-Flight Magazine, and were present at two high profile regional/state events.

The goal of increased vineyard development has been harder to achieve. Initial growth has been through developed vineyard owners increasing acreage or opening wineries (two vineyard owners are now bonded winery owners and will be producing estate wines in 2018). Although we have fielded many inquiries - most are from land owners that want to lease land for vineyard development but do not want to manage a vineyard themselves. We know that a priority next step will be to work with the area realtors' associations to identify available properties within the LCV AVA boundaries currently on the market so we have a better understanding of development potential.

Vineyard development is an expensive, and timely, capital venture and the LCV Wine Alliance needs a better toolbox to be able to assist those wanting to enter into the industry. The LCV Wine Alliance needs to develop a stronger value chain and foster relationships with transactional partners such as the University of Idaho, Washington State University, university extension officers, realtors, and financial lenders.

And finally, industry cluster development requires the involvement of a variety of stakeholders and supporters. Without the assistance provided by USDA, the Lewis-Clark Valley AVA and Wine Alliance would not have been able to develop a marketing campaign to increase awareness of Idaho's newest American Viticultural Area or respond to potential developers. Economic development organizations are essential as industry development requires value-chain growth, gap analysis, and strategic planning. Tourism partners help leverage resources and market the industry on their behalf. Without the efforts of these partners, and many more, industry growth would be slower and disjointed. We believe we are stronger through collaboration and are looking forward to growth!

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Creating Awareness of Idaho Apples through In-Store Promotions, Website Development, and Social Media

Subrecipient

Idaho Apple Commission (IAC)

Project Summary

The proposal “Creating Awareness of Idaho Apples through In-store Promotion, Web Site Development, and Social Media” outlines a project that was conducted by the Idaho Apple Commission. The two-year project included the development, creation, and distribution of a 5-6 minute video showcasing the apple growing, maturity, and the harvest and packing season of Idaho apples, and still photography was acquired for each stage. The video and photography has been used on the Commission’s web site and Social Media channels.

The Commission held in-store sampling demos in Idaho Supermarkets to continue to build awareness, and this was an excellent way to introduce Idaho apples to the local consumer. The in-store demos helped reinforce the message to retailers about the great tasting products Idaho has to offer. The Commission hoped to show the video in the produce departments during the sampling sessions, where that service was available. To further utilize the still photography the Commission developed a tri-fold brochure containing nutritional information and recipes that were handed out with the apple samples.

Project Approach

The Idaho Apple Commission (IAC) started at the beginning of the grant period with the production of the Apple Informational Video. The IAC ran radio ads during the month of September 2017, and offered fall in-store tasting demos during the month of October at local Albertson’s and Walmart Stores in 2016 and 2017. The IAC also had promotional materials printed for use during this grant and in IAC on-going promotions. There were not any project partners with this grant. This project was conducted to benefit the Idaho Apple Industry and to bring awareness of the Idaho Apples. The projects conducted with this grant did bring awareness to Idaho Apples.

This grant was written to bring awareness of Idaho Apples through a new video, social media and in-store sampling, and it was successful. Some of the accomplishments included a finalized video that has been utilized many times, and is posted as a YouTube video. Copies of the video were provided to the industry for use in at their companies, and the Social Media was increased as mentioned in the final report. The in-store sampling was very successful in bringing awareness to Idaho Apples and showed that when people are given an option they prefer to buy local. This fact helps the local economy as well and the Idaho Apple Industry. This project was successful and did benefit the Idaho Apple Industry.

Goals and Outcomes Achieved

The first project that was started for the 2015 Grant was the promotional video. The Commission received the voice-over for the video from Dale Dixon Media, and the video filming was conducted by Blake Brenan Photography. Both of these activities worked well toward the goals and the completion of the project. The filming was conducted to give a great overview of the area and how apples in Idaho are grown, harvested, and packed. The video was placed on

different avenues of Social Media. Between YouTube and Facebook there have been about 100 views of the video. The video gets shared periodically to help build awareness of Idaho Apples.

The IAC also purchased flash drives and put the video and promotional information on the videos to distribute to potential buyers. These will be used for future promotions for Idaho Apples. The IAC was not able to use the videos in the stores during the promotions as we had hoped. Social Media was another goal of the IAC and In March of 2016 we had a baseline of 100 page likes on our Facebook page and at the time of this report (November 2018) we have 108 page likes. The activity report on the Facebook page shows there is more likes of posts and more activity during the months of our in-store demos and promotions. On the web-site for the same time period of March 2016 to November 2018, the Commission has increased page views from 1,687 in March 2016 to today a total view of 7,345.

During the grant period, the IAC was able to have in-store demos conducted at Walmart and Albertson stores. The demos gave consumers an opportunity to taste Idaho Apples and to help build identity for the apples in retail stores. The IAC Executive Director was able to be at some of the demos and experience first-hand, how giving the consumer an option to taste the product does encourage them to buy what they have sampled. In 2017 IAC partnered with Idaho Preferred to hold demos in Albertson. During the course of the grant the IAC was able to offer 36 in-store demos; twenty of the demos were held in local Walmart stores and 16 were offered in local Albertson stores.

The one store where the Commission thought they would pay the personnel directly for the demos was bought out by Albertsons before the demos actually took place. The money for those proposed demos helped pay for the demos at the Albertsons and Walmart stores.

The IAC was able to have the information brochure completed as well as other information sheets that were used during the in-store demos, and in other promotional avenues where the IAC participated.

Beneficiaries

The main beneficiary of this project is the Idaho apple industry. There are approximately 55 apple growers and their families and about 3 apple shippers. Over the years the apple industry in Idaho has gotten smaller creating a smaller budget for the IAC to work and to maintain promotions for the industry. This grant money was able to bring more recognition to the Idaho Apple industry. The growers and shippers are appreciative of the videos, promotions and added exposure through the Specialty Crop Grant.

Lessons Learned

One lesson that was learned in regard to the in-store demos was in the timing of the demos. There are a lot of demos conducted during the month of September. When the IAC wanted to run their demos in October, retailers were not excited to run demos again in October. The situation was corrected by the IAC joining in the with the September demos the following year. The video was a very successful project and was used by the shippers in their business.

Another lesson the IAC learned was in regard to showing the video during the demos. The produce departments where the demos were held did not offer that service. However, the video was shown at other venues where the IAC exhibited.

Water and Soil Conservation and Effective Weed Management for Sustainable Dry Bean Production

Subrecipient

Idaho Bean Commission (IBC)

Project Summary

In cooperation with the Idaho Bean Commission, plant and soil scientists and water management engineers at the University of Idaho conducted two field experiments to develop sustainable water and soil conservation and weed management strategies for dry bean and garden bean production. The garden bean study focused on the effects of water management using subsurface drip irrigation versus furrow irrigation in two tillage systems: conventional and strip tillage (irrigation x tillage study). Crop growth and yield response to these water and soil management practices was measured. The dry bean study focused on the effects of three tillage systems - conventional tillage, strip tillage, and direct seeding - and nine weed control treatments on crop growth and development (tillage x weed control study). These experiments were conducted at two locations in southwestern and south central Idaho and repeated over two years.

Project Approach

This project was developed to directly address the most current issues bean growers are dealing with. In January 2015, Bean Schools held in Twin Falls and Nampa, ID, attracted 226 attendees. Grower surveys conducted at the Bean Schools indicated a strong interest of Idaho bean growers in reduced tillage practices for soil and water conservation. The objective of this project was to develop improved water and weed management strategies for dry bean and garden bean production through two uniquely different field experiments.

Field study descriptions

Both experiments were conducted at two locations each year. In 2016 growing season studies were located in SW Idaho, in a cooperating grower's (Eric Jemmett) field near the University of Idaho Parma Research and Extension Center, and the other in SC Idaho - at the University of Idaho Kimberly Research and Extension Center. Unfortunately, in 2016 precipitation in October shortly after the garden beans were cut in preparation for harvest delayed thrashing the beans in the plots. The cut bean plants in each plot were placed in burlap bags, brought into the greenhouse and dried. Once they were dry, the beans were thrashed by dumping the plants from each bag into the plot harvester. Unfortunately, the technician who was overseeing this operation did not realize that the beans were not getting moved into the bin where they are weighed and recorded. Consequently, the plot weights were very inconsistent, ranging from less than 1 pound to just over 17 pounds. Typical weights from the harvested plots should have ranged from 3 to 5 pounds. In 2017, the SW Idaho study was moved to University of Idaho Parma Research and Extension Center. The experiment at all locations in both years were set up in a split block randomized complete block design. Each treatment was replicated 4 times. In both experiments, beans were harvested at maturity with a small-plot harvester to determine bean yield and quality response. Two graduate students were trained in sustainable dry bean production and utilization of subsurface drip irrigation, reduced tillage, and weed control methods.

Irrigation x tillage study - comprised of 8 irrigation x tillage treatment combinations, including surface and subsurface drip irrigation applied at three levels (100%, 75%, and 50% ET) in a conventional vs a strip tillage system. Crop ET was calculated using crop coefficient approach (Allen et al., 1998). The crop water loss was determined using reference ET obtained from the AgriMet weather stations located within 0.5 km of site. Crop-specific coefficients for beans were used and adjusted based on crop growth stage. The following agronomic, cultural and environmental parameters will be assessed: biomass (plant height, biomass weight, plant health and vigor (NDVI), chlorophyll content (SPAD), environmental (estimated evapotranspiration and amount of irrigation water actually applied, and soil moisture levels), and bean yield and quality (pod length).

Tillage x weed control study – Dry bean production and soil-active herbicide efficacy were compared in three tillage systems (conventional, strip till, no-till), which were the main plots. The weed control treatments, which included the herbicides Basagran, Eptam, Outlook, Sonalan, and Varisto were the sub-plots. A total of 27 tillage x herbicide treatment combinations were established under sprinkler irrigation. Weed seedling emergence was monitored within fixed 0.25 m² areas in each treatment. Weed counts were taken when dry bean attained >50% emergence, prior to the postemergence herbicide applications, and at two-week intervals for four weeks after the last herbicide application. Weed control was evaluated using a visual scale of 0–100%, where 0 = no weed control and 100 = complete weed control.

The support of the Idaho Bean Commission and the Idaho bean growers - without their support and interest, these field studies would not have been done or completed.

Goals and Measurable Outcomes Achieved

Our short-term goals and targets were:

- 1) *To evaluate the efficacy of subsurface drip irrigation and reduced tillage on garden bean yield, quality and water use and to demonstrate reduction in irrigation water use with utilization of subsurface drip irrigation while maintaining or improving dry bean yield and quality*

In general, higher yields were observed under conventional tillage with surface furrow irrigation. The highest yield was obtained with furrow irrigation at 75% ET under conventional tillage. All other treatments resulted in comparable yields, independent of tillage (conventional, strip) and irrigation delivery method (drip, sprinkle). Early in the season, NDVI (estimate of plant biomass production and greenness) was notably higher for strip-till plots. Later in the season this trend was reversed, higher NDVI for conventionally tilled plots, especially those irrigated with surface furrow system, were reflected in higher harvested yields. There was no consistent trend for bean plant height across the site-years. For above ground biomass weight, conventionally tilled plots (both furrow and sub-surface drip irrigated) had shown this pattern: 50% ET < 75% ET > 100% ET. However, for all strip-till plots (both sprinkle and sub-surface drip irrigated), the pattern looked different: 50% ET > 75% ET > 100% ET. For all tillage x water combinations, the greatest pod length was noted for plots irrigated at the 75% ET level. At Parma in 2016, data showed significantly higher garden bean yield under strip-till with 75% ET irrigation level. This may be a strong indicator that the water use efficiency and its' effect on garden bean growth may be highly influenced by environmental conditions during the crop growth. For example, mean air temperatures for both Kimberly and Parma were much higher in 2016 compared to 2017, which may have affected water use efficiency, especially for the furrow-irrigated plots, and provided yield advantage to plots irrigated with sub-surface drip irrigation (due to lower water loss associated with evaporation), and plots under strip-tillage (due to higher

moisture conservation ability, and cooler soil and crop canopy temperatures). Repeating the irrigation x tillage study for two more growing seasons at two locations would allow for more sound conclusions.

2) *To develop effective weed management strategies for dry beans grown in reduced tillage under sprinkler irrigation and to demonstrate that weed control costs could be reduced by 20% or more by utilizing newly developed effective weed management practices*

Summary of preliminary results (Parma and Kimberly)

There were no differences in weed densities or weed control among the three tillage systems. Weed control, densities and biomass were influenced by the level of chemical weed control, i.e. treatments receiving postemergence (POST) sequential herbicide application following pre-emergence herbicide applications controlled weeds better than those that did not receive a sequential POST herbicide application. Dry bean stand was slightly lower in the no-tillage treatments compared to the conventional and strip tillage treatments. The tillage treatments did not greatly influence the weed densities, weed control or weed biomass. Dry bean yields were equal among the tillage treatments where the weed control was acceptable. No-tillage dry bean production can equal conventional and strip tillage dry bean production with reduced tillage inputs. However, the challenge remains for harvesting. Direct seed dry bean cannot be undercut and swathed like conventional tillage dry bean. Choosing dry bean cultivars that produce pods that remain 3 or more inches above the soil surface is necessary for direct seed dry bean to facilitate either direct harvesting or cutting above-ground level and swathing.

3) *To train 2 graduate students for 2 years (providing educational and employment opportunities)* - Kathrin LeQuia and Samara Arthur have been trained. Kathrin graduated with a M.S. in Plant Science in Fall 2018. Samara did not complete her M.S. degree and decided to pursue other career opportunities.

The results of these studies were presented at several conferences and grower meetings:

- Walsh O.S., D. Morishita, A. Woolf-Weibye, J. R. McClintick-Chess, and S.M. Blanscet. Irrigation Water Amount and Delivery Method Effect on Garden Bean Production under Conventional and Strip Tillage Systems. 2017. Proc. of the ASA International Annual meetings.
- Walsh O.S., D. Morishita, A. Woolf-Weibye, J. R. McClintick-Chess, and S.M. Blanscet. Irrigation Water Amount and Delivery Method Effect on Garden Bean Production under Conventional and Strip Tillage Systems. 2017. Proc. of the Agrophysics Trends Conference.
- Walsh O.S., D. Morishita, A. Woolf-Weibye, J. R. McClintick-Chess, and S.M. Blanscet. 2017. Irrigation Water Amount and Delivery Method Effect on Garden Bean Production under Conventional and Strip Tillage Systems. Proc. of the Western Crop Science Society Conference.
- Walsh, O.S., Morishita D., Wenninger, E., Woodhall, J., and S. Shafian. Quick Facts – Idaho Beans – University of Idaho Extension publication, 2 pages (under review).
- Comparing dry bean productivity, weed incidence and management in three tillage systems. UI Bean School. Twin Falls and Nampa, ID. January 25-26, 2017
- Irrigation Water Amount and Delivery Method Effect on Garden Bean Production under Conventional and Strip Tillage Systems. Walsh O.S., D. Morishita, A. Woolf-Weibye, J. R. McClintick-Chess, and S.M. Blanscet. Western Crop Science Society Conference. Parma, ID, June 6-7, 2017
- Effect of tillage and herbicides on weed control and dry bean production. UI Kimberly R&E Center Pest Management Research Field Day, June 20, 2017
- Garden Bean Irrigation under Various Tillage. UI Parma R&R Field Day, June 21, 2017

Publications:

- A new UI Extension publication – “A Quick Guide – Beans” has been accepted for publication and is planned to be released in spring of 2019.
- A research publication “Effect of tillage system on weed control and dry bean production” is planned to be submitted to Weed Technology in winter 2018.

To measure the project performance we proposed to:

- 1) *Measure and compare the amount of irrigation water applied under subsurface drip and surface furrow irrigation* – For subsurface drip irrigation, 13 h 35 min was sufficient to provide 100% ET irrigation amount; the prorated times for 75% and 50% were 10 h 12 min, and 6 h 48 min, respectively. The differences between 100% ET and 50% ET ranged from 3 to 5 in per growing season, depending on the site-year for the subsurface drip irrigation. For sprinkler irrigation, 1 h 35 min was sufficient to provide 100% ET irrigation amount; the prorated times for 75% and 50% were 1 h 12 min, and 48 min, respectively. For surface furrow irrigation, 30 min was sufficient to provide 100% ET irrigation amount; the prorated times for 75% and 50% were 25 min, and 15 min, respectively. To put the water use into perspective, the amount of water delivered by these three irrigation systems for the 100% ET treatment was 665 gallons for drip, 945 gallons for sprinkler, and 720 gallons for furrow irrigation, for each irrigation event. Our preliminary results show that utilizing subsurface drip irrigation may deliver substantial water savings; our bean yield data showed that bean production was optimized under furrow irrigation at both locations in 2017 and with subsurface drip – at Parma in 2016.
- 3) *Measure weed control efficacy in conventional and reduced tillage systems* - One of the concerns at the beginning of this study was how much previous crop residue (wheat stubble) would influence the activity of the soil-active herbicides. There were no differences in weed densities or weed control among the three tillage systems. (The tillage treatments did not greatly influence the weed densities, weed control or weed biomass.
- 4) *Access the change in dry bean grower awareness, perception and adoption of subsurface drip irrigation* - Subsurface drip irrigation use tends to vary greatly in Idaho depending on the crop. For example, 90% of onion production in Idaho is under drip irrigation. The majority of beans are still furrow irrigated in Idaho, with several growers using sprinkler system. Annual cropping schools hosted in Caldwell each February included a detailed demonstration of subsurface drip irrigation system suitable for most crops grown in Treasure Valley. Several presentations on bean production and irrigation systems were well attended. Our grower survey has shown that 95% of attendees reported receiving new valuable information they can readily use in their farming operations; 65% of growers said they plan to share the information with family and fellow growers. The most positive comments were associated with subsurface drip irrigation. Most grower questions focused on water savings and yield response to various irrigation types.
- 5) *Survey of reduced tillage and subsurface drip irrigation equipment dealers to measure increase in equipment sales and grower adoption* – our surveys and literature research showed that Idaho is 5th in the US in irrigated acres and 2nd in irrigated water use. Currently, sprinkler irrigation is the most widely used in Idaho. About 88% of acres is irrigated with sprinkler irrigation, 12.5% - with surface flowing, and <1% - with subsurface drip irrigation systems. We contacted several equipment dealers in the Treasure Valley and, unfortunately, they were unable to provide us with any definite estimates of sales which would indicate increase in reduced tillage adoption among Idaho growers. However, they stated that the interest in conservation agriculture, including reduced tillage, is generally high in Idaho. The interest among farmers has been also evident by the large number of Idaho Direct Seed Workshops conducted each spring.
- 6) *Blog visits and Twitter comments will be recorded.* – Although we received only one comment on our posts related to these studies (which was positive), the Idaho Crops & Soils Blog has had over 4,590 visitors since the project was funded. Regular updates on this project’s activities were published in the Idaho Crops & Soils Newsletter. The

newsletter has been very well received by the Idaho crop producers, agricultural industry representatives, the commodity groups, as well as students and researchers. The newsletter was produced monthly in 2015 and 2016 and is published on a quarterly basis starting 2017. The newsletter is distributed via listservs, direct mail to over 5,000 individuals, and is posted on the Idaho Crops & Soils Blog.

Problems and Delays

- At Kimberly, some persistent weeds were present in most of the plots, which may have affected bean yield.
- At Kimberly, both dry bean and garden bean yield was compromised by excessive harvest errors due to problems related to the plot harvester and inexperience of the technician. The data for 2016 growing season has been lost for irrigation x tillage study.
- Significant spider mite infestation was noted at Parma, pest control measures were taken to alleviate the problem.
- At Parma, beans under sprinkle irrigation were less affected by the spider mites, these plots dried out much slower and were not fully ready to be harvested when the rest of the plots were completely dry and easily threshed. The decision was made to collect the bean yield manually from each of the sprinkle irrigated plot at Parma. The pods were collected, dried, threshed and bean seed yield was recorded for 1 sq ft area and extrapolated to by acre yield.
- Detailed notes on what plots were affected were taken, so that the yield data can be adjusted accordingly.

Lessons Learned

Idaho dry bean growers, estimated around 500 along with the local bean warehouses, will benefit from this research project. We have made several strides to be able to advise growers with better water and weed management information. We found that the tillage treatments did not greatly influence the weed densities, weed control or weed biomass. Also, dry bean yields were equal among the tillage treatments. We were able to confirm several issues associated with direct seeding dry beans, especially in terms of harvesting. One of the key findings of this study – results indicate that the water use efficiency and its' effect on garden bean growth may be highly influenced by environmental conditions during the crop growth. Repeating the irrigation x tillage study for two more growing season at two locations would allow for more sound conclusions.

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Novel Genetic Systems to Develop Bean Varieties Resistant to Viruses for Export to Mexico

Subrecipient

Idaho Bean Commission (IBC)

Project Summary

Bean common mosaic virus (BCMV) and *Bean common mosaic necrosis virus* (BCMNV) are two bean viruses causing serious and often devastating losses in common beans (*Phaseolus vulgaris* L.). Both are transmitted by aphids and also through seed with high efficiency (up to 80%), and because of this present a global threat everywhere common beans are grown. Two approaches are used to control BCMV and BCMNV: 1) seed certification maintaining virus infection level at minimum, and 2) breeding for virus resistance, with incorporation of known resistance genes into main classes of beans. There are currently seven known pathotypes of BCMV and BCMNV, distinguished due to interaction with multiple resistance genes. Hence, breeding of resistant varieties of beans requires tedious, multiple challenges with different strains of these viruses. Here, we propose to greatly simplify this process through the development of genetically engineered infectious clones of both BCMV and BCMNV which can be maintained as uniform cDNA sequences in an ordinary plasmid vector. These genetically engineered clones can be made available to any bean breeding program facilitating selection of virus-resistant lines and streamlining the search for sources of resistance in common beans.

Project Approach

The following activities were conducted:

1. Create full-length infectious clones of BCMV (pathotype VII) and BCMNV (pathotype VI) with defined uniform sequences as standards for common bean breeding and selection.

During 2016, several attempts to synthesize a full-length BCMNV (isolate TN1) cDNA clone were unsuccessful producing non-infectious clones with deletions preceding the CI cistron, that created frameshifts preventing the expression of the virus polyprotein. The assumption was made that the obstacle for the BCMNV clone construction is the toxicity of the corresponding CI protein product to the *E. coli* cells used for intermediate clone maintenance.

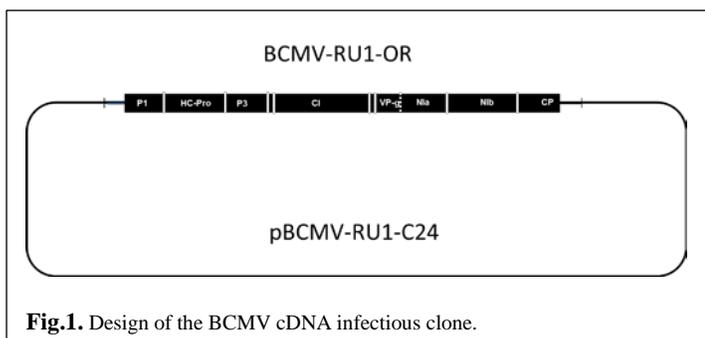


Fig.1. Design of the BCMV cDNA infectious clone.

Obviously, the addition of the ST-LS1 intron to the BCMV genome sequence did not prevent the toxicity of the CI product. In contrast, a viable full-length BCMV (isolate RU1-OR) clone was designed and built using the overlapping RT-PCR fragments synthesized with the high-fidelity Taq-polymerase supplied by the New England Biolabs, Inc. This full-length BCMV genome cDNA copy was moved to the pCambia 1300 binary vector, to create the pBCMVRU1-C24 construct (Fig. 1). This pBCMVRU1-C24 construct was transformed into the *Agrobacterium tumefaciens* using electroporation, and individual colonies

of the bacterium able to grow on the selective medium with kanamycin and rifampicin were tested for the presence of the full-length BCMV sequence using PCR.

2. Develop manipulatable genetic systems using BCMV clones, utilizing an agro-based delivery of virus genomes to the bean plant

In 2017 and in 2018, *Nicotiana benthamiana* and common bean plants were agro-inoculated with pBCMV-RU1-C24 binary construct and analyzed for the development of systemic infection, using BCMV-specific ELISA and RT-PCR tests. Agro-inoculation directly into bean plants was found inconsistent and inefficient, resulting in only 20-30% of the plants infected with the pBCMV-RU1-24 virus, while the efficiency of agro-inoculation in *N. benthamiana* was consistently close to 90%. In *N. benthamiana*, systemic BCMV infection in upper, non-agro-inoculated leaves could be detected by ELISA and RT-PCR 4-6 weeks post-inoculation (wpi). No visual symptoms were observed during the BCMV infection, consistently with the original, wild-type BCMV (isolate RU1-OR) infection. The pBCMV-RU1-C24 infected *N. benthamiana* plants were used to mechanically inoculate the entire differential panel of common bean cultivars, to confirm infectivity of the clone for beans and to verify the pathotype of the cloned virus. In cultivar Dubbele Witte, the pBCMV-RU1-C24 virus induced mosaic, yellowing, and leaf deformations typical of the wild-type BCMV-RU1-OR virus (Fig. 2).



Fig 2. Symptoms in the common bean plant infected with the pBCMV-RU1-C24 virus, 4 weeks post-inoculation; left - healthy plant, right – pBCMV-RU1-C24 virus.

With the differential panel of 11 common bean cultivars, the pathotype VII of the pBCMV-RU1-C24 was verified and confirmed. The symptomatology and disease development during pBCMV-RU1-C24 infection was similar to the original isolate RU1-OR. We assumed that we succeeded in creating a manipulatable genetic system based on the full-length clone of the BCMV-RU1-OR (pathogroup VII).

3. Validate application of these standard clones for consistent, quick selection of virus-resistant lines, primarily for Idaho

In the process of validation of the pBCMV-RU1 infectivity, two spontaneous mutants were characterized, selected from the *N. benthamiana* plants infected with BCMV-RU1-OR, and exhibiting altered pathogenicity profiles, i.e. with reduced pathogenicity. Specifically, one mutant, called C4 had pathotype II, and another, called C5 had pathotype IV. Whole genomes for all mutants and the wild-type viruses were sequenced and determined to have only 2 (C4) and 1 (C5) substitutions in the virus polyprotein, clustering in the P3 (C4) and VPg (C4, C5) cistrons. Corresponding mutations were introduced into the full-length pBCMV-RU1-C24 clone to test and confirm the changes in the BCMV pathogenicity. This is the first direct experiment addressing the mechanisms of resistance conferred by the two recessive genes, *bc-1* and *bc-2*, both of which affect the long-distance spread of BCMV in the plant.

Goals and Outcomes Achieved

- A full-length, cDNA clone was designed and built for the pathotype VII BCMV-RU1-OR
- This cDNA construct was cloned into a binary vector suitable for agro-inoculation, and a manipulatable genetic system was produced to study BCMV in common bean
- This genetic system was applied to the study of two resistance genes, *bc-1* and *bc-2* available in common bean
- Preliminary assignment was made of the virus genetic determinants involved in overcoming the resistance conferred by *bc-1* and *bc-2* genes, these are likely to be P3 and VPg cistrons
- The pBCMV-RU1-C24 clone was validated as a great tool to develop resistant cultivars of common beans suitable for export markets

Lessons Learned

- Resistance to BCMV in common bean can be overcome by a single mutation in the virus genome
- Both *bc-1* and *bc-2* genes can interact with the VPg cistron of the virus
- BCMNV clone still remains an elusive goal due to the toxicity of the CI protein

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Additional Information

Peer-reviewed scientific publications:

(* graduate student)

Feng, X., *Orellana, G.E., Myers, J.R., and Karasev, A.V. (2018) Recessive resistance to *Bean common mosaic virus* conferred by the *bc-1* and *bc-2* genes in common bean (*Phaseolus vulgaris* L.) affects long distance movement of the virus. *Phytopathology* **108**: 1011-1018 (<http://dx.doi.org/10.1094/PHTO-01-18-0021-R>).

Feng, X., Guzman, P., Myers, J.R., and Karasev, A.V. (2017) Resistance to *Bean common mosaic necrosis virus* conferred by the *bc-1* gene affects systemic spread of the virus in common bean. *Phytopathology* **107**: 893-900 (<http://dx.doi.org/10.1094/PHTO-01-17-0013-R>). – Fig. 4 of this paper was featured on the cover of the July 2017 issue of *Phytopathology*.

Feng, X., Myers, J.R., and Karasev, A.V. (2016) Molecular characterization of *Bean common mosaic virus* overcoming the *bc-3* allele in common bean. Annual Report of the Bean Improvement Cooperative, Vol. 59; pp. 21-22.

Feng, X., Myers, J.R., and Karasev, A.V. (2016) Biological and molecular characterization of *Bean common mosaic virus* isolates from pathogenicity groups I and V. Annual Report of the Bean Improvement Cooperative, Vol. 59; pp. 99-100.

Abstracts of scientific presentations:

Chikh-Ali, M., Feng, X., and Karasev, A.V. (2017) Development and characterization of an infectious clone of *Bean common mosaic virus*. Abstracts of the 2017 Bi-annual Meeting of the Bean Improvement Cooperative, East Lansing, MI, October 29 – November 1, 2017; p. 14.

Karasev, A.V., Feng, X., and Myers, J.R. (2017) Resistance to *Bean common mosaic necrosis virus* conferred by the *bc-1* gene affects systemic spread of the virus. Abstracts of the Bi-annual Meeting of the Bean Improvement Cooperative, East Lansing, MI, October 29 – November 1, 2017; p. 48.

Creating Awareness of Idaho Cherries through In-Store Promotions, Website Development, and Social Media

Subrecipient

Idaho Cherry Commission (ICC)

Project Summary

The proposal “Creating Awareness of Idaho Cherries through In-store Promotion, Web Site Development, and Social Media” outlines a project that was conducted by the Idaho Cherry Commission. The two-year project included the development, creation, and distribution of a 5-6 minute video showcasing cherry growth, maturity, harvest and packing of Idaho Cherries. Still photography was acquired for each stage. The video and photography has been used on the Commission’s web site and Social Media channels.

The Commission held in-store sampling demos in Idaho Supermarkets to continue to build awareness, and this was an excellent way to introduce Idaho cherries to the local consumer. The in-store demos helped reinforce the message to retailers about the great tasting products Idaho has to offer. The Commission hoped to show the video in the produce departments during the sampling sessions where that service was available.

Project Approach

The Idaho Cherry Commission (ICC) started at the beginning of the grant period with the production of the Cherry Informational Video. The video was also translated into Mandarin to attract potential international buyers. The ICC also worked to set up in-store tasting demos at local Albertson and Walmart stores. There were not any project partners with this grant. This project was conducted to benefit the Idaho Cherry Industry and to bring awareness of the Idaho Cherries. The projects conducted with this grant did bring awareness.

This grant was written to bring awareness of Idaho Cherries through a new video, social media and in-store sampling, and it was successful. Some of the accomplishments included a finalized video that has been utilized many times, and is posted as a YouTube video. The video was also translated into Mandarin to be used in Taiwan an important country for Idaho cherries. Copies of the video were provided to the industry for use in at their companies, and the Social Media was increased as mentioned in the final report. The in-store sampling was very successful in bringing awareness to Idaho Cherries and showed that when people are given an option they prefer to buy local. This fact helps the local economy as well and the Idaho Cherry Industry.

Goals and Outcomes Achieved

The first project that was started for the 2015 Grant was the promotional video. The Commission received the voice-over for the video from Dale Dixon Media, and the video filming was conducted by Blake Brenan Photography. Both of these activities worked well toward the goals and the completion of the project. The filming was conducted to give a great overview of the area and how cherries in Idaho are grown, harvested, and packed. The video was translated into Mandarin. The English and Mandarin versions were both placed on YouTube. There were about 100 likes for the two versions of the video on YouTube. In March of 2016 we had a baseline of 39 page likes on our Facebook page and at the time of this report, November 2018, we have 53 page likes. On the web-site for the same time period of March 2016 to

November 2018, the Commission has increased page views from a baseline of zero (0) in March 2016 to today a total number of 1,100 page views.

The ICC also purchased flash drives and put the video and promotional information on the videos to distribute to potential buyers both domestically and internationally. At the end of the grant period the ICC has about 20 of the 50 zip drives that were purchased. Some of the drives were given to the area shippers so they could distribute them as they saw fit. These will be used for future promotions for Idaho Cherries. The ICC was not able to use the videos in the stores during the promotions as we had hoped as they did not have the technology set up and available.

During the grant period, the ICC was able to hold in-store demos at Walmart and Albertsons grocery stores. The demos gave consumers an opportunity to taste Idaho cherries and to help build identity for the cherries in retail stores. The ICC Executive Director was able to be at some of the demos and experience first-hand, how giving the consumer an option to taste the product does encourage them to buy what they have sampled. Due to the timing of the cherry crop in Idaho, the ICC was able to have in-store demos at various Albertsons and Walmart stores in July of 2016, 2017, and 2018. In all the ICC offered 68 demos.

The one store where the Commission thought they would pay the personnel directly for the demos was bought out by Albertsons before the demos actually took place. The money for those proposed demos helped pay for the demos at the Albertsons and Walmart stores.

The ICC had table tents and cherry posters created for on-going use in the ICC promotions for cherries.

Beneficiaries

The main beneficiary of this project is the Idaho cherry industry. There are approximately 39 cherry growers and their families in Idaho and 3 cherry shippers. Over the years the cherry industry in Idaho has gotten smaller, creating a smaller budget for the ICC to work with and to maintain promotions for the industry. This grant money was able to bring more recognition to the Idaho Cherry industry. The growers and shippers are appreciative of the videos, promotions and added exposure through the Specialty Crop Block Grant.

Lessons Learned

One lesson that was learned was in regards to showing the video during the demos. The produce departments where the demos were held did not offer that service. However, the video was shown at other venues, such as trade shows, where the ICC exhibited.

Another lesson that was learned was to work with the retailers in regards to in-store demos as early as possible to get the demos on the schedule. Some of the supermarket demo companies can be challenging to work with.

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Utilizing Educational Tools to Market and Propel the Idaho Wine Industry Forward

Subrecipient

Idaho Grape Growers and Wine Producers Commission

Project Summary

With more than 50 wineries within the state of Idaho, up from 11 in 2002, the Idaho Grape Growers and Wine Producers Commission (IWC), works to promote and educate on behalf of all of the Idaho wineries and wine grape growers. Through the work of the IWC, not only did the economic impact of the industry increase from \$73 million in 2008 to \$169 million in 2013, but the quality of production also improved through education and experience. Education, marketing and events are all important objectives for the IWC throughout the year. These umbrella objectives have been applied to industry members directly, consumers, restaurants, buyers and media. By providing educational opportunities and tools for each of these groups, better serves to grow the Idaho wine industry as a whole and continue on a path of quality growth. The efforts completed during the course of this ISDA specialty crop block grant project accomplished many key educational and marketing objectives that built on the foundation that was laid with the assistance of previous ISDA specialty crop block grant funds through advertising, media education tours, and industry specific educational seminars among other elements that will be detailed below.

Project Approach

Each time the Idaho Wine Commission (IWC) approaches a new project with several moving parts, all staff members connect with both the marketing agency (Rizen Creative) and public relations firm (Fahlgren Mortine) to address project specifics, deadlines, budgets and desired outcome from each element. Through the State of Idaho Division of Purchasing, Rizen Creative and Fahlgren Mortine have been contracted for all ,marketing and public relations work produced for the IWC. This follows state guidelines for work to be conducted with a single company that exceeds \$30,000. With top priorities outlined in terms of time of completion, work began in early November 2015.

When initially looking at the projected timeline and what the top priorities would be, educational seminars for the IWC annual meeting in February, a promotional plan for the establishment of the Lewis-Clark Valley American Viticulture Area (AVA) and selecting and placing advertisements to promote the industry rose to the top. Education has been a focus for the IWC and with many industry experts outside of the state; it makes sense for the IWC to host them at one central time during the industry's annual meeting where the majority of the industry are able to benefit from the knowledge shared. There were four experts brought in for the 2016 annual meeting in February from both Oregon and Washington. In large part due to limited expenses for these speakers, much of the grant funding was not spent as planned. This allowed for six additional speakers to be hosted for the 2017 annual meeting and to also focus on vineyard-specific education. Each year the IWC determines the direction of educational focus based on industry needs and feedback. The greatest desire for education came for information and training specific to Idaho's vineyards and therefore Anthony Domingos was contracted to educate the industry on the needs and issues found within the state. Since funding ended up being limited for the two previous meetings, it allowed for extensive focus and time dedicated to the vineyards. For full agendas and speakers of both the 2016 and 2017 Idaho Wine Commission Annual Meetings.

While the IWC was working on the annual meeting and educational seminars, Fahlgren Mortine began working on items such as press releases, talking points and invite-only media tours for selected journalists, following the approval of the Lewis-Clark Valley AVA. It was important to have a unified message available to all outlets when the AVA launched in order to make sure that information was consistent and correct across all boards. The Northern Idaho Media tour took

place June 23rd – 26th taking six journalists and media influencers through the newly established Lewis-Clark Valley American Viticultural Area and traveling north through Moscow, Coeur d’Alene and Sandpoint in order to experience as many northern Idaho wineries as possible with this captured audience. In addition to featuring wineries, this tour also allowed for integrating many tourism attractions of the state of Idaho to provide a well-rounded understanding of the many charms Idaho has to offer. During this time, Fahlgren Mortine also began work on the Southern Idaho media tour, which hosted eight different journalists to the Treasure Valley, September 20th – 22nd. These individuals were taken through the first AVA in the state of Idaho and where the majority of the state’s wine grapes are grown and wine is produced. Both the Northern and Southern Media Tours were conducted in conjunction with Idaho Preferred and the State of Idaho Division of Tourism to aid it adding as many Idaho-focused features as possible. Fahlgren Mortine handled all outreach, vetting and scheduling of journalists to ensure those who were truly open and excited about a trip to Idaho were attending these tours and would get the best experience possible. Between the two media tours, fourteen national journalists were given an intimate and detailed look into the Idaho wine industry. During the project, the IWC also hosted two other journalists on individual tours. These journalists included Tina Caputo with Zester Daily and Wendy Van Diver with Touring and Tasting. Although the grant proposal had originally asked for travel for five journalists, with assistance from partnering organizations, the IWC was able to host three times as many over the course of the year. Due to these trips, ten stories have been published to contribute credibility and quality of this specialty crop product found in Idaho. For a full list of journalists who participated in tours or were hosted in conjunction with this ISDA specialty crop block grant, please see Appendix B.

Following the Southern Idaho Media Tour in September 2016, the IWC also hosted an Industry Boot Camp that took local representatives from restaurants and hotels around many areas featured in the Southern Idaho Media Tour in order to give them an inside look of the industry. This gave them knowledge of our industry, allowing them to take that back to their establishments to further promote the products they serve. There were 53 individuals who took part across two days of the Boot Camp on September 27th and 28th.

While education for the industry and of journalists and influencers was being addressed, the IWC began working with Rizen Creative to develop the script for an educational video for consumers. This video was completed in April 2016 and posted to the IWC social media pages and website, as well as used for the media tours and trade shows. The video is a snapshot of the industry with many facts being recited as views of Idaho vineyards and Idaho landscapes play through. To date there have been 562 views of the video online. This compares to 14,299 views of the original promotional video that was completed with ISDA specialty crop block grant funds in January 2014 and 1,160 views of the second promotional video completed in June 2015, also with the assistance of ISDA specialty crop block grant funds. These numbers of views only reflect the views online and not directly through IWC platforms and presentations. The educational video is a more sophisticated approach to the Idaho wine industry, targeting media and journalists with important facts to help further educate the public.

In addition to the many educational components, there were a number of marketing and promotional elements used to make the presence of Idaho wines more prominent not only within the state of Idaho, but also in neighboring states. Advertising began in the fall of 2015 and ran through June 2017 to emphasize such industry highlights such as Thanksgiving Weekend, Idaho Wine Competition results, Idaho Wine Month, industry events and general quality promotion. Advertising outlets utilized were *Wine Press Northwest*, *Great Northwest Wine*, *The Inlander*, *The Spokesman Review*, *Northwest Travel Magazine*, *Salt Lake City Weekly*, *SIP Northwest Magazine* and the IWC social media channels. Some of the highlights that were advertised included 21 gold medals awarded during the Idaho Wine Competition among the 169 entries, Thanksgiving weekend attractions for consumers to experience the Idaho wine industry with enticing specials during their holiday travels, and all of the Idaho wine focused promotions during Idaho Wine Month which is June as declared in 2009 by the Governor. The IWC also supported these grant-funded advertisements with matching fund advertising in the *Idaho Business Review* and *Idaho Statesman*.

Although there were initial plans for participation in the Seattle Wine and Food Experience and Vintage Spokane, upon surveying the industry for sending wine and representation, the IWC found that the wants of the industry had shifted and the focus was to be moved fully toward TasteMakers in Salt Lake City, Utah and a different Washington event, Riesling Rendezvous in Woodinville. In June 2016, the IWC and five Idaho wineries attended TasteMakers, which was hosted by Salt Lake Magazine with an attendance of over 13,000 individuals over the course of two days. With many consumers traveling to Idaho from Salt Lake City, this was the perfect audience for Idaho to market to. Additionally, Riesling Rendezvous took place in July 2016 at Ste. Michelle Wine Estates in Woodinville, WA with 250 Riesling producers from around the world. Idaho has proven to consistently produce beautiful Rieslings over the years and being on the same state as Rieslings from Washington, California, New York, Germany and Australia was quite telling for the industry's quality. In addition to the various events, an IWC staff member traveled to Lodi, California for the three day Wine Blogger's Conference to network with individuals who blog specifically about wine and to learn how to better connect digitally with those individuals. The IWC was able to represent the industry as a whole at each of these events and pour Idaho wine products for the consumers in attendance at TasteMakers and Riesling Rendezvous.

Additional signage elements included 110 street banners to replace old, tattered and outdated banners that were previously purchased with ISDA specialty crop block grant funds which ended up costing less than the original quote due to a promotion with the printing company. The banners were hung throughout the state for the full month of June and will be used in following years during June to continue Idaho Wine Month's promotion. Fifty thousand wine bottle neckers were also printed to be placed on bottles of Idaho wine in retail stores for the month of June and beyond to bring attention to which wines are from Idaho. By doing this, the neckers offered consumers a snapshot of the industry's history and current facts. Lastly while working with Rizen Creative, the IWC made updates to the industry website allowing consumers easier access to Idaho Wine Month information.

With the significant savings on the replacement street banners and other signage project elements, the remaining funds were used in conjunction with IWC matching funds to participate in an advertising campaign with The Idaho Statesman as well as complete an update to AVA maps for each of the three regions in Idaho. This campaign covered a variety of marketing features including print, television, billboards and airport posters.

Below is a selection of articles about the Idaho wine industry.

- The Written Palette- [COILED WINES](#)
- Wine Business Monthly - [FUJISHIN FAMILY CELLARS](#)
- Chicago Tribune - [GIVE NAPA A REST](#)
- Capital Press - [COMMISSION SEEKS TO CHANGE](#)
- Idaho Statesman - [A HARSH WINTER'S IMPACT ON IDAHO](#)
- The Daily Meal - [THE NEWEST WINE DESTINATIONS](#)
- KIVI - [IWC PRESENTS TO HOUSE AGRICULTURAL COMMITTEE](#)
- Idaho Statesman - [BEHIND WILLIAMSON ORCHARDS & VINEYARDS](#)
- KBOI - [WINE LOVERS, BEWARE: HARSH WINTER](#)
- Idaho Statesman - [SNAKE RIVER WINERY TASTING ROOM](#)
- Idaho Statesman - [IDAHO WINE TASTING ROOMS](#)
- Vinedulge - [A TASTE OF IDAHO WINES. YES, IDAHO!](#)
- Great Northwest Wine - [2017 VINTAGE OFF TO COOL START](#)
- Idaho Statesman - [COILED WINES IS OPENING A TASTING ROOM](#)
- Great Northwest Wine - [COILED TO OPEN TASTING ROOM](#)
- Wine Press Northwest - [2017 IDAHO WINERY TO WATCH](#)
- Wine Press Northwest - [2017 IDAHO WINERY OF THE YEAR](#)

- KIVI - [IDAHO WINE BILL PASSES SENATE](#)
- KTVB - [HARSH WINTER WEATHER TAKES TOLL](#)
- Great Northwest Wine - [Clearwater Canyon Cellars comes of age on Idaho century farm](#)
- Great Northwest Wine - [Lindsay Creek Vineyards adds to growth of Lewis-Clark Valley wine](#)
- The Gray Report - [New Lewis-Clark Valley AVA in Idaho and Washington: A voyage of discovery](#)
- Forbes - [Wine Growlers? Absolutely. You'll Never Guess Where They're From.](#)
- Great Northwest Wine - [Northwest wines shine at San Francisco International Wine Competition](#)
- Forbes - [The Newest Real Estate Investment In Wine? Here's A Tip](#)
- Great Northwest Wine - [Idaho wine industry states its case for Riesling](#)
- Travel Pulse - [Wineries in the Boise, ID Area: Thriving Under the Radar](#)
- Idaho Statesman - [Ste. Chapelle, Sawtooth effort will make for a tasty blend](#)
- Idaho Statesman - [Koenig Vineyards brings a touch of Italy to Idaho](#)
- Idaho Statesman - [23 year old Idaho Winemaker](#)
- Capital Press - [Winery part of Idaho's burgeoning industry](#)
- Sip Northwest - [4 Questions with Jed Glavin of Split Rail Winery](#)
- Great Northwest Wine - [Second generation moves Williamson Vineyards along](#)
- Forbes - [Syrah In Idaho, Chardonnay In Virginia, And The Expanding World Of American Wine](#)
- Great Northwest Wine - [Koenig Vineyards dessert wine tops 7th Idaho Wine Competition](#)
- Idaho Statesman - [Williamson Orchards still selling fruit, but now it's by the glass](#)
- KIVI - [Industry leaders undergo "Wine Boot Camp" to embrace local wine industry](#)

Throughout the grant fund spending, the IWC was able to negotiate rates and find cost-saving avenues in order to be able to expand certain elements to provide additional educational and marketing opportunities for the industry. This further assisted in propelling the industry forward and highlight this specialty crop's strengths. During the duration of the project, Fahlgren Mortine and Rizen Creative assisted in developing and fulfilling the different elements to create a cohesive message propelling the industry forward. While completing each element, the IWC also contributed matching funds for supplemental advertising, conference travel, industry representation, and contractual work.

Goals and Outcomes Achieved

There were several goals for this grant project that were based on the growth of exposure and interaction received from the efforts of the many project elements. With several digital components, the IWC strived to increase website traffic, social media involvement, mailing list memberships and overall participation for Idaho Wine Month in events and web traffic.

The original goal for Idaho Wine Month was to increase each the website traffic, participation and number of events during the month of June by 10% from the 2015's numbers. In 2016, participation increased by 18.5% across wineries, restaurants and retail shops. Overall events connected with Idaho Wine Month increased by 35%, however web traffic saw a decrease by 2% from 2015. Although there was a slight decrease in traffic during the month of June, the number of average visitors per month to the website rose from 4,628 by the end of 2015 to 5,782 by the end of 2016.

Social media has become a strong force for propelling the industry outreach forward and has seen continued growth. Each social media platform (Facebook, Twitter and Instagram) has been able to offer direction connections and real time interactions with consumers or potential consumers. Originally the IWC wanted to see Twitter followers increase to 5,500 and that was surpassed to 5,884 total followers. Facebook saw a slower growth to rest at 4,320 when the goal was to hit 5,000. Although the number of followers has not increased as much as the IWC would have liked, the interactions of those following these pages has increased. Facebook interaction increased by 22% and Twitter increased by 13%.

The final goal for this grant project was to increase the mailing list membership for the industry newsletter. This consumer based opt-in mailing list receives updates on the industry, events and guides for touring. The list started with 2,142 individual email addresses in 2015. The original goal was to reach 2,400 individuals by the end of 2016. This goal was surpassed with 2,544 in April of 2016. A new goal of 2,700 was then set for the end of 2016 and the consumer list currently is back up to 2,796. The IWC has been pleased with the accomplishments of the first year of the grant project. The remaining objectives will be to continue to assist the goals of the IWC and to make these grant projects grow.

Beneficiaries

As the state of Idaho's agency, whose mission is to educate market and promote all Idaho wineries and vineyards, along with consumers, trade and the general public, the IWC is dedicated to making sure that each of its efforts reflect the mission it stands for. There are currently over 50 wineries within the state of Idaho and more than 1,300 acres of wine grape vineyards planted. Each of the individuals who own, work or contribute to the industry via these wineries and vineyards directly benefit from the daily workings of the IWC be it through grant funded projects or matching funds. In 2014, the IWC contracted an economic impact study to highlight the growth of the industry from 2008 and how the industry has impacted the state of Idaho's economy. The report revealed that the Idaho wine industry contributed more than \$169 million in 2013 to Idaho's economy, which was nearly \$100 million more than in 2008. The number of jobs also doubled in that time from round 600 to 1,226.

While it is important to continue to aid in the promotion of the industry which generally results in more wine sales, the bigger picture is for more wine sales to increase production and therefore demand a need for more wine grapes to be planted within Idaho. As this demand increases, the IWC continues to assist in providing education to industry members to ensure the vineyards that are growing will produce quality fruit and support the agricultural community.

The intent of this ISDA specialty crop block grant was to utilize educational tools to market and propel the Idaho wine industry forward. The IWC believes this was accomplished and continues on even following the completion of the grant as the IWC's work to education, promote and propel the Idaho wine industry and its beneficiaries forward will never cease.

Lessons learned

Through each ISDA specialty crop block grant that the IWC has been awarded, there are lessons learned that help to improve the production and completion of future projects. One lesson that the IWC has worked through is to adapt the timeline and scope of the original project in order to accommodate an extension of funding due to negotiated rates and fewer expenses than anticipated. This is not to say that the overall scope of the project or its elements changed, but being able to broaden the reach and educational opportunities available did take flexibility from the IWC.

Even with the extended timeline, this project met the IWC's expectations for assisting with marketing the industry and propelling it forward. Through education, the quality of product that Idaho is producing has improved and the IWC has been able to inform media as well as the general public of this via advertising, media tours, events and conferences. There were no unexpected outcomes as a result of this grant project.

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International Business Development for Idaho Potatoes*

Subrecipient

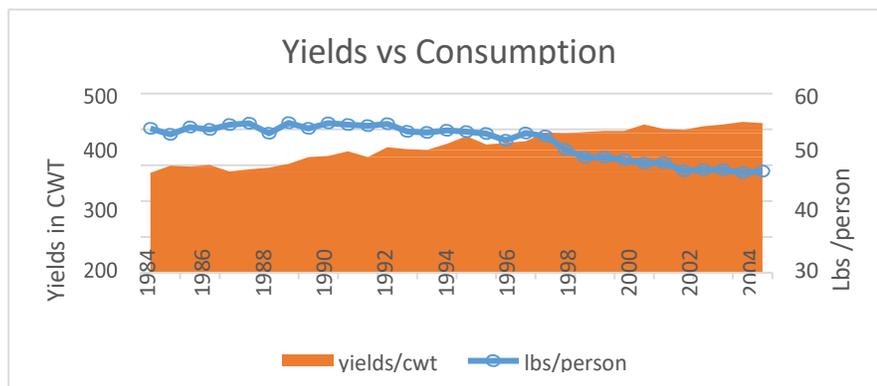
Idaho Potato Commission (IPC)

Project Summary

The purpose of this project was to be able to maintain brand awareness and grow customer demand in markets currently being shipped and to support our Idaho growers/shippers to expand their reach into new countries and markets outside the US.

The Idaho® potato growers and shippers have been focused on the domestic market and have very little budget to seek out and build new markets internationally. Because more potatoes are being harvested in the US and consumption of potatoes are on the decline in the US, the IPC created an international marketing department with its sole purpose to find and develop new markets for the Idaho® potato.

In the approximately 10 years the IPC has been exploring international markets, we have been successful in aiding Idaho shippers in their efforts to sell Idaho® potatoes into more than ten international markets. In just the last two years, we added the Philippines and Taiwan to our expanding list of overseas markets.



The IPC is funded through a "potato tax" that has not seen an increase in many years. As the IPC's responsibilities and activities grow, the income from taxes of Idaho® potatoes sold has been flat. The budget for international activities has also remained flat. This grant funded project has allowed the IPC to maintain maturing markets and continue to find and develop new markets for Idaho® potatoes.

Project Approach

Our approach was different in varying markets, depending upon the brand awareness of the markets and any known synchronicities of a particular market. In general, markets where the Idaho® potato has been sold for several years, we want to keep and expand the brand awareness in the community. In these markets, we worked with USDA and the ATO's participating in local festivals, US Food events, IPC led foodservice events and chef competitions, as well as with the shippers, distributors and store chains to implement in-store promotions – often times using local chefs we have met in the various markets.

The Idaho® potato program has been so successful in Guatemala that the distributor become overly excited about our colored varieties and ordered several pallets. When they arrived at the grocery chain warehouse, the produce manager did not know what to do with these potatoes. Fortunately, through the excellent relationship with our IPC

representative for Latin America, they called Imalinx for support. Within 2 weeks, we had promotional and educational material sent to them, had a chef develop recipes with these new potatoes and were able to provide 60 sampling days in 10 retail stores. The produce manager has been reordering colored varieties ever since – increasing their overall Idaho® potato sales by 64% in the full marketing year of 2015/16 over 2014/2015.

In new and targeted markets, primarily Asian markets with this grant funding, the Idaho Potato Commission was present in the larger food shows and worked with culinary institutes and the foodservice industry to create awareness not only for the Famous Idaho Potato brand, but to develop unique potato dishes for menus in markets where rice is the first starch option on the plate. The IPC also takes advantage of WUSATA and ISDA sponsored trade mission in order to meet buyers we may never find ourselves.

In the Philippines, an Idaho® potato branded delivery truck campaign is building awareness and demand as the U.S. spud launches at both retail and foodservice locations. Idaho® potatoes already are generating repeat orders at supermarkets in Cebu City, the entry point for the national market. Shoppers ate up an innovative promotion featuring Idaho russet fries made with a straight-fry cutter stationed in the produce department. The IPC representative also worked with the popular Philippines restaurant chain known for pan-Asian fare and tableside smokeless grills, to introduce Idaho® potatoes in specially created recipes, including an original seasoning for freshly cut Idaho® potato wedges developed by their Executive Chef.



The Taiwan market opened with fresh Idaho® potato product in central Taiwan’s leading supermarket, Taiwan Fresh, in 2015 supported by in-store promotions and branding initiatives. High-end hotel restaurants and supermarkets in Taiwan also rolled out premium fingerling potatoes from Idaho, and in November 2016 more than 130 chefs, importers and supermarket buyers participated in IPC chef training seminars and cooking demonstrations

From these seminars we managed to win Wellcome, a large grocery chain, on board in 2016. Sales of Idaho® potatoes – all varieties increased by 186% over marketing year 2015.



In Malaysia and Singapore, the IPC with grant funding has been able to support our major distributors with branded delivery trucks and 16 weeks in each country of In-store sampling in two of the largest grocery chains (Giant in Malaysia and Cold Storage in Singapore) with an average sales increase of 76% over the same time frame as the year before.



Representatives from each of the regions have been key to the success of the marketing programs in their regions. They each organize the trade shows, promotional materials and activities, and training events locally, as well as maintain great working relationships with our buyers and distributors in-country

Goals and Outcomes Achieved

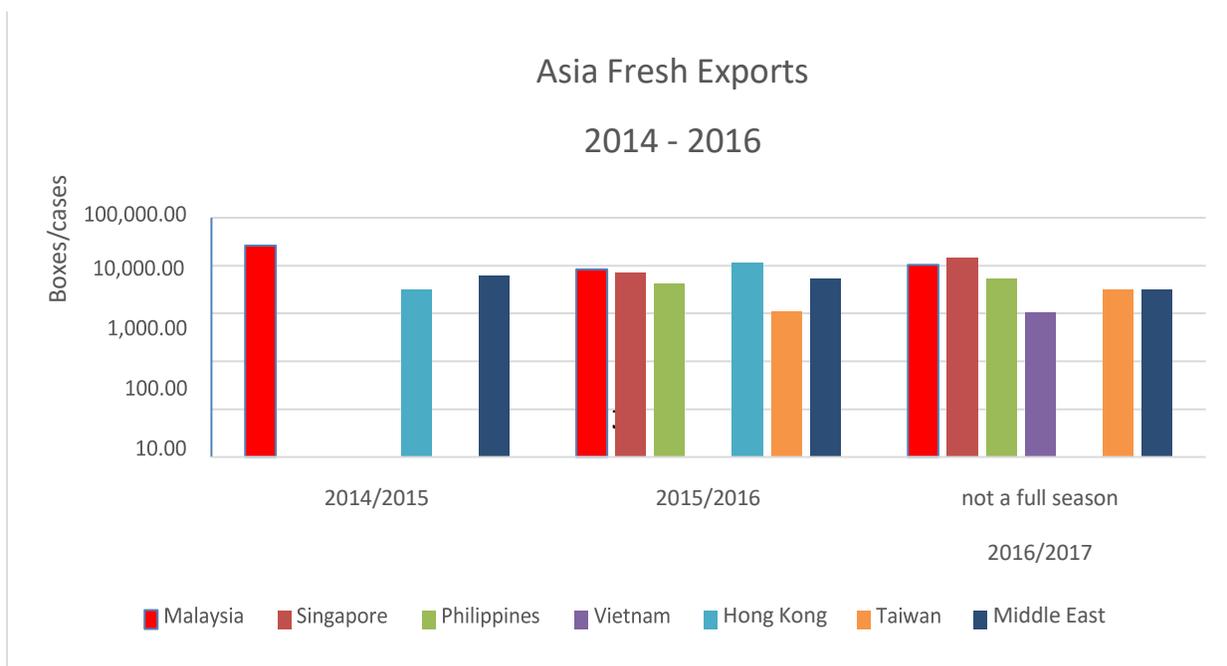
The overall goal was to achieve a minimum of 25% year-on-year growth in volume in each of the targeted markets. In most of the markets in the regions, we were able to achieve this goal. In some markets more and in some markets, due to extenuating circumstances, we lost sales.

Due to a very warm weather harvest in 2016, portions of the crop coming out of storage late spring and early summer 2017 were not the quality necessary to survive weeks on the water and have a full shelf-life. The 2016/2017 shipping year will come to an early end, leaving the IPC to abandon most May - June promotional plans and adjust downward in sales estimates.

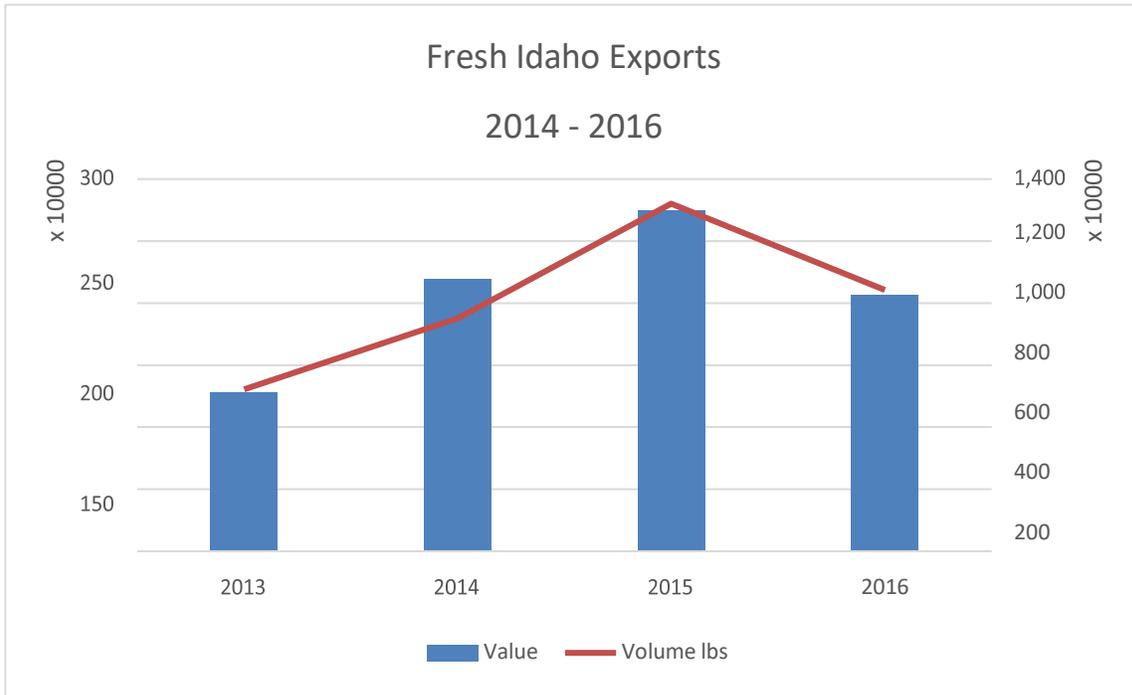
Fresh:

With the support of the IPC Latin American Idaho® potato sales have increased on average of 189% from 2014 to June of 2017 (not quite a full export season.)

In Asia there was an average sales increase across the 3 marketing years of 196% with the addition of Philippines in 2015 and Taiwan and Vietnam in 2016 joining the Idaho® potato export markets.



Total Idaho exports to all markets in value and volume over the last 4 marketing years. (note: 2016 decrease is due to early end to the export season)



	2013	2014	2015	2016
Value	1,278,900	2,194,500	2,745,225	2,061,675
Volume lbs	6,090,000	8,767,500	13,072,500	9,817,500
% Value		72%	25%	-25%
% Volume lbs		44%	49%	-84%

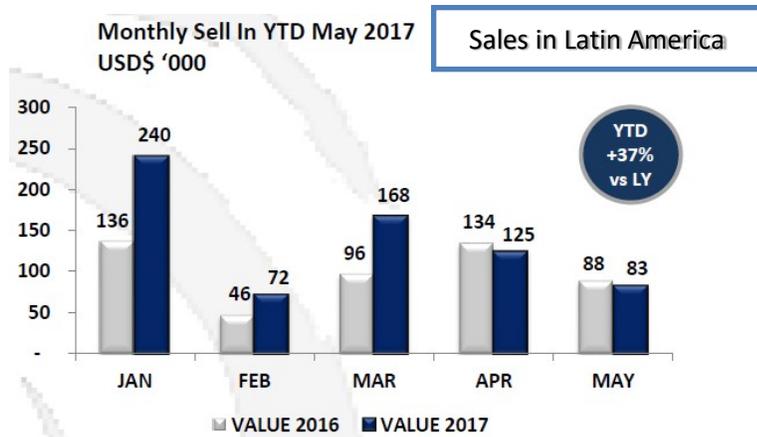
Dehydrated:

The IPC has been working closely with Idaho dehydrated potato distribution in Mexico, Hong Kong and starting in 2016 in China. We have used grant funds to support in-store sampling, chef competitions and trade shows.

The Idaho Potato Commission was able to support a major dehydrated processor in the retail and foodservice industries to expand its reach throughout Mexico and Central America. The IPC sponsored a Mexican chef to travel to Idaho in order to train with the dehy company's head chef. While in Idaho she experienced the various products and learned to work with the different flake and granule consistencies. She has been creating recipes for restaurants and sampling demonstrations at the retail level, as well as training foodservice chefs throughout the region.



Below are the latest updates from the LATAM and Hong Kong dehy representative showing a 2- year comparison of sales and a 37% increase in value for LATAM and 114% increase quantity for their regions.



Sales in Hong Kong

Type	Item Code	Item	2014/15	2015/16	Change %
			Quantity (Unit)	Quantity (Unit)	Quantity
Flavored Mash	IDH0135	Buttery Golden Selects Flavored Mashed Potatoes 4.1oz(116.4g)	5,590	10,895	95%
	IDH0145	Four Cheese Mashed Potatoes 4oz(113.4g)	7,327	15,421	110%
	IDH0146	Butter & Herb Mashed Potatoes 4oz(113.4g)	6,418	12,463	94%
	IDH2151	Bacon & Cheddar Chipotle Mashed Potatoes 4oz(113.4g)	8,543	20,051	135%
	IDH01414	Buttery Homestyle Mashed Potatoes 4oz(113.4g)	/	760	/
Subtotal			27,878	59,590	114%

Frozen:

Support of frozen products has proven to be more difficult. The frozen processors have all grown into such large volume producers that they very rarely will commit a product line to solely Idaho® potatoes. Only in these instances can the IPC offer support. This past marketing year, we were able to work with one of the large Idaho producers, their representative in Mexico and City Club (similar to Sam’s Club) to provide support for sampling in stores.



Below is a chart showing total sampling days of all Idaho® potato products in the markets we targeted. (Sample days calculation: 4 days x 4 stores = 16 days)

	Fresh		Dehy		Frozen		Total	
	2015/16	2015/16	2015/16	2015/16	2015/16	016/17	2015/16	016/17
Guatemala	60	25					60	25
El Salvador	110	60					110	60
Mexico	80			396		140	80	536
Hong Kong	60		30	60			90	60
China				120			0	120
Taiwan	69						69	0
Philippines	42						42	0
Malaysia	60		60				120	0
Singapore	20	60					20	60
Total Promotional days	501	145	90	576	0	140	591	861

Beneficiaries

The obvious beneficiaries of our marketing programs are the shipping and processing companies, whose sales have increased with our support— this includes all of the overseas exporters of table-stock potatoes, at this time six - and one of Idaho's largest dehydrators in the retail space. The less obvious beneficiaries are the number of potato growers, who grow for varying export shippers and for the processing plants. The Idaho Potato Commission seeks, through its international program, to develop new markets for Idaho® potato products in order to keep our growers in business.

Lessons Learned

Building and maintaining brand awareness for the Idaho® potato and potato products is, like any other brand, a continuous effort. The IPC has taken note of what has happened to US potatoes in markets where Potatoes USA had cut back or stopped their activities in a market that was solidly US. Taiwan is a very good example of where US potatoes lost their ground to European and Australian grown potatoes. For this reason, the IPC endeavors to keep a presence in all markets, where the Idaho® potato is being shipped.

Country export regulations can change from one month to the next: There was a massive spike in exports to Mexico in the marketing year 2014/15 when Mexico opened up entirely for US fresh potatoes. In less than a month, Idaho shippers sent 100+ containers to Mexico. The market closed shortly after opening. We have been able to maintain a constant presence in the 15 mile swath along the Mexican border, but only a fraction of what we know is possible.

Mother Nature certainly played role in the export business as well as labor issues that arose in the west coast ports. At these times when Idaho cannot get product to our customers, it has been so important for the IPC to maintain close relationships and an open channel of communication with the not only the buyers, but the shippers as well.

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Development of Pale Cyst Nematode resistance in russet-skinned potato clones for Idaho

Subrecipient

Idaho Potato Commission (IPC)

Project Summary

Receive resistant lines from U.S. sources, place into tissue culture and screen for viruses
Potato lines potentially possessing PCN resistance that were already in the U.S. included lines or varieties from: Europe (Sante and Eden); New Zealand (Moonlight, Karaka, and Bondi); Peru (Maria Huanca); Holland (Innovator); New York (NY121, PA01N32-1, NZA8904-2, A10889-1PCN). These lines were put into tissue culture from sprouts and grown out and evaluated for bacterial contamination. These lines and varieties were used in hybridizations in past years. Recently seeds from the National Plant Germplasm System (NPGS) were received for three populations (NYW 69, NYW 72 and NYW 73) generated in the 1990s for resistance to *G. rostochiensis* and *G. pallida*. Seeds were germinated and seedlings maintained in tissue culture. Peruvian cultivar, Laram Ajawiri, was requested from NPGS and is being maintained as tissue culture plantlets.

Receive resistant lines from outside the U.S. following mandated evaluation by APHIS prior to release into the U.S. More recently lines from Holland (Ambassador, Basin Russet, and Performer) were identified with U.S. distributors and will be used in 2017 hybridization. Lines that were in quarantine (received from outside the U.S.) with USDA, APHIS include Dutch lines Arsenal and Alicante, and German lines Nautilus and Tokia have been released. Three South American cultivars, Senora Warni, Chimi Lucki and Negrita, were shipped from the International Potato Center in Lima, Peru and were in quarantine with APHIS. All three clones were released from APHIS after they were determined to be pathogen free. These three clones are being propagated in tissue culture and will be used in future hybridizations to incorporate new sources of PCN resistance.

Screen resistant lines newly received and progenies from hybridizations with parents previously identified as having PCN resistance in screenings conducted by U of I.

A manuscript has been published by American Journal of Potato Research recording PCN screening of 22 of the lines mentioned above including 13 breeding clones and 9 potato varieties. This work demonstrated that five of the lines had very high resistance to two of the three *Globodera* species evaluated.

A total of 50 plants from New York populations NYW 69, NYW 72 and NYW 73, 19, 15 and 16 plants respectively, were grown in the greenhouse (4 reps per plant) and analyzed to determine resistance levels to *G. pallida*. Fourteen plants had rating scores of 6 or 7 (less than an average of 20 cysts per pot), such that all plants had RS scores less than 10.0 and Rf scores less than 2.0. The susceptible control was Desiree and an average of 202 cysts per pot.

Seventeen breeding lines were screened for resistance to *G. pallida*. Nine of the seventeen had less than 20 cysts per pot. The presence of lines with less resistance is not greatly concerning since these lines will be used to combine partial resistances into resulting progeny with higher levels of resistance.

Screen breeding lines and progenies currently in the U.S. for agronomic and common disease resistances.
Apply molecular markers for known resistance genes

A total of 139 families representing 125,220 true potato seeds have been generated using PCN resistant parents. In 2016, seedling tubers of 9,287 individuals representing 52 families were produced in the greenhouse and were be planted in the field in 2017. An additional 96 breeding clones with PCN resistant parents were selected in the field in 2016 from single hill plantings of 4,422 individuals. Four clones of PCN-resistant parents also advanced to replicated field trials. In particular, the family A10915, Eden x Wester Russet, has generated 224 progeny, most of which have been evaluated with *G. pallida* and have been established in tissue culture. The 224 progeny of A10915 also had seed produced in the greenhouse in 2016, and clones were planted in the field in 2017 for initial agronomic evaluation. Thirty-one progeny were selected in the 2017 field trial, showing nice russetting and tuber type. Two were particularly nice, and have molecular markers associated resistance to *G. rostochiensis* and *G. pallida*, A10915-41 and A10915-71. Both clones have been evaluated for *G. pallida* resistance, showing intermediate resistance between Eden and Western Russet, with clone -71 showing higher levels of resistance than -41. Both clones were also shown to be resistant to *G. ellingtonae*. 2018 field trials included all 31 A10915 progeny, mentioned above selected in 2017 showing nice russetting and tuber type. 2018 harvest was recently completed and results are under review.

Progeny from the three New York populations were screened with molecular markers for PCN resistance genes, H1, Gpa1Vadg, Gpa5, Ro2, Gro1-4 and Gpa2. All progeny screened, except one, were positive for genes on chromosome 5, however these results do not correspond with resistance to *G. pallida*. The same set of molecular markers were also used to screen 22 breeding clones. New Zealand clones (Moonlight, Karaka, and Bondi) were positive for Gpa1Vadg, but mostly negative for resistance genes on chromosome 5. However, European clones were largely negative for Gpa1Vadg and positive for one or more genes on chromosome 5.

Presentations:

Three posters were presented at the World Potato Congress in Cusco, Peru in May of 2018 by Joseph Kuhl, Jonathan Whitworth and Richard Novy. Poster titles were: Breeding and development of Globodera-resistant potato varieties with long tuber shape and russet skin for production in the western United States; Seeking host resistance in potato to three Globodera species; and Globodera Alliance (GLOBAL): Risk assessment and eradication of Globodera spp. in U.S. Production of Potato. Co-authors included: Louise-Marie Dandurand, Glenn Bryan, Vivian Blok Walter De Jong, Dee Denver, Pamela Hutchinson, John Joes, Chris McIntosh, Benjamin Mimee, Michael Thornton, Xiaohong Wang, and Inga Zasada.

A presentation by Jonathan Whitworth, Joe Kuhl and Rich Novy was made at the Idaho Potato Conference in Pocatello, ID in January 2017. Title of the talk was Developing PCN resistance in US potato cultivar. Contributors included Jonathan Whitworth, Rich Novy, Louise-Marie Dandurand, Joseph Kuhl, Inga Zasada, and Xiaohong Wang.

Later that week a similar talk was given by Rich Novy and Joe Kuhl at the USDA, APHIS PCN Research Meeting, also in Pocatello, ID. .

Project Approach

1. Increase germplasm base for PCN resistance

Potato lines potentially possessing PCN resistance that were already in the U.S. were acquired, which included lines or varieties from: Europe (Sante and Eden); New Zealand (Moonlight, Karaka, and Bondi); Peru (Maria Huanca); Holland (Innovator); New York (NY121, PA01N32-1, NZA8904-2, A10889-1PCN). These lines were put into tissue culture from sprouts and grown out and evaluated for bacterial contamination. These lines and varieties were used in hybridizations in past years and have continued to be used in hybridizations since. Seeds from the National Plant Germplasm System (NPGS) were received for three populations (NYW 69, NYW 72 and NYW 73) generated in the 1990s for resistance to *G. rostochiensis* and *G. pallida*. Seeds were germinated and seedlings maintained in tissue culture. Peruvian cultivar, Laram Ajawiri, was requested from the National Plant Germplasm System, NRSP-6 (Sturgeon Bay, WI) and is being maintained as tissue culture plantlets.

a. Screen existing breeding clones derived from parents with some level of PCN resistance

Twenty-two parent clones, including 13 breeding clones and 9 potato varieties, were evaluated for PCN resistance. This work demonstrated that five of the lines had very high resistance to two of the three *Globodera* species evaluated. This work was published in the Plant Disease.

A total of 50 plants from New York populations NYW 69, NYW 72 and NYW 73, 19, 15 and 16 plants respectively, were grown in the greenhouse (4 reps per plant) and analyzed to determine resistance levels to *G. pallida*. Fourteen plants had rating scores of 6 or 7 (less than an average of 20 cysts per pot), such that all plants had RS scores less than 10.0 and Rf scores less than 2.0. The susceptible control was Desiree and an average of 202 cysts per pot.

Seventeen breeding lines were screened for resistance to *G. pallida*. Nine of the seventeen had less than 20 cysts per pot. The presence of lines with less resistance is not greatly concerning since these lines will be used to combine partial resistances into resulting progeny with higher levels of resistance.

b. Obtain additional PCN-resistant cultivars and breeding lines from programs outside of the US for use as parents in hybridizations

Breeding clones from Holland (Ambassador, Basin Russet, and Performer) were identified with U.S. distributors and were used in 2017 hybridizations. Lines that were in quarantine (received from outside the U.S.) with USDA, APHIS include Dutch lines Arsenal and Alicante, and German lines Nautilus and Tokia, have been released. Three South American cultivars, Senora Warni, Chimi Lucki and Negrita, were shipped from the International Potato Center in Lima, Peru and were in quarantine with APHIS. All three clones were released from APHIS after they were determined to be pathogen free. These three clones are being

propagated in tissue culture and will be used in future hybridizations to incorporate new sources of PCN resistance.

2. Screen existing putative PCN resistant breeding lines for common scab, early blight, leafroll virus net necrosis, soft rot, dry rot and agronomic traits.

A total of 139 families representing 125,220 true potato seeds have been generated using PCN resistant parents. Screening of parental clones and progeny include field evaluations (2016, 2017, and 2018) and selection, including common potato diseases such as common scab and early blight, as well as agronomic traits such as tuber type and yield. In 2016, seedling tubers of 9,287 individuals representing 52 families were produced in the greenhouse and were planted in the field in 2017. An additional 96 breeding clones with PCN resistant parents were selected in the field in 2016 from single hill plantings of 4,422 individuals. Four clones of PCN-resistant parents also advanced to replicated field trials. The 224 progeny of A10915 also had seed produced in the greenhouse in 2016, and clones were planted in the field in 2017 for initial agronomic evaluation. Thirty-one progeny were selected in the 2017 field trial, showing nice russetting and tuber type. Two were particularly nice, and have molecular markers associated resistance to *G. rostochiensis* and *G. pallida*, A10915-41 and A10915-71. Both clones have been evaluated for *G. pallida* resistance, showing intermediate resistance between Eden and Western Russet, with clone -71 showing higher levels of resistance than -41. Both clones were also shown to be resistant to *G. ellingtonae*. 2018 field trials included all 31 A10915 progeny, mentioned above selected in 2017 showing nice russetting and tuber type. 2018 harvest was recently completed and results are under review.

3. Marker assisted screening will be applied when available.

The 224 progeny of A10915 (Eden x Western Russet) also had seed produced in the greenhouse in 2016, and clones were planted in the field in 2017 for initial agronomic evaluation. All 224 progeny were screened with molecular markers for H1 and GpaIV, PCN resistance loci. Molecular marker data was used to select thirty-one progeny in the 2017 field trial, showing nice russetting and tuber type. Two were particularly nice, and have molecular markers associated resistance to *G. rostochiensis* and *G. pallida*, A10915-41 and A10915-71. Both clones have been evaluated for *G. pallida* resistance, showing intermediate resistance between Eden and Western Russet, with clone -71 showing higher levels of resistance than -41. Both clones were also shown to be resistant to *G. ellingtonae*.

Progeny from the three New York populations were screened with molecular markers for PCN resistance genes, H1, GpaIV_{adg}, Gpa5, Ro2, Gro1-4 and Gpa2. All progeny screened, except one, were positive for genes on chromosome 5, however these results do not correspond with resistance to *G. pallida*. The same set of molecular markers were also used to screen 22 breeding clones. New Zealand clones (Moonlight, Karaka, and Bondi) were positive for GpaIV_{adg}, but mostly negative for resistance genes on chromosome 5.

However, European clones were largely negative for GpaIV_{adg} and positive for one or more genes on chromosome 5.

The overall scope of the project solely benefitted a specialty crop, potato.

Significant contributions and role of project partners in the project:

Joseph Kuhl

Helped to identify and acquire PCN resistant germplasm.

Applied molecular markers associated with PCN resistance to parental clones and progeny.

Helped to selected potato clones and progeny in the field for agronomic performance.

Louise-Marie Dandurand

Screened potato germplasm for response to *G. pallida*.

Rich Novy and Jonathan Whitworth

Helped to identify and acquire PCN resistant germplasm.

Conducted potato hybridizations to generate families and populations segregating for PCN resistance.

Selected potato clones and progeny in the field for agronomic performance.

Goals and Outcomes

Did the grantee supply the activities that were completed in order to achieve the performance goals and measurable outcomes identified in the approved project proposal or subsequent amendments?

Receive resistant lines from U.S. sources, place into tissue culture and screen for viruses

Potato lines potentially possessing PCN resistance that were already in the U.S. included lines or varieties from: Europe (Sante and Eden); New Zealand (Moonlight, Karaka, and Bondi); Peru (Maria Huanca); Holland (Innovator); New York (NY121, PA01N32-1, NZA8904-2, A10889-1PCN). These lines were put into tissue culture from sprouts and grown out and evaluated for bacterial contamination. These lines and varieties were used in hybridizations in past years and have continued to be used in hybridizations since. Seeds from the National Plant Germplasm System (NPGS) were received for three populations (NYW 69, NYW 72 and NYW 73) generated in the 1990s for resistance to *G. rostochiensis* and *G. pallida*. Seeds were germinated and seedlings maintained in tissue culture. Peruvian cultivar, Laram Ajawiri, was requested from the National Plant Germplasm System, NRSP-6 (Sturgeon Bay, WI) and is being maintained as tissue culture plantlets.

Receive resistant lines from outside the U.S. following mandated evaluation by APHIS prior to release into the U.S.

Breeding clones from Holland (Ambassador, Basin Russet, and Performer) were identified with U.S. distributors and were used in 2017 hybridizations. Lines that were in quarantine (received from outside the U.S.) with USDA, APHIS include Dutch lines Arsenal and Alicante, and German lines Nautilus and Tokia, have been released. Three South American cultivars, Senora Warni, Chimi Lucki and Negrita, were shipped from the International Potato Center in Lima, Peru and were in quarantine with APHIS. All three clones were released from APHIS after they were determined to be pathogen free. These three clones are being propagated in tissue culture and will be used in future hybridizations to incorporated new sources of PCN resistance.

Screen resistant lines newly received and progenies from hybridizations with parents previously identified as having PCN resistance in screenings conducted by U of I.

A manuscript has been published by Plant Disease recording PCN screening of 22 of the lines including 13 breeding clones and 9 potato varieties. This work demonstrated that five of the lines had very high resistance to two of the three *Globodera* species evaluated.

A total of 50 plants from New York populations NYW 69, NYW 72 and NYW 73, 19, 15 and 16 plants respectively, were grown in the greenhouse (4 reps per plant) and analyzed to determine resistance levels to *G. pallida*. Fourteen plants had rating scores of 6 or 7 (less than an average of 20 cysts per pot), such that all plants had RS scores less than 10.0 and Rf scores less than 2.0. The susceptible control was Desiree and an average of 202 cysts per pot.

Seventeen breeding lines were screened for resistance to *G. pallida*. Nine of the seventeen had less than 20 cysts per pot. The presence of lines with less resistance is not greatly concerning since these lines will be used to combine partial resistances into resulting progeny with higher levels of resistance.

Screen breeding lines and progenies currently in the U.S. for agronomic and common disease resistances. Apply molecular markers for known resistance genes

A total of 139 families representing 125,220 true potato seeds have been generated using PCN resistant parents. In 2016, seedling tubers of 9,287 individuals representing 52 families were produced in the greenhouse and were planted in the field in 2017. An additional 96 breeding clones with PCN resistant parents were selected in the field in 2016 from single hill plantings of 4,422 individuals. Four clones of PCN-resistant parents also advanced to replicated field trials. In particular, the family A10915, Eden x Wester Russet, has generated 224 progeny, most of which have been evaluated with *G. pallida* and have been established in tissue culture. The 224 progeny of A10915 also had seed produced in the greenhouse in 2016, and clones were planted in the field in 2017 for initial agronomic evaluation. Thirty-one progeny were selected in the 2017 field trial, showing nice russetting and tuber type. Two were particularly nice, and have molecular markers associated resistance to *G. rostochiensis* and *G. pallida*, A10915-41 and A10915-71. Both clones have been evaluated for *G. pallida* resistance, showing intermediate resistance between Eden and Western Russet, with clone -71 showing higher levels of resistance than -41. Both clones were also shown to be resistant to *G. ellingtonae*. 2018 field trials included all 31 A10915 progeny, mentioned above selected in 2017 showing nice russetting and tuber type. 2018 harvest was recently completed and results are under review.

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If outcome measures were long term, was a summary of the progress made towards this achievement provided?

Breeding potato takes many years, and while the proposed project never promised to developed a PCN resistant potato cultivar, significant progress was made towards developing a PCN resistant cultivar. The parent clones received, the populations generated, and the selected clones will all continue to be utilized with the end goal of releasing a commercially accepted potato cultivar, some time in the future.

Did the grantee provide a comparison of actual accomplishments with the goals established for the reporting period?

Project Goals	Accomplishments
Identify and request <i>G. pallida</i> resistant lines from Europe, S. America and the U.S.	PCN resistance germplasm was requested and received from the US, Europe, New Zealand and S. America.
Receive resistant lines from U.S. sources, place into tissue culture and screen for viruses	PCN resistance germplasm that was received was placed into tissue cultivar and screened for viruses.
Receive resistant lines from outside the U.S. following mandated evaluation by APHIS prior to release into the U.S.	PCN resistant material was requested and received from Europe and S. America and followed APHIS mandated quarantines prior to receiving.
Screen resistant lines newly received and progenies from hybridizations with parents previously identified as having PCN resistance in screenings conducted by U of I.	Newly received parental clones and progeny were screened for <i>G. pallida</i> resistance.
Screen breeding lines and progenies currently in the U.S. for agronomic and common disease resistances	Previous obtained clones and related progeny were screened for agronomic and quality traits such as scab.
Apply molecular markers for known resistance genes	Molecular markers associated with PCN resistance were applied to parental clones and progeny
Conduct hybridizations with available PCN- resistant lines	Hybridization were made with PCN resistance parental clones.
Present final results at annual potato meetings, e.g. PAA	Final results were presented as three posters at the World Potato Congress in May, 2018

Did the grantee clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets?

Receive resistant lines from U.S. sources, place into tissue culture and screen for viruses

This outcome has been achieved, new potato clones from the United States have been identified and received. These clones to the extent possible have been surveyed for viruses and when possible placed into tissue culture. These clones are fully incorporated into the PCN breeding program. See above for specific names of cultivars.

Receive resistant lines from outside the U.S. following mandated evaluation by APHIS prior to release into the U.S.

This outcome has been achieved, new potato clones from the outside the United States have been identified and received. These clones have been surveyed for viruses (part of the requirement of bring into the United State) and when possible placed into tissue culture. These clones are fully incorporated into the PCN breeding program. See above for specific names of cultivars.

Screen resistant lines newly received and progenies from hybridizations with parents previously identified as having PCN resistance in screenings conducted by U of I.

This outcome has been achieved within the time frame of this grant and continues to be pursued as new clones and progenies are generated (outside of this proposal).

A manuscript has been published by Plant Disease recording PCN screening of 22 of the lines including 13 breeding clones and 9 potato varieties. This work demonstrated that five of the lines had very high resistance to two of the three *Globodera* species evaluated.

A total of 50 plants from New York populations NYW 69, NYW 72 and NYW 73, 19, 15 and 16 plants respectively, were grown in the greenhouse (4 reps per plant) and analyzed to determine resistance levels to *G. pallida*. Fourteen plants had rating scores of 6 or 7 (less than an average of 20 cysts per pot), such that all plants had RS scores less than 10.0 and Rf scores less than 2.0. The susceptible control was Desiree and an average of 202 cysts per pot.

Seventeen breeding lines were screened for resistance to *G. pallida*. Nine of the seventeen had less than 20 cysts per pot. The presence of lines with less resistance is not greatly concerning since these lines will be used to combine partial resistances into resulting progeny with higher levels of resistance.

Screen breeding lines and progenies currently in the U.S. for agronomic and common disease resistances.

Apply molecular markers for known resistance genes

This outcome has been achieved within the time frame of this grant and continues to be pursued as new clones and progenies are generated (outside of this proposal).

A total of 139 families representing 125,220 true potato seeds have been generated using PCN resistant parents. In 2016, seedling tubers of 9,287 individuals representing 52 families were produced in the greenhouse and were planted in the field in 2017. An additional 96 breeding clones with PCN resistant parents were selected in the field in 2016 from single hill plantings of 4,422 individuals. Four clones of PCN-resistant parents also advanced to replicated field trials. In particular, the family A10915, Eden x

Wester Russet, has generated 224 progeny, most of which have been evaluated with *G. pallida* and have been established in tissue culture. The 224 progeny of A10915 also had seed produced in the greenhouse in 2016, and clones were planted in the field in 2017 for initial agronomic evaluation. Thirty-one progeny were selected in the 2017 field trial, showing nice russetting and tuber type. Two were particularly nice, and have molecular markers associated resistance to *G. rostochiensis* and *G. pallida*, A10915-41 and A10915-71. Both clones have been evaluated for *G. pallida* resistance, showing intermediate resistance between Eden and Western Russet, with clone -71 showing higher levels of resistance than -41. Both clones were also shown to be resistant to *G. ellingtonae*. 2018 field trials included all 31 A10915 progeny, mentioned above selected in 2017 showing nice russetting and tuber type. 2018 harvest was recently completed and results are under review.

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Did the grantee highlight the major successful outcomes of the project in quantifiable terms?

A manuscript has been published by Plant Disease recording PCN screening of 22 of the lines including 13 breeding clones and 9 potato varieties. This work demonstrated that five of the lines had very high resistance to two of the three *Globodera* species evaluated.

Whitworth, J.L., R.G. Novy, I.A. Zasada, X. Wang, L-M. Dandurand, and J.C. Kuhl (2018) Resistance of potato breeding clones and cultivars to three species of potato cyst nematode. Plant Disease. 102:2120-2128.

This project has initiated the breeding for PCN resistance in the Pacific Northwest, especially Idaho.

Beneficiaries

Did the grantee provide a description of the groups and other operations that benefited from the completion of this project's accomplishments?

The target audience for PCN resistance research is primarily potato breeders, however this work will benefit in the long term potato growers and the larger potato industry by facilitating the incorporation of nematode resistance into new potato varieties. The larger potato industry in Idaho and throughout the United States benefits from the establishment of PCN resistant cultivars through better control of PCN.

Did the grantee clearly state the number of beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project?

PCN infested fields in Idaho are located on land owned by approximately twenty potato growers. All potato growers in the state of Idaho benefit from the development of PCN resistant cultivars.

Lessons Learned

Did the grantee offer insight into the lessons learned by the project staff as a result of completing this project?

Development of PCN resistance potato clones requires a sustained, long term effort that will require more time to complete, however the success of this project provides an excellent basis from which to start.

Did the grantee provide any unexpected outcomes or results that were an effect of implementing this project?

One unexpected result was the correlation of resistance to *G. rostochiensis* with resistance to *G. ellingtonae*. This correlation, while not absolute, will simplify the process of generating resistant potato clones to these two nematode species.

If goals or outcome measures were not achieved, did the grantee identify and share the lessons learned to help others expedite problem-solving?

All goals and outcomes were achieved.

Contact Person

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Promoting Specialty Crops through Advertising, Retail, and Foodservice Promotions

Subrecipient

Idaho Preferred

Project Summary

A survey of specialty crop producers conducted in 2015 by the Idaho State Department of Agriculture found that the top priority identified by 62% of respondents was “Increasing Marketing and Promotion.” As a result, Idaho Preferred, the domestic promotion program of the Idaho State Department of Agriculture, designed an integrated advertising, retail and foodservice promotion program to increase consumer awareness, availability and purchases of Idaho specialty crops including fruits, vegetables, herbs, wine and nursery products. The advertising campaign plan included television advertising to increase awareness and digital advertising on Facebook and Google to allow consumer engagement. The popularity of “local” foods at retail and foodservice continues to expand. Therefore, this campaign included projects to assist chefs, restaurants and distributors to identify and source locally produced specialty crops through tours, events and menu promotions. Consumers are also demanding more local products at their grocery stores. To assist retailers in sourcing and encouraging in-store promotions of local produce, this project allowed for the development and implementation of training and educational events for producers and retailers as well as statewide in-store consumer promotions, materials and events.

Project Approach

Six new 15 second television ads were produced in 2015 which included images of summer squash, sweet corn, tomatoes, apples, peaches and melons. Production costs were paid from previous specialty crop grant funds. Although the work plan called for production of two additional ads, it was decided that the current ads were adequate and that saving production costs would allow for more airtime. The ads ran for 3 weeks in markets statewide in August and September 2016. In addition, Facebook and Google Adwords ran in September and October 2016 promoting apples, peaches, watermelon, tomatoes, squash and sweet corn. In 2017, television ads ran 9 weeks from July-September. This grant funded 3 weeks of this campaign. In addition, Facebook advertising and Google Adwords promoted specialty crops July-September 2017 including cherries, melons, tomatoes, peaches, apples, potatoes, onions and squash. In September 2018, additional funds became available for this promotion program. As a result, 2 weeks of ads ran in the Spokane market that allowed us to reach consumers in northern Idaho with a message about availability of Idaho specialty crops in that region of the state.

In addition to advertising, retail promotions helped increase consumer awareness of Idaho-grown specialty crops available in retail grocery stores. Banners were produced and distributed that promoted locally grown nursery items in April and May 2017 and banners promoting locally grown fruits and vegetables were produced and distributed to retailers in August-September 2017. In 2018, 80 produce bins were produced and distributed to retail grocery stores across the state. These retail partners displayed apples, peaches, green beans, squash, pears, nectarines, sweet corn and watermelon throughout the fresh produce season. In-store demos for apples, hummus, asparagus and processed fruit products were conducted. In November 2017, a retail seminar was held to connect local producers to buyers from

Albertsons. Attending were producers of sweet corn, pumpkins, apples, peaches, cherries, table grapes, wine and nursery items. In addition, members of Albertsons produce merchandising team toured 3 local producers of tree fruit and produce and took pictures that were integrated into store-produced signage.

Per the grant plan, a Farmer Chef Collaborative was held in April 2017 in Boise. 16 companies that produce specialty crops participated and 32 chefs/foodservice representatives were present. A second Farmer Chef Collaborative was held in Moscow in March 2018. Nine specialty crop producers attended. The first of two Chef Tours was held in July 2017. 31 chefs and foodservice representatives took part in the tour which included stops at farms that produced sweet potatoes, apples, watermelon, cantaloupe and mint. The second Chef tour occurred in July 2018 and included farms that produced potatoes, melons, squash, peppers, tomatoes and pumpkins. 36 chefs and foodservice industry personnel took part in the tour.

Finally, this grant provided funding for a staff person to conduct the advertising, retail and foodservice programs detailed above. In addition, this staff person was responsible for Farm to School activities that included conducting workshops at the Idaho School Nutrition Association conferences in 2016, 2017, and 2018 and sending monthly e-newsletters to school foodservice staff statewide. According to the USDA National Farm to School Census, the number of Idaho schools who reported serving more fruits in their schools increased by 10% from 2014 to 2016 and 14% reported serving more vegetables in this same period. USDA has not conducted another census since 2016.

The grant-funded staff person was also responsible for social media posts promoting specialty crops on Facebook and Instagram as well as writing and posting blogs on the Idaho Preferred website. During 2016-2017 270 Facebook and Instagram posts were made promoting Idaho specialty crops. In addition, 23 blogs and 65 newsletter articles were posted to the Idaho Preferred website. Efforts of this staff person also resulted in 20 new specialty crop producers joining Idaho Preferred to participate in these marketing programs between 2016-2018. Eight new restaurants began identifying Idaho specialty crops on their menus and 5 retail chains began using in-store promotional materials to identify their local specialty crops during this grant period from 2016-2018.

Goals and Outcomes

Advertising Outcomes:

Consumer market research was conducted in September 2014 and October 2016.

The following are baseline and goals per the plan and actual outcomes:

Measurable	Baseline 2012	2014 Goal	2014 Actual	2016 Goal	2016 Actual
Awareness	50%	60%	52%	54%	42%
Have Seen TV ads	65%		63%	65%	55%
Buying More Local	27%	40%	30%	35%	18%
Seeing Message at retail	40%	50%	37.2%	45%	31.6%*
Buying more Fruits/veggies	79%	80%	94%	94%	77%
Buying more Nursery items	3.8%	12%	12.1%	15%	19.6%
Buying more ID Wine	5.5%	12%	6.5%	10%	15.5%
Buying local at foodservice	1.0%		4.0 %	8%	5.2%

*Question on seeing message at retail separated “grocery store” and “on a food product label.” Results for “on a food label” increased from 14% in 2014 to 23.3% in 2016 which may account for some the decrease in ‘grocery store” response.

Digital Outcomes: The chart below reports the outcome of digital and television engagement. Total gross impressions including television, Facebook and Google increased in 2017 and cost per thousand impressions decreased. However, click through rate for both Facebook and Google declined and therefore cost per click to the website increased in 2017 vs 2016.

	2016 Results	2017 Results
Television Gross Impressions	5,470,236	8,522,000
Facebook Impressions	1,052,183	1,456,421
Facebook Clicks to website	15,298	13,312
Click Rate/cost per click	1.5%/\$0.43	0.9%/\$0.93
Google Impressions	134,143	193,972
Google Clicks to Website	6,179	2,781
Click Rate/cost per click	4.6%/\$0.71	1.4%/\$1.90
Cost per thousand impressions of TV and digital	\$16.14	\$10.75

Beneficiaries

According to the latest (2012) USDA Agricultural Census for Idaho, 3629 farms report growing or producing fruits, vegetables, nursery stock and other specialty crops. Since reporting to the Ag Census is voluntary, there are likely additional specialty crop producers in Idaho that are not represented by the census. All of these farms can potentially benefit from the promotion of specialty crops in Idaho.

Lessons Learned

From the Outcome chart above, it is obvious we did not meet our goals of increasing awareness. In reviewing our media spending, we found direct correlation between spending, reach, frequency and awareness. Due to increasing cost of media and flat or decreased ad budgets, the number of spots purchased has declined and with it has come a decrease in reach, frequency and gross impressions. As a result, our advertising awareness has declined as well. It becomes obvious that to make significant increases in overall consumer awareness and intent to purchase, additional resources would need to be allocated to advertising. However, we do feel significant progress has been made in retail promotion programs. Although not quantified by research, we have seen vastly increased interest from retailers in sourcing local produce and identifying it in their stores. Requests from retailers for point of sale materials, in-store sampling and other promotional programs designed to increase consumer awareness and sales of local products have expanded. In fact, we see many of these retail chains creating their own unique “buy local” programs within their chain in order to differentiate themselves from the competition.

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Building International Markets in Mexico and Central America through Foodservice Promotional Activities and Trade Missions

Subrecipient

Idaho-E. Oregon Onion Committee

Project Summary

Onions grown in the Idaho-Eastern Oregon onion region are governed by Federal Marketing Order #958 (M.O.); the M.O. maintains quality and size standards that exceed USDA standards. The Idaho-E. Oregon Onion Committee (IEOOC) was formed to promote this high-quality onion, and the onions are distributed both domestically and internationally. One purpose of the project was to develop awareness with foodservice professionals and consumers of the versatility and benefits of yellow Idaho-E. Oregon Onions in the Mexico market. To accomplish this, the IEOOC proposed to have IMALINX conduct a Yellow Onion Promotion in various cities in Mexico. The IEOOC thought this would be an excellent avenue to let the foodservice segment know of the versatility and availability of Idaho-E. Oregon Onions. There would be culinary demonstrations held in certain venues that would show the cooking attributes of Idaho-E Oregon Onions, and a menu promotion would be implemented to bring awareness to the Mexico consumer.

The project would also help determine the most effective way to build market share through participation in trade missions. The project proposal included two WUSATA trade missions throughout the course of the grant period. It was anticipated there would be a trade mission to Central America during the grant period, and the IEOOC would also choose an additional trade mission that fell into the Committee's area of focus. The Committee did ask for a change in focus on the grant to be able to participate in the Taiwan Trade Mission.

Project Approach, Goals and Outcomes

During the course of the grant there were many activities that took place. Two Export Committee Members represented the Idaho-E. Oregon Onion Committee on a trade mission to Taiwan in December, 2016. They traveled with the WUSATA group and the Committee members felt that this mission was met with positive results. They felt the companies they visited during the trade mission expressed interest in Idaho and E. Oregon Onions. Some of the companies they met with in Taiwan included: TKK Logistics; Uni-President Organics-Corp.; Chaun-Lian Enterprise (Largest Supermarket); Preamax Trading Co. (trader/Supplier); City Queen; Shin Hu; Three Shine; and Chaomin Vegetables Fruits Firm. They also had an opportunity to meet with Pride Enterprise Co.; and Chia-Wei.

In June 2017, members of the Idaho-E. Oregon Onion industry attended a WUSATA Trade Mission to Mexico which focused on the foodservice industry and hotel business. The industry members felt this too was a positive trip.

The Committee contracted with IMALINX, a company in Mexico to offer the Yellow Onion Promotion. The 2016 Yellow Onion promotion was originally scheduled for 2015, but due to the Mexico market and the onion crop they waited until 2016 to implement the program. The activities included a menu promotion where yellow Idaho and E. Oregon onions were present. It was a fall menu at Jaso Restaurant that Chefs

Sonia and Jared Reardon prepared for the season. IMALINX organized a dinner, inviting several Mexico media representatives for them to have the opportunity to learn about the versatility of Idaho and E. Oregon Onions. There was also in-store promotions offered during this time frame. There were 8 stores and 5 cooking shows during the month of December where sampling activities took place.

The Export Committee was represented in November of 2017, at the Taiwan International Fresh Fruit and Vegetable Show, as well as on the Idaho Governor's Trade Mission to Taiwan. The International Fresh Fruit and Vegetable Show is a new show and the Committee participated on the second year of the show. It was reported the show had been busy. At the conclusion of the trade show the Committee's representative joined Idaho Governor's Trade Mission for the Taiwan segment. During the course of the three-day trade show 29 business cards were collected. After joining the trade mission there were six buyer meetings conducted. The information collected at the trade show and during the trade mission was shared with the Export Committee and area shippers.

Beneficiaries

The beneficiaries of this project include the 165 onion growers and the approximately 26 onion shippers in the Idaho-Eastern Oregon growing region. Increasing consumption and traveling to other countries helps the industry by creating new avenues and market share for the onions to be sold.

Lessons Learned

The projects outlined in this grant took place with few problem and/or delays. The trade missions IEOOC attended were felt to be a positive experience, and the Yellow Onion Promotion continues to be successful in making the different industry segments aware of Idaho and Eastern Oregon Yellow onions. Increase in onion shipments don't always correlate with increase in sales as onion price is volatile from season to season. However, the IEOOC and the surrounding industry are appreciative of the grant money and the promotions.

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IdaBOT: An Autonomous Utility Robot for Managing Idaho Specialty Crops

Subrecipient

Northwest Nazarene University

Project Summary

Precision agriculture techniques hold much promise for Idaho specialty crops and will potentially allow growers to maximize yield while controlling crop input costs. While precision agriculture holds great promise, it is challenging to implement in specialty crops because managing specialty crops, such as apples or grapes, typically requires significant manual labor. For example, it is not uncommon for grapes and other fruit to be pruned and/or harvested by hand. Even the seemingly simple task of estimating fruit yield can consume multiple days of a laborer's time since the fruit on the trees must be manually counted. Therefore, precision agriculture techniques add to an already expensive manual labor burden that specialty crop growers must shoulder. One way that labor costs can be reduced and labor-intensive precision agriculture techniques made feasible is through the use of automation. Robots can cheaply do many manual-labor tasks and significantly enhance the productivity of the specialty crop laborer. While the agriculture industry has seen significant innovation in robotics, many of these robots are intended for standard row-planted crops (e.g., self-driven combines). Therefore, there is a need for robots tailored specifically for the specialty crops grown in Idaho.

The purpose of this research project was to design and prototype the IdaBot – a low-cost, autonomous utility robot to assist Idaho specialty-crop growers in the day-to-day maintenance and harvesting of their crops. The project was completed successfully by 4 undergraduate engineering students between October, 2015 and May, 2018. The IdaBot prototype has successfully demonstrated 1) autonomous navigation of a vineyard and 2) precision application of chemicals to grape vines to reduce waste from overspray.

Project Approach

The IdaBot prototype was built upon a relatively small, track-driven robotic platform purchased from SuperDroid Robots, shown in Figure 1. In its unmodified form, the robotic platform could be driven with a remote control, but in this project, the robot was outfitted with sensors, controllers, an RFID reader, and a small tank sprayer to allow it to autonomously navigate and apply chemicals in a vineyard. The final IdaBot prototype is shown in Figure 2. Although the robotic platform and tank sprayer are certainly smaller than what would be needed for day-to-day farm use, they provide an easy means to demonstrate how RFID can be used to autonomously navigate a robot through a vineyard or orchard and apply chemicals in specific locations without the need to work with large equipment. The techniques demonstrated on this small prototype of the IdaBot can be transferred to other, larger vehicles.



Figure 1: The track-driven robotic platform purchased from SuperDroid Robots. The unmodified robotic platform could be driven with a remote control, but in this project, it was outfitted with sensors, controllers, an RFID reader, and a small tank sprayer to allow it to autonomously navigate and apply chemicals in a vineyard.

The IdaBot prototype autonomously navigates by following a heading providing by a magnetic compass and determining the distance that it has traveled using motor encoders. While these sensors may, in principle, allow the robot to autonomously navigate, they are prone to errors that accumulate with the distance traveled. For example, if the tracks of the robot slip on soft dirt, the encoders may report that the robot has travelled some distance, while, in fact, the robot has not moved at all. Therefore, an RFID system is used to provide error corrections to the robot so that it can accurately determine the distance that it has traveled and also determine when it is adjacent to a particular vine or tree. The RFID navigation system works as follows: small, passive RFID tags (shown in Figure 3) are placed above the grape trellis (or on an orchard tree), as shown in Figure 4. The RFID tags are passive (i.e., they do not contain a power source) and are encapsulated in plastic, allowing them to remain in the vineyard for many years without maintenance. The RFID tags are read by an RFID reader mounted on the IdaBot. By applying a spatial-averaging algorithm to the phase of the radio frequency signals received from each RFID tag, the IdaBot's distance to each tag can be determined with resolution up to 3-4 inches¹. Since the RFID tags are fixed on the grape trellis, knowing the distance from the IdaBot to each tag allows the IdaBot to remain centered between the grape trellis rows and accurately estimate how far down the trellis row it has traveled.

The IdaBot prototype was tested on the NNU campus and at Bitner and Williamson Vineyards prior to its demonstration at Williamson Vineyard on April 27, 2018. In the testing and the demonstration, the IdaBot was able to perform the following:

1. Read RFID tags attached to the grape trellis and estimate the distance to each tag.
2. Sense that it was not centered between the grape trellis rows and make a correction.
3. Accurately estimate the distance traveled down the grape trellis row
4. Turn on/off the sprayer when passing a certain set of RFID tags

These abilities form the core of what must be done for the IdaBot to autonomously navigate a vineyard and apply chemicals. Therefore, we consider the IdaBot prototype a success. Of course, much more work is needed to turn the IdaBot prototype into a commercially viable tool for growers. Improvements that may be pursued in future research or a commercialization effort include:

1. Transferring the RFID navigation technology to a larger robot platform and a larger sprayer. A small tractor would likely be a good choice.
2. Optimize the software for speed and robustness.
3. Modify the RFID distance estimate algorithm to so that it can frequency hop (as required by the FCC for commercial use). Frequency hopping was ignored for the IdaBot prototype to simplify this proof-of-concept project.

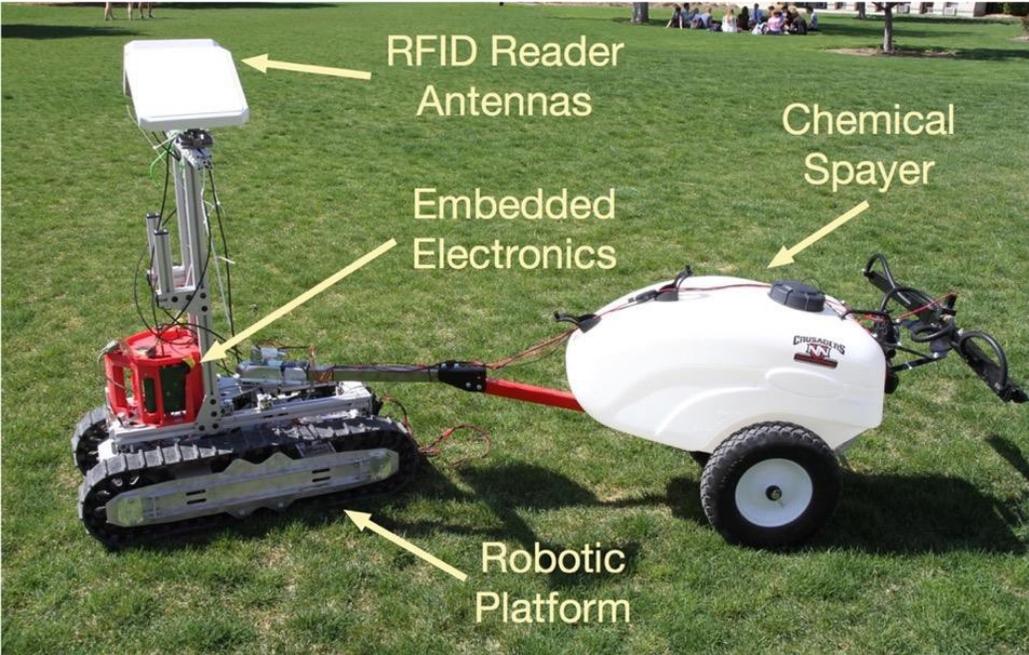


Figure 2: The final IdaBot prototype showing the robotic platform, embedded electronics (microcontrollers and sensors), the RFID reader antennas, and the tank sprayer.



Figure 3: One of the RFID tags that was mounted on the grape trellis row to allow the IdaBot to autonomously navigate.

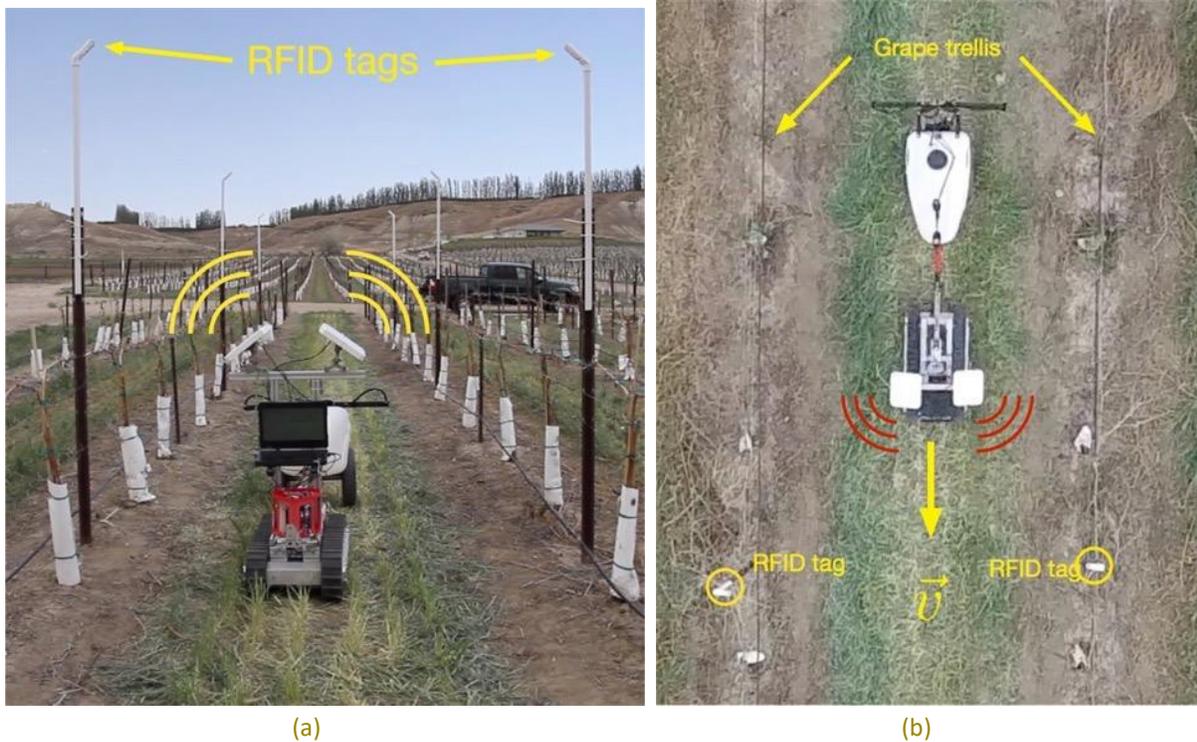


Figure 4: The Idabot navigating a grape trellis row at Williamson Vineyard from a (a) front and (b) aerial viewpoint. The RFID tags are mounted above the grape trellis on white poles. Three pairs of tags can be seen in (a).

Goals and Outcomes Achieved

The first objective of this project was to reduce the operating cost for specialty crop growers by developing the IdaBot, an autonomous utility robot that can navigate a vineyard or orchard. This objective was achieved through the following goals:

Goal 1: The performance results of the IdaBot prototype will be published in a regional and/or international conference.

Outcome 1: To this date, the IdaBot project has been presented at the following conferences:

- **Idaho Conference on Undergraduate Research:** Richie Grindstaff and Lucas Pomeroy presented a poster titled *“IdaBot: An Autonomous Utility Robot for Managing Idaho Specialty Crops”* at the 2016 Idaho Conference on Undergraduate Research. The project was well received by the audience, see Figure 5.
- **RFID Journal Live:** The RFID Journal Live Conference is an international tradeshow and conference focused on RFID technology and was held in Phoenix, AZ from May 8-11, 2017. Dr. Griffin presented a talk entitled *“IdaBot: An RFID-enabled robot to reduce labor costs and increase productivity for farmers.”* The talk was well received and Dr. Griffin was invited to speak again at the next RFID Journal Live event; however, he was unable to do so because scheduling conflicts.
- **American Society of Agricultural and Biological Engineers Annual International Meeting:** The conference was held in Spokane, WA from July 16-19, 2017. Lucas Pomeroy and Duke Bulanon presented a talk entitled *“A Navigation System for an Unmanned Ground Vehicle Using Radio Frequency Identification Tags.”*

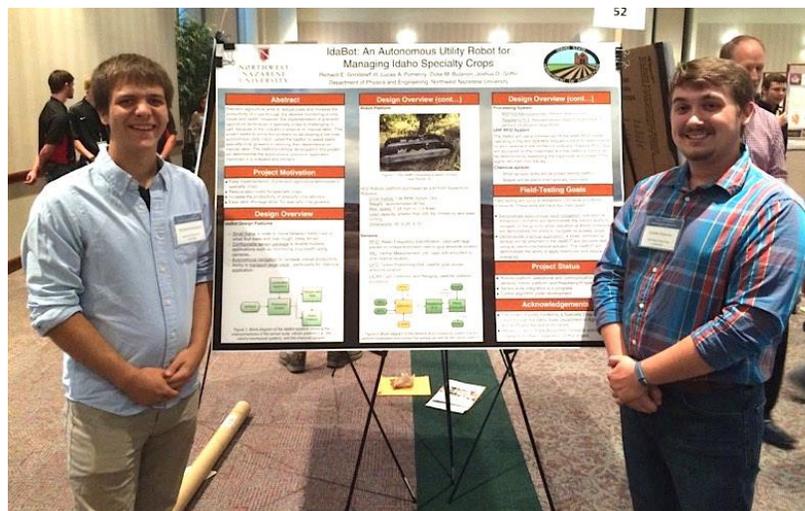


Figure 5: Richie Grindstaff (left) and Lucas Pomeroy (right) presenting their IdaBot poster at the Idaho Conference on Undergraduate Research in July, 2016.

Goal 2: An overview of the IdaBot project and performance results will be made available to specialty crop growers on a website hosted by NNU.

Outcome 2: A website surveying the IdaBot project has been created. The website can be accessed at the following address: <https://engineering.nnu.edu/research/idabot>

Goal 3: A demonstration of the IdaBot will be given to at least 20 grape growers in the Sunny Slope area, near Caldwell, Idaho. The demonstration attendees will be given a survey to assess the impact of the IdaBot prototype on vineyard/orchard operations and seek feedback on desired changes or functionality for the IdaBot.

Outcome 3: The IdaBot was demonstrated to 20-25 people on April 27, 2018 at Williamson Vineyard (a vineyard on Sunny Slope near Caldwell, ID). The attendees were a mix of growers, students, faculty, and other interested parties. Each attendee was given a survey to assess the perceived usefulness of the IdaBot. Unfortunately, only 3 completed surveys were returned. The survey results are presented in the following table:

	<i>Low</i>			<i>High</i>	
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
1. Usefulness of IdaBot for orchard/vineyard work				33%	67%
2. Danger of using IdaBot in the orchard/vineyard	67%	33%			
3. Interest in using IdaBot				33%	67%
4. Rate the importance of cost in acquiring IdaBot				67%	33%
5. Rate the importance of ease-of-use in using IdaBot				33%	67%

Each survey provided an area for comments. We received the following comment from one grower: “This is exciting technology that I see many avenues for Potential uses from performing tasks Like mowing, spraying, But at the same time measuring would Be an amazing tool. Im very greatfull to be able to cooperate with you.”

Goal 4: A manuscript describing the results of the project would be submitted for publication in a peer-reviewed journal.

Outcome 4: Time has not yet allowed the preparation of manuscript for peer review. While we certainly hope to report this project in a peer-reviewed journal, the manuscript will have to be prepared after completion of this grant.

Goal 5: Present the project at the University of Idaho Annual Fruit Day.

Outcome 5: The Fruit Day event was not held in 2017 or 2018; therefore, the IdaBot project was not presented.

A second objective of this project is to increase the awareness of technology use for farming among the next generation of farmers. This objective was accomplished through the following goals:

Goal 6: The IdaBot will be demonstrated to at least 20 students enrolled in the pre-engineering program led by Dennis Zatterio at Caldwell High School in Caldwell, Idaho.

Outcome 6: The IdaBot has been shown to the following groups of high school students:

- **Southwest Idaho Manufacturing Alliance Made Here Expo and Job Fair:** The IdaBot was displayed at the Expo on October 4, 2017, which was held in the Ford Idaho Center in Nampa, ID (see Figure 7). Hundreds of high school students from the Treasure Valley attended the Expo and many expressed keen interest in the IdaBot project.

- **Vineyard Demonstration:** pre-engineering students from Caldwell High School and their instructor, Mr. Dennis Zatterio, were invited to attend the demonstration at Williamson Vineyard; however, only Mr. Zatterio attended.



Figure 6: An aerial view of the people gathered for the IdaBot demo at Williamson Vineyard



Figure 7: Dr. Griffin describing the Idabot to a group of high school students at the Southwest Idaho Manufacturing Alliance Made Here Expo.

Beneficiaries

The following groups have been impacted by this project:

- **Idaho Specialty Crop Growers:** At least 4 grape growers were involved with the project and at least 3 attended the demonstration. Furthermore, the project has been featured in numerous media outlets including those targeted at members of the agriculture industry (i.e., Capital Press and The Spokesman, see the list of press coverage at the end of the report).

- **Idaho Agriculture Technology Sector:** The chief technology officer of a local software company that works in the agriculture industry attended the IdaBot demonstration. We hope that this project will help generate interest in specialty crop applications for the Idaho technology industry by calling attention to several of the needs for implementing precision agriculture techniques in specialty crops and demonstrating a potential solution for some of those needs.

- **Idaho Students:** This project was shown to a few hundred high school students at the Southwest Idaho Manufacturing Alliance Made Here Expo and Job Fair and has directly enhanced the studies of the 4 undergraduate engineering working on the project. This project has exposed all of these students to engineering applications for specialty crops. We hope that the success of this project will encourage some of these students to pursue an engineering career related to agriculture.

Lessons Learned

1. In this first proof-of-concept prototype of the IdaBot, the RFID tags were placed above the grape trellis on poles. This placement was chosen because it is optimal for the localization of the RFID tags. However, we learned during the course of this project that this placement would be problematic for some automated grape pruners and harvesters whose machinery extends over the grape trellis. In the opinion of the growers we spoke with, a better placement for the RFID tags would be just above the ground on the trunk of the grape vine or on the first trellis wire. Future research is needed to evaluate the effectiveness of the localization algorithm for tags in these positions.

2. Although the IdaBot project was a success, its scope was too large for a small team of undergraduate students. At times it was difficult to make progress on the IdaBot prototype and a grant extension was required. Choosing a smaller project scope will allow the project to be completed within the original grant period and allow more time for analysis of results.

3. At the beginning of the project, we chose to purchase a track-driven robotic platform because we believed that it would be able to navigate tough terrain. However, we found that rocks and grass were occasionally stuck in the tracks. In the future, a better choice would be to use a robot with four, independently-powered wheels.

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Western Treasure Valley Pumpkins

Subrecipient

Snake River Economic Development Alliance (SREDA)

Project Summary

This project has been amazing! Our original purpose was to figure out how to successfully grow pumpkin snack seeds, as well as harvesting, cleaning and drying them for the USA market. Because the seeds are hull-less or naked, there were certain challenges with planting, harvesting and cleaning that we learned along the way. The USA food processing industry is focused on natural products and pumpkin seeds have found a niche. They are used in raw energy bars, processed energy bars, toasted with flavor as a snack seed and also used for pumpkin butter. The photo to the right is that of one of the



potential markets for USA grown snack pumpkin seeds. SuperSeedz has historically purchased their seeds from China and they, like many other companies, are searching for a USA grown source of pumpkin seeds. There are very few locations in the USA that have the quantity that is needed. For example, SuperSeedz indicated that they wanted 5 million pounds. So our local farmers asked, “why not grow them in Idaho?”

The project started out with obtaining the proper kind of seeds. We traced a seed source from the late 1960’s in Northern California to Western Oregon to the University of New Hampshire where we were given samples of seeds that they were developing for the snack industry. This worked great for the 1st year of testing at the OSU Malheur Experiment Station as well as a few small plots on farmer’s fields. However, when we went to order seeds the next year, it was difficult to find any quantity within the seed industry. Additionally the harvesting of the pumpkins the first year, was done by hand, and is not a viable solution.



Test plots for the pumpkin seed



Harvesting and cleaning the seeds by hand

The farmers began to look for equipment and found that there was nothing readily available. They realized they had a great potential market and could grow the crop, but lacked the means to harvest and process

the crop for market. Therefore, they reached out to the Idaho State Dept. of Agriculture and Snake River EDA for assistance.

Project Approach:

We reached out to several organic farmers as well as other specialty crop growers in the Western Treasure Valley to see if there was interest in test growing the seed pumpkins. We had several who were interested and took seeds to plant. The organic growers had a few issues with pest control, but seemed to have found solutions. The other growers were able to grow the crop, experimenting with the best practices that have worked at the University of New Hampshire, and Malheur OSU Experiment Station, and under the direction of seed scientist, Ron Amarel. The unforeseen shortage of seeds available for planting was not something that we had considered, so the partnerships we had started developing proved to be very valuable. Ron helped teach the growers how to grow the seed as a seed crop due to the shortage of seed available at planting time. As the project progressed, we saw some of the seed companies start their



research and propagation of the seeds for commercial use. This is a key factor in being able to provide a customer with a million pounds of harvested and cleaned product. Another area of concern was to locate the right kind of equipment that could be set up to harvest, wash, and dry the delicate pumpkin seeds. The farmers spent a considerable amount of time researching where to find used equipment that was for sale and companies that could manufacture new equipment. What had other farmers done back in the 1960's and 1970's? The result of their investigating was that many of the current processes were proprietary and there was no access to the information. However, they were able to locate some equipment in a bone yard that had been used previously in the late 1960's. They were able to purchase the equipment and transport it from California to Idaho where it was refurbished. The photos above, left, shows the smaller unit used the 1st year of the project on the larger fields as well as for the smaller organic farmers. The photo above, right, shows the larger harvester that was revamped from the junk yard.

During the last year of the project, and after a great deal of publicity through the local newspapers and multi-state agricultural publications, we were contacted by another farm in the Midwest who had run into

similar harvesting issues as we had in Idaho. They had just found a new company in Turkey who was going to produce a harvester that was very affordable for the farmer. This was a great connection and our farmers began discussions with the Midwest farm and the company from Turkey. The farmers ordered the harvester and will be able to harvest more efficiently with a cleaner product than with the failing 1970's harvester.

During the project, the farmers were building a network of partners while they researched. These partners were also instrumental in helping educate the farmers on tricks of the cleaning and drying processes. The first year using equipment for harvest, they found that the cleaning station was not adequately cleaning the pumpkin slime off of the seeds. They then tried to blow off the extra pumpkin waste, but the seeds were still not as clean as they should be. This required even more research and development so that the product could be presentable for marketing. The next year this addressed and a system was put in place at an abandoned dairy that had the infrastructure in place to handle the cleaning.

The farmers were also able to develop storage for the seeds for future sales and in some cases for seed production. This proved to be very valuable when they lost one season of pumpkin harvest due to an early and long lasting winter with record breaking snow fall. Only a couple of the organic farmers were able to harvest their test plots. Most of the growers were not able to get into their fields before the snow hit. This past year, the crop did very well and the farmers harvested earlier than normal to avoid any potential snow issues.

Goals and Outcomes Achieved:

We have not only grown the awareness of the potential of this snack seed crop to other growers and seed companies, but we have also connected with farms in the Midwest via this grant program and subsequent reports on our progress. Eckler Farms, Michigan, has been trying to figure out some of the same frustrations that we have been such as where to get the seeds from, how to grow and harvest the product and how to process it.

They reached out to us and we were able to connect to one of our Idaho farmers. They worked together on finding a new company in Nevsehir, Turkey, that was trying a prototype pumpkin harvester that was not only efficient but would also be affordable for the everyday farmer. Thanks to the grant and our farmers working collectively, we were able to secure one of two harvesters that are now in the USA.

Pumpkin harvest is almost complete for this year. Acreages were down a bit from the previous year, but access to seed for planting is still a barrier. Therefore, Idaho farmers are focusing on seed production, with sales for seed snacking as a secondary option. Additionally we have local seed companies that are gearing up for the need for seed.



This project was very successful and through the 2 year process we had to revise some of our pre-conceived notions that we started with, but overall it turned out very positive for our Idaho growers as well as for our neighboring growers in Oregon.

On the marketing side, the demand is still very strong for purchasing USA grown pumpkin snack seeds. It's a great problem to have, but it will be great to have the quantity we need to hit the market full speed.

Expected Measureable Outcomes:

Increased Knowledge among producers with harvesting techniques of hull-less (Naked) pumpkin seeds.

Year 1: Target 10-15 producers through onsite tours/training as well as follow up educational seminars/meetings to share the techniques. October through December 2015. We have been successful in educating the area growers on the use of pumpkin snack seeds in their crop rotation plans. We have had the expertise of seed scientist and the OSU Malheur Experiment station assisting us in the education portion of the crop.



Year 2: Target 35-50 producers through onsite tours and training as well as follow up educational seminars/meetings to share the techniques. January through February, 2016 and then during October through December 2016. Again we were fortunate to have the Malheur Experiment station work closely with us on the project in addition to the group of farmers in Idaho that were growing the seeds. A change in personnel at the Extension service created a void in the 2017 planting of the pumpkins at the experiment station testing plots.



Basic and advanced increased knowledge for growers who are focused on naturally and organic grown hull-less pumpkin seeds. Establish Best Management Practices that meet or exceed required state thresholds. Target 4-10 producers. December 2015 and January 2016. We had 4 farmers who tried to grow the pumpkins naturally/organically. They

were very successful, however, the limiting factor was the harvesting and processing of their small plots. These ended up being done by hand and were very time consuming.

Increased knowledge among producers/growers in handling the hull-less (Naked) pumpkin seed through washing, drying and packaging, with emphasis on a high quality, locally grown product. Target 10-25 producers. December 2015 and December 2016 – We have been developing a plan to monitor the success of farmers' adoption of new techniques and best management practices. The farmers have been very good about sharing the techniques that they have found to be useful when growing and harvesting the pumpkins. Although we did not do the individual surveys, we helped coordinate several smaller, very successful, producer meetings for the benefit of sharing best management practices.

We were able to get information out about the pumpkin snack seed project through our website, the Capital Press (5 state farm publication), the Idaho Business Review, and the local bi-state newspaper, the Argus Observer. Because of this effort, more contacts were made for the farmers and the pumpkin seed industry for both processing and sales! Being able to have the avenue to sell the crop is huge and we feel that we have accomplished that. We did discover that we still had a seed shortage for growing the crops. This past growing season, much of the seed will be used as a seed crop and not for human consumption. The seed, if stored correctly, can be viable for 2-3 years. Our scientists are working with the local growers to develop their own varieties so that we will have the seed available as we move forward.

HARVESTER: The specialized Harvester will only be used for technical and on farm research plots. Because there are no harvesters currently designed for a hull-less pumpkin snack seed, this will be experimental and used to help develop a machine that is capable of handling the semi-bush plants, breaking up the meat and extracting the seeds in the field. During the 2 year process we utilized a very old and small hand operated machine; a very large machine that was used in the 1960's and pulled by a tractor; and finally we plan to try a smaller, yet very efficient machine that has just been developed overseas in Turkey and is now available to the USA. Finding information on the harvest process has been a long ordeal. Several small existing farms/companies are unwilling to share their "secrets" – Our farmers, as well as our seed scientist, were diligent and traveled to Western Oregon, California and other regions trying to find the right kind of equipment for use in Idaho. The recent connection with the Michigan farms has been very helpful – without this project that connection would not have been made.

PROCESSING: The processing of the pumpkin seeds seemed to go through several stages of growth over the 2 years. The first year the washing was not enough and the seeds were plagued with strings of pumpkin meat. They dried the seeds in make shift dryers and then tried to air blow off the unwanted pumpkin trash from the seeds. This was not very successful. This past year, the experimental wash station was upgraded and worked much better. The farmers involved have been to numerous seed cleaning facilities around the west coast trying to find solutions for processing the seeds efficiently and economically. The air dryers are probably the easiest to develop as there are many types of dryers for other seed crops that could be modified for the pumpkin seeds.

Overall Success

The pumpkin snack seeds were successfully grown here, which is not a surprise to anyone in the Western Treasure Valley area. However, more research is needed to fine tune the variety of seed used as well as the best management practices that would be recommended. Soil types seemed to play a big role in whether the field was to be pre-irrigated, as recommended by the scientists from University of New Hampshire to avoid mildew and spoilage (seeds have no shells for protection), but one of our organic growers had very sandy soil and he lost his first crop. He learned to adapt and irrigate the seeds up that were planted in his soil type.

Other issues were crop diseases as discovered by the OSU Experiment Station plot tests; harvesting dates and potential seed sprouting within the pumpkin itself; and the exploration of other growing techniques. Several of the growers have stated that, even though the data and information on growing the pumpkin snack seeds, they will continue to allocate a percentage of their farm acres to the crop. The seed scientists continue to work closely with them as well as some of the new growers.

Beneficiaries and Economic Impact

The impact was to identify the specialty crop stakeholders who would benefit from the implementation of this project. We started with a potential of 6 farm sites, including 1 Idaho Certified Organic site. There was a larger group of approximately 12-18 growers that indicated they would like to participate but without any way to harvest (other than manually cutting the pumpkins and scooping out the seeds) they were very reluctant to invest and plant. The introduction and refinement of processes has opened up numerous possibilities for our growers in Idaho and surrounding states. Admittedly, the project is still in its infancy, but is moving forward with several farmers interested; and the possibility of the snack seed pumpkins being a major crop in the Western Treasure Valley is limited. The growers and producers have proved that they can grow the pumpkins and it is a viable crop as part of their 4-5 year crop rotations. We believe it will continue to be a specialty crop – but not like the potatoes and onions grown here.

This project allowed for the development of equipment that is capable of harvesting, cleaning and processing the seeds. This is a major milestone as the type of equipment needed was one of the biggest challenges this project faced. The type of equipment needed to develop this specialty crop in Idaho was not available at the local John Deere Dealership. The team did extensive research on what is available and made trips to California to try and find used equipment. However, there is very little available. They have found a couple of harvesters from the early 70's that have been decommissioned and are not usable. The original USA company that had the capability of making a harvester that would work was no longer in business. There were 2 individuals that had the ability to create these specialty harvesters located in Northern California. Their cost was well above the anticipated \$50,000. The team looked at other types of harvesters such as a cucumber seed harvester, but with the type of changes that would be required, the cost would be prohibitive – fruit size and seed types were very different. The team also looked at a unique harvester in Western Oregon, but the harvester is proprietary and not available on the open market. A test

plot harvester was located and transported from Northern California. It was a hand fed machine and in poor condition. It cost about \$12,000 to get it operational and was limited to harvesting about 1-2 acre plots. As mentioned above, 2 other machines were eventually located. One out of a 'bone yard' that was fixable and very large and the 2nd one from Turkey.

In conclusion, the project was a success. There is a strong market for the crops grown both in the USA as well as internationally. We continue to field calls with regards to purchasing large quantities of the pumpkin snack seeds. At this point, we have not developed the acreage needed to hit the 5 million pounds per year of seed threshold. We anticipate that it will take a couple more years of research and development with cooperation from both the farmers and the seed scientists to be at that level of production.

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Impact of Canopy Design, Cluster Management, and Cultivars on Quality, Yield, and in Table Grapes

Subrecipient

University of Idaho

Project Summary

The University of Idaho Pomology and Viticulture Program in Parma has experimented with numerous genotypes of table grapes and as a result, a new table grape industry, is emerging in Idaho. However, there are challenges facing this industry, and this study will address two of these major areas of needed research in Idaho. In this proposed project we studied the effects of various canopy designs and cluster numbers in 'Alborz' table grapes (the major table grape in Idaho, introduced from our program) on yield, berry and cluster quality, cold tolerance, and disease infections. We also studied performance, fruit quality, and sustainability of the newest 16 cultivars of table grapes under conditions of the Intermountain West. In 2016, 20017, and 20018, vines with a quadrilateral structure had significantly higher yield than those with a one-sided bilateral cordon structure, while no major difference existed in their berry quality. Among grape cultivars from Sheegene's Genetics, 'Sheen-20-Allison' had the most outstanding clusters and berry shape, cold tolerance, and quality, followed by 'Magenta Seedless', and 'Timson'.

Project Approach; Methodology, Data Collection and Vineyard Cultural Practices:

Objective 1; To Study the effects of canopy design and management on yield, fruit maturity and quality, cold tolerance and disease infections of table grapes: For this objective, three different canopy designs were established in 'Alborz' table grape in March 2016. The canopy designs were: 1) Quadrilateral canopy: In this system, the main trunk was cut at about 52-inch height from the ground level and two 18-inch arms (short arms) were trained at an about 90o degree angle on the trunk. On each of these short arms, a bilateral cordon system was established. Therefore, each vine will have 2 bilateral (Quadrilateral) structures. At least seven support wires were installed through these cross arms to form a trellis system. Risers were trained on both sides of these trellis walls. 2) One-sided/Tilted Bilateral Cordon canopy: In this system, the main trunk was cut at about a 55-inch height from the ground level and a bilateral cordon system was formed on each vine. However, in this system, the entire canopy was laid on one side of the V shape wall (that was described earlier). Each vine was trained in an alternate orientation to the previous vine. For example, if one vine was laid on the east side of the trellis wall, the next one was on the west etc. 3) Traditional Bilateral Cordon system: The vine spacing and wooden post support in this technique was similar to those of Quadrilateral. However, cordon arms were trained to a bilateral system at about 55-inch height.

Within each canopy system in 'Alborz' table grapes, three levels of crop loads (three different numbers of cluster per vine) were established in March 2016. However, based on the unusual growth pattern, we changed the crop load treatments and used only vines with a quadrilateral cordon system, either with "resting" or "non-resting" spur system. In vines with a "non-resting" spur system, eight 3-bud spur structure were left on each arm and the remaining shoots were removed completely in 2016. Each arm in the "resting" system was permitted to have up to a maximum of 16 clusters (2 per 3-bud structure). In vines with "resting spur" structure, eight 3-bud spur structure were left on each arm and the remaining shoots were removed completely. However, fruits of four 3-bud spur structure along each arm were removed, allowing up to 2 clusters per remaining 3-bud spur structure (total of 8 clusters/arm). Fruit were harvested and evaluated for cluster size, yield, and sugar.

In January 2017, temperatures plunged down to -21 F, seriously damaging or killing fruiting buds in both wine and table grapes region-wide. We cut down all damaged and dead portions of these vines and rejuvenated them. Under this situation, we maintained a 3-bud spur structure in all systems. In 2018, vines in each of the three canopy systems were trained into either four 3-bud spurs or eight 3-bud spurs in each of three canopy systems. Fruit were harvest in mid-September each year and fruit quality attributes including cluster numbers, yield, soluble solids and berry size in each treatment were measured during 2016-2018. Fruit quality attributes after 3 to 6 weeks of storage were also evaluated.

Objective 2: Fourteen new genotypes of table grapes were planted at the University of Idaho vineyard during the spring of 2015 and 2016, each in four 3-vine blocks (total of 12 vines per cultivar). These genotypes include: 'Magenta Seedless', 'Timco Seedless', 'Allison Seedless', 'Sheegene 21 Seedless', 'Timpson Seedless', 'Great Green Seedless', 'Key Seedless', 'Luisco Seedless', 'Early Globe', 'Improved Red Globe', 'Persian Gulf', 'Improved Calmeria Type', 'Green Globe Type', and 'Sheegene 16'. These plants were trained to a tall bilateral cordon system in spring of 2017. Vine survival were measured in spring of 2017, and 2018. Fruit quality in fruit-bearing cultivars were measured in 2016-2018.

Goals and Outcomes Achieved

Goals and purpose: Suitable land and water for fruit production is decreasing as world population is increasing, and this trend mandates a more efficient use of vineyard lands and growing unique fruit with a greater margin for profitability. Our first goal in this project was to study the effects of canopy design and spur management on yield, fruit maturity and quality, and cold tolerance. The outcomes of our first goal were extremely successful and these outcomes are listed as follows:

1. In 2016, 2017, and 2018, vines with a quadrilateral structure had significantly higher yield than those with a one-sided bilateral cordon structure, while no major difference existed in their berry quality.
2. Vines with an either one-sided canopy or quadrilateral cordon had much better fruit finish, and thus higher pack-out (packable clusters) than those with a straight bilateral cordon (traditional training) in all 3 years.
3. Pressure of powdery mildew disease was much less in the vines with a quadrilateral cordon and one-sided canopy as compared to those with a bilateral cordon with lower height from the ground levels.
4. Post storage life and fruit quality of grapes in the vines with a quadrilateral cordon or one-sided canopy was better than those with a simple straight bilateral cordon.
5. Crop load was lower in the "resting"/ non-resting" treatment than that in vines with an eight 3-bud structure (control) in 2016.
6. No clear pattern was found between berry quality in the vines with four resting and four fruiting spurs and those with eight 3-bud fruiting spurs in 2016. This was due to the unusual growth pattern in 2016.
7. Previously resting vs. non-resting structure did not seem to prevent the freezing damages when temperatures were extremely low (as was the case in the winter of 2017). Most of the new shoots in 2017 grew directly from the main arm or from the lowest bud.
8. Yield in vines with eight 3-bud/arm structure was higher than those with four 3-bud/arm 2018, structure in all three canopy architectures, while fruit quality was similar in both crop load treatments. This suggests that there is no advantage to cut the number of fruiting spurs lower than eight 3-bud spurs per arm under conditions of our study in fully mature vines and having eight 3-bud per vine is not imposing excess stress on these established vines. Cutting number of clusters of 'Alborz' table grape in newly-established young vines did improve cluster and berry quality attributes in our earlier studies.

As part of our goal, we provided several vines to our cooperators. Those materials were planted in Sunny Slope, Parma, Payette, and Emmett Idaho by our cooperators. We monitored their progress and their results

were similar to ours. All cooperators were pleased with establishing the height of their vines at about 6 ft from the ground level, the way we suggested.

Our second goal in this study was to study the effects of 16 new genotypes of table grapes, each with 12 vines on vine survival, growth, cluster shape and berry quality over 2016-2018. The findings of this objective were as follows:

1. Major differences were found among different cultivars in their tolerance to freezing temperatures. 'Thomcord' grapes survived 100% without any damage and had a full crop in 2017 and 2018. 'Persian Gulf and Alborz also survived better than other tested cultivars and thus recommended for planting under conditions of this study.
2. Berry weight of 50 berries in this cultivar ranged from 128 to 188 grams. Berry diameter and yield per vine in 'Thomcord' ranged from 15 to 18 mm and from 4.4 kg to 20 kg/vine, respectively in 2017 and 2018.
3. Among grape cultivars from Sheegene's Genetics, 'Sheen-20-Allison' had the most outstanding clusters and berry shape, cold tolerance, and quality, followed by 'Magenta Seedless', and 'Timson'.
4. Based on the results of our study in southwest Idaho, we conclude that 'Allison Seedless' may have a good potential for planting under conditions of intermountain West region. Performance of this cultivar under different canopy designs deserves further study.
5. We stored these grapes in regular atmosphere storage and they were evaluated after 2 and 3 months. Post storage quality attributes of these cultivars were consistent with their performance at harvest. Cultivars that had earlier maturity or had bird and wasp damages had shorter storage life.
6. We tested some vines from 'Sheegene's Genetics that showed symptoms of virus infection at the virus detection laboratory at the University of Idaho in 2018. The results showed that some of these grapes had virus. In the infected plants, stems and risers were long (leggy) and twisted and leaves were studded. 'Allison Seedless' had fewer symptoms than other Sheegene selections. Vines of 'Alborz' and 'Persian Gulf' grapes were perfectly healthy and had no signs of any virus. Obviously, growers must demand clean stocks when purchasing any grape vine.

Measurable Outcomes

We clearly achieved our original objectives, as observed in the outcomes. We have observed a movement towards production of table grapes in Idaho, Utah, Oregon, Colorado, and Washington as a direct result of our project. Idaho growers are finding a niche market in which they can make a higher income than their traditional crops. Following the findings of this study, the majority (over 90%) of table grape growers are training the vines at about 56-60 inches above the ground level rather than traditional 46 inches.

We monitored the number of specialty crop producers who participate in our workshops and tours, and field days, and interviewed them in person or by e-mails and follow to see how many of them are growing table grapes, using our recommendations. We concluded the followings:

1. At least 130 small businesses, home gardeners, commercial growers, families, and numerous workers in various sectors of fruit production and packinghouses are affected by this project in different ways. We believe that the production of table grapes in Idaho has increased at least by three folds because of this study and as a result of our previous table grape research projects.
2. Many of these table grapes or their bi-products, such as raisins and grape juice are appearing in farmers' markets in different cities of Idaho. Examples for the increase in table grapes because of our project is as follows:
 - a. There is two 6-to 8-acre commercial planting of table grape in Emmett in two locations, using our varieties and training systems.

- b. There is a 2-acre commercial planting of table grape in Fruitland, a one-acre vineyard in Eagle, and two 3-4-acre vineyards in Sunnyslope, Idaho.
 - c. Following the findings of this research, there are numerous (at least 45) small-scale table grape growers, in addition to those mentioned in items 2-a and 2-b, in southern Idaho, Riggins, and Lewiston Idaho, who sell their fresh grapes or raisins at Farmers' markets.
 - d. Using our recommendations and based on the results of this study, four major commercial grape production are established in St. George, Utah, Mesa Colorado, and near Salem Oregon.
 - e. Receipts are developed and/or improved for making jellies, jams, sour grape juice for Mediterranean style food, and raisins in Idaho. For example, some growers in Riggins area have started producing raisins from our selected grape cultivars and canopy systems. These raisins with different flavors (cinnamon, sugar powder, etc.) have entered in the market now.
 - f. There is much less market competition and thus, more demand and potential profit for table grape production than traditional fruit.
3. Talking to visitors, growers, and students in our educational tours, media interviews and programs, and demonstration classes during the duration of this project, we believe that we have significantly increased the consumption of table grapes among young school and college students.
4. We offered at least 8 educational classes, 6 tours, and 5 practical workshops at different regions of Idaho, Utah, and Colorado, and New Mexico during the period of this project. In each class, we thought basics physiology on the growth and climate requirements, limitations and potential that exist for production, canopy design, and crop load management of table grapes. Each of the five tours was offered at the critical growth cycle of this crop. For example, one was offered at training and pruning time and another one at bloom time, thinning and harvest time etc. In each of the three practical workshops, we showed the flowering and fruiting habits, diseases and deficiencies, training and pruning, and harvesting to participants. We asked each participant to prune or thin these grapes by himself/herself to have a personal experience and develop self-confidence to work with alternative fruits.

Work with Cooperators

We worked with our cooperators, including some commercial and home gardeners. They have used some of the promising table grapes in their operations with great results. These cooperators have been following the progress in every step of our experiment and we have closely cooperated with their pilot studies. We expect a larger scale of application of these materials within the next few years.

Lessons Learned

Results of this project have been extremely informative. Based on our results:

1. Planting any table grapes in colder pockets should seriously be avoided.
2. Training 'Alborz' table grapes into a "quadrilateral" system will result in higher production and higher net pack out than training into traditional systems.
3. Some table grapes, particularly 'Thomcord,' 'Persian Gulf', and under low frost risk 'Alborz' can successfully be grown in Idaho and they can have a great chance for success at a commercial scale.
4. 'Allison Seedless and 'Timson' may be great cultivars for planting under conditions of southwest Idaho if clean plant materials are planted. This area needs further study.
5. Training grapes at about 58 to 60 inches from the ground level is much more beneficial than training at lower height.

6. Under severe cold conditions, leaving rested buds vs. fruiting buds do not affect the following years crop, assuming that all crop load of all vines is adjusted to a reasonable number (i.e., eight 3-bud spurs).

Beneficiaries

Based on monitoring the number of specialty crop producers who participate in our workshops and tours and interviewed them in person or by e-mails concluded that at least 130 small businesses, home gardeners, commercial growers, families, and numerous workers in various sectors of fruit production and packinghouses are positively affected by this project in different ways. We also estimate that well over 1200 people in Idaho and neighboring states were educated in classes and tours about benefits and possibilities of growing table grapes during the course of this project. Also, growers in Idaho can make more money than California growers because they “fresh” grapes later than California growers do.

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Identifying How Potato Skin Wastes Produced in Idaho Can be Used to Modulate Glycemic Response

Subrecipient

University of Idaho (U of I)

Project Summary

Background:

Idaho is the top potato producer in the United States, producing over 14 billion pounds of potato each year. Over 50% of potatoes are processed into various foods, such as frozen French fries. The potato processing industry generates over half-million tons of potato peel wastes in Idaho per year, which primary of the waste goes to landfill and a small amount is mixed with animal feeds. The huge amount of potato peel waste is a burden to the industry, and many valuable components existing in potato peels are not utilized. For example, potato peels contain an inhibitor of mucosal α -glucosidase, which is the enzyme to convert carbohydrate to glucose in the human. Potato peels also contain a great amount of dietary fiber, which has a similar function to interfere with starch digestive enzymes and manipulate the postprandial glycemic response. Potatoes are thought of as “bad foods” because many processed potato products generated high postprandial glycemic responses, which are known to be associated with obesity, Type 2 diabetes, and some chronic diseases. However, potatoes contain some molecules that have the potential to manipulate the postprandial glycemic response and promote human health.

Motivation:

The potato peel waste is a burden to the potato processing industry, and the debates of the impact of consuming potatoes on human health are confusing to the society. The project was proposed to provide a solution and clarification, which are critical to the potato and potato processing industry that directly impact the agricultural economy and sustainability in Idaho state.

Relationship with previously funded projects:

This project was funded project for the first time in FY15. Thus, it is not relevant to any of the previously funded projects.

Project Approach

Activities performed:

Approved tasks provided in the work plan (revised in May 2018, July; the last update in July 2018):

This project has four objectives, and the activities performed for each objective are listed below:

Objective 1: Investigate the influence of the potato peel wastes on glycemic response in an in vitro model

The activities performed include (1) processing potato peel wastes, (2) investigating the influence of the potato peels on glycemic response in an in vitro model, (3) investigating the mechanisms of inhibition of the potato peel extracts on starch digestive enzymes, (4) communicating with potential beneficiaries.

Objective 2: Quantify the functional compounds in potato peels

The activities performed include (1) planting and collecting potato peels, (2) quantifying calystegines, (3) quantifying dietary fiber (i.e., pectin), (4) quantifying micro-elements, (5) quantifying phenolic acids, (4) Communicating with potential beneficiaries

Objective 3: Screen the most commonly grown potato varieties in Idaho for the functional ingredients and examine their influence in glycemic response in an in vitro model

The activities performed include: (1) planting potatoes, (2) quantifying calystegines, (3) quantifying dietary fiber, (3) quantifying micro-elements, (4) quantifying phenolic acids, (5) examining the glycemic response in an in vitro model, (6) communicating with potential crop and processing beneficiaries, (7) reporting study findings at the 10th World Potato Congress, and (8) reporting results at the Potato Association of American Annual Conference.

Objective 4: Examine the effectiveness of potato peel waste on modulating glycemic response in an in vivo system – healthy and diabetic rats

The activities performed was an animal study.

Significant results and accomplishments:

We successfully obtain potato peels from three sources: J.R. Simplot (Caldwell, ID), Basic American Foods (Blackfoot, ID), and potatoes grown at the Parma Research and Extension Center (Parma, ID). The peels from J.R. Simplot and Basic American Foods were collected from their plant sites to represent the two primary types of potato peel wastes generated in the industry in the United States. The peels from J.R. Simplot was steam-peeled, and the peel waste from Basic American Foods was abrasion peeled. The five potato cultivars grown at the Parma Research and Extension Center in 2016 and 2017, were washed and then hand-peeled. A portion of potatoes grown at the Parma Research and Extension Center in 2017 was steam-peeled at the pilot plant of J.R. Simplot (Caldwell, ID). All of the peels, including industrial peel wastes, were freeze-dried, ground. The functional component is water soluble according to our preliminary study. Thus, we extract functional components using water and perform the proposed analyses.

We conducted in vitro starch digestibility studies, and our data showed that all of the potato peels obtained for this project have significant effects on two starch digestive enzymes: α -amylase and mucosal α -glucosidase. Regarding mucosal α -glucosidase, it is comprised of maltase-glucoamylase (MGAM) and sucrase-isomaltase (SI) We further separated MGAM and SI and revealed that potato peels impacted both of their activities. In the human, α -amylase quickly breaks starch molecules to oligomers, and mucosal α -

glucosidase can directly convert starch to glucose or processing the α -amylase hydrolysates to glucose. MGAM and SI have different roles in converting starch molecules to glucose. The inhibition of potato peels on all of the starch digestive enzymes demonstrate that potato peels can influence the digestion at all levels during the digestion, which makes potato peels a potential ingredient to manipulate postprandial glycemic response.

We further investigate the mechanism of the inhibition of starch digestive enzyme activities. Our data showed that potato peels interfered α -amylase hydrolytic activity through a non-competitive inhibition mechanism, which indicates potato peels alter enzyme's structure or binding with the substrate (starch molecules) and reduce the enzyme ability to hydrolyze starch. Regarding mucosal α -glucosidase, potato peels impact the enzyme glucogenesis activity through a mix of competitive and non-competitive inhibition, which indicate that potato peels can compete with the substrate (starch molecules or α -amylase hydrolysates) to bind with mucosal α -glucosidase or alter the enzyme structure or binding capacity that lead to the reduction of the glucose production.

We advanced the study by identifying several functional components that contribute to such strong inhibition on starch digestive enzyme hydrolytic activity. Regarding the calystegine, which was reported in the literature, we identified a new isoform in our potato peels and found calystegine, in addition to the inhibition on mucosal α -glucosidase, also affect α -amylase activity within the quantity identified in our potato peels. In addition, phenolic acids in potato peels have a strong influence on α -amylase activity, and we identified three primary phenolic acids in our potato peels. We also identify that pectin, the primary molecules of the dietary fiber in potato, impact α -amylase activity; however, the quantity existing in potato peels do not have a significant influence on both enzyme activities in our in vitro starch digestibility model. Several mineral components are reported to have an influence on mucosal α -glucosidase activity, but the quantity in our potato peels did not have much impact on the enzyme activity.

These inhibition effects were shown in all the potato peels that we collected, including the industrial wastes collected from steam-peeling and abrasion-peeling techniques and all of the selected processing varieties. The industry steam-peeled wastes had the highest inhibition power among all of the samples. Comparing the three peeling techniques: steam-, abrasion-, and hand-peeling, the peels collected by the steam peeling had the highest inhibitor powers. A reason is that the peels contain fewer starch molecules and a higher concentration of the functional components. For the selected processing varieties, the peels collected from 2016 had a higher inhibition power than the peels obtained in 2017. We assumed that the environment (such as temperature) has a strong impact on the concentration of those functional ingredients. Each variety is different in their inhibitor powers, but the trends were similar in two years.

We verify our in vitro findings with an in vivo model using healthy rats, and our data showed that potato peels delayed the glucose spike from 30 min to 60 min, which was a significant delay of starch digestion.

We actively communicate with stakeholders, researchers, and the food and pharmaceutical industries, and we will continue developing manuscripts for publication.

Conclusion and recommendations and favorable or unusual developments:

Our findings revealed that potato peels contain several functional ingredients that significantly affect two starch digestive enzymes and delay starch digestion. Our findings generate a few recommendations to the potato industry: (1) potato peels have a great potential to be a nature-sourced enzyme inhibitor to manipulate postprandial glycemic response, which is worth to continue the research with a focus on technology development, (2) potatoes contain several enzyme inhibitors that the breeders may consider to enhance that component to develop new varieties with a lower impact on postprandial glycemic response, (3) the consumer should reconsider the question, “is potato a bad food to glycemic response?” Delayed starch digestion is a strategy to provide sustained dietary glucose from starchy foods and provide long-lasting energy. Our data are valuable for the potato industry in the debate of the disadvantage of consuming potato foods.

Benefitted Commodities :

The overall scope of the project is to benefit the potato industry; the funds were used to solely enhance the competitiveness of specialty crops.

Contributions and role of project partners:

Lin, Amy (Hui-Mei): project leader, perform the primary study and report to ISDA
Thronton, Mike: project collaborator, planted potatoes
McGeehan, Steve: project collaborator, quantify calystegines and minerals in potato peels
Qin, Xu: project collaborator, processing a portion of potato peels for extracting functional ingredients (i.e., phenolic compounds)

Goals and Outcomes Achieved

Goal 1 - Target dieticians and other influencers of consumer information on health benefits through the development of fact sheets on the dietary fiber content and glycemic response moderating power contained in potato peels.

We presented our research findings at the Starch Digestion Consortium workshop at the USDA-ARS Children’s Nutrition Research Center at Baylor College of Medicine and Texas Children’s Hospital (Houston, TX), at the Annual Meeting of the American Society for Nutrition at the Experimental Biology Conference (ASN EB), and at the Annual Meeting of the Institute of Food Technologists (IFT). Through our presentations, we communicated with enzymologists, nutritionists, dietitians, pharmacists, and medical care providers about the potential health benefits of potato peels. We also encouraged the food industry to consider using potato peels - a natural resourced inhibitor, to moderate postprandial glycemic response.

Goal 2- Work with potato processors to document the current production and utilization of potato peel waste in Idaho, which is estimated at around 15 million pounds per year.

The graduate student assigned to assist this project was selected to give an oral presentation at the 225th American Chemical Society (ACS) National Meeting & Exposition (New Orleans, LA). The promotion of utilizing potato peels was well received, and many valuable questions and suggestions were brought by the audience regarding the progression of the in vitro study to an animal study. We also presented this project at

the 10th World Potato Congress in Peru and at the Potato Association of America Meeting in Boise, Idaho to distribute to researchers, potato growers, and potato processors at international and national levels, our research findings on utilizing potato peels. The lecture targeted all three goals with additional goals to interact with other potato processors to utilize our technology. The lectures were very well received.

Goal 3- Information on the dietary fiber content and glycemic response moderation of specific potato varieties grown in Idaho will be compiled into reports that will be shared with the four major potato processors in Idaho.

We presented our research findings at the Northwest Potato Research Consortium meeting, and we visited J.R. Simplot, McCain Foods, Lamb Weston, and Basic American Foods to promote the potential utilization of potato peel waste in Idaho. We are submitting two manuscripts to peer-reviewed journals for publication, and the graduate student assigned to this project is projected to graduate in December 2018.

Project Beneficiaries

The project benefits the entire potato industry that potato processors have a solution to utilize potato peels. The knowledge of the positive impact of potato on postprandial glycemic response and the recommendation to a variety of developers to enhance those functions ingredients will benefit the potato industry through encouraging consumption.

Lesson Learned

Through solving the problem of the lack of utilization of potato peels, we revealed that potatoes contain a good amount of inhibitors on starch digestive enzymes. Our findings change the dilemma that “is potato a bad food for the postprandial glycemic response.” Current view that is consuming potatoes causing the increase of glycemic response related sickness is oversimplified.

Some researchers are developing new varieties with a low postprandial glycemic response, and most of them focus on altering the starch structure, which leads to poor sensory attributes. Through this project, we learned that enhancing those enzyme inhibitors is a new strategy in developing low GI potatoes.

We expected that our animal study would validate ours in vitro data. We learned that potato peels do not decrease the total glucose generation but delayed the digestion. This finding generates a new nutrition value of potatoes because providing sustained energy is a new concept that will generate a lot of health benefits beyond the manipulation of postprandial glycemic response.

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Additional Information:

In our animal study, we proposed to use both healthy and diabetic rats to study the impact of potato peels on starch digestion. We decided to use healthy rats and removed diabetic rats from the study because the data generated from healthy rats were promising.

Education and Outreach for Media Professionals

Subrecipient

USA Dry Pea & Lentil Council

Project Summary

Pulses are valuable crops for the Pacific Northwest region's agriculture and are primarily grown in rotation with wheat and cereal crops. The pulse industry has been very successful in marketing pulse crops throughout the world. Despite their excellent nutritional profile, low cost and versatility, pulses – home and professional chefs often overlook dry peas, lentils and chickpeas – because full nutritional benefits are unknown, and they are perceived as bland and difficult to prepare. There is a need for proper education to consumers as well as food industry professionals, to ensure accurate information and options are presented, and presented in a way that is appealing and leads to consumption. Pulses are a cook-from-scratch menu item, which are often ignored in the heat-and-serve world of processed food of today. Education, as well as easy to prepare recipes, have never been needed more.

Public health has been the center of many political debates here in the U.S., as concerns with rising health cost associated with increased obesity, diabetes and other chronic diseases such as heart disease continue to plague the nation. The topic of health is no longer confined to discussions with medical professionals. Food manufacturers, politicians, and educators are now playing a key role in the health of nation in addition to the medical community, and consumers are taking their health into their own hands and educating friends and families about the best options available. This leads to the need for proper education to all of these channels to ensure that accurate information and options are presented, and presented in a way that is appealing and leads to consumption.

Pulses have many health benefits that can help combat the rising obesity epidemic in the nation and other health issues such as diabetes and heart disease. As one of the most cost efficient sources of protein, an excellent source of fiber and low in fat and cholesterol, pulses are a perfect fit for heart healthy food. Pulses have a rich culinary history and are widely consumed around the world. In the U.S., however, consumers and food manufacturers have gotten away from using pulses in the typical American diet. This is beginning to change as more consumers and food manufacturers are realizing not only the health benefits of pulses, but also their culinary diversity, flavor attributes and functional applications, but there is still a general lack of understanding among consumers about what pulses are and how to prepare them, and among the foodservice industry about how to incorporate them into menus, recipes and products.

Momentum in the rest of the world is building for pulses – the United Nations has declared 2016 the “International Year of Pulses” – and the USADPLC want to capitalize on this in the United States, building a base of foodservice entities as well as consumers to spread the word about benefits and usage of pulses. The USA Dry Pea & Lentil Council believes domestic trade will be enhanced with continued education about the benefits and uses of pulses. This project has not been submitted to any other state or federal grants.

National and International publications as well as social media channels in the food manufacturing/food servicing industries are seeking out relevant and useful information to pass on to their readers and followers. There has been a limited introduction of pulses to food industry

professionals at trade shows and the USADPLC's social media presence and it has created great interest among different outlets in the marketplace. However, distributing resources in its current form as reference material is only a starting point to effectively promote the adoption of pulses as mainstream ingredients in these publications. Food industry professionals need to be adequately educated to write about all the characteristics and versatilities of pulses. This training will provide them with the tools they need to move forward with the development of pulse-based stories and resources for their readers and followers. To accomplish this, the USADPLC is requesting funds for a new and unique two-and-a-half-day educational hands-on symposium targeted to editors of high-end trade publications, dietitians and Directors of national health movements like Michelle Obama's Let's Move! Campaign. The course will be conducted at the Culinary Institute of America in Napa Valley. The USADPLC has experience developing and executing product development courses that were well attended and well received. However this course will have a media focus and a full class of different food industry professionals from all over the United States who are keenly interested in educating their readers and followers of the versatility and functionality of pulses as ingredients.

USADPLC has received funds through a previous SCBGP-funded effort that focused on research and development with the course participants being chefs. This project will complement the prior project by bringing in media professionals instead of R&D chefs. By bringing media into the kitchen, we will be able to promote specialty crops in a new light. This project has not been funded previously. USADPLC does have experience with development courses; however, this project is new and focused on promoting cooking with pulses directly to the media.

Project Approach

The 2.5-day Pulses Immersion at the Culinary Institute of America in Napa Valley served as the official "West Coast" launch for the International Year of Pulses, and also a deep-dive educational event for cooking and baking bloggers, test kitchen editors and health/nutrition influencers.

To maximize the value of the CIA-organized event, Maxwell secured attendance from 40 food, lifestyle and nutrition media, bloggers and influencers. Our primary goal was to educate the contacts that have significant influence on our target audience – millennials – on all things pulses. To do so, the event consisted of a mix of educational sessions, instructional time in the kitchen and free time for experimentation that inspired and armed attendees with information ranging from how to prepare pulses, to their impressive nutritional benefits and role in food and lifestyle trends.

The event has received extremely positive praise from attendees, many of whom intend to share their newfound pulse knowledge with their reader and client bases in the coming months.

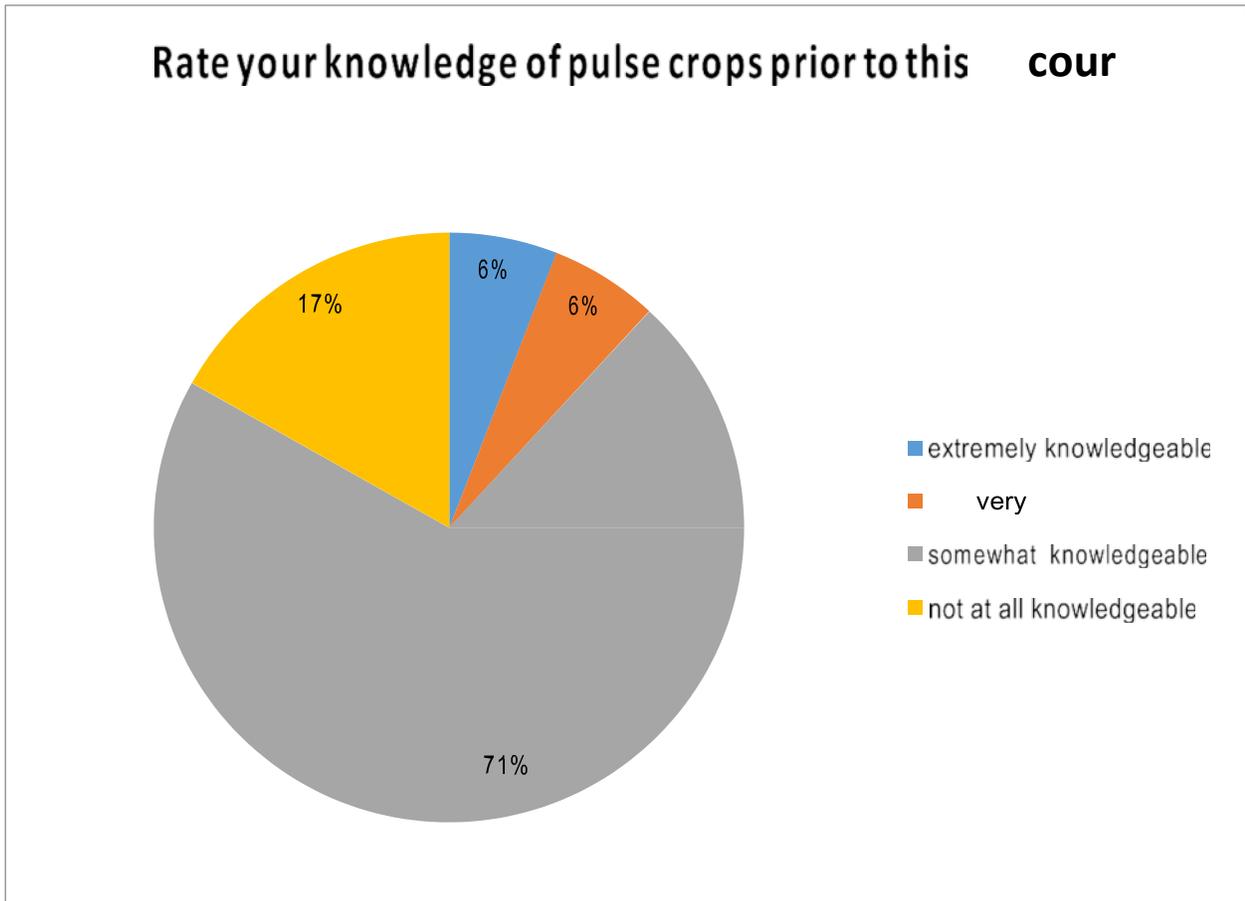
Through targeted outreach to national and West Coast-based contacts, we drew a total of 40 attendees to the event, ranging from test kitchen and food directors at top tier media outlets, to registered dietitians that contribute regularly to media, as well as food bloggers and industry influencers.

Additionally, 9 of our attendees who had not previously taken the Pulse Pledge – including contacts from Food Network, Cooking Light, Rodale (parent company for Prevention and Women's Health) and Brit+Co – made a commitment to eat more pulses in 2016, during the event.

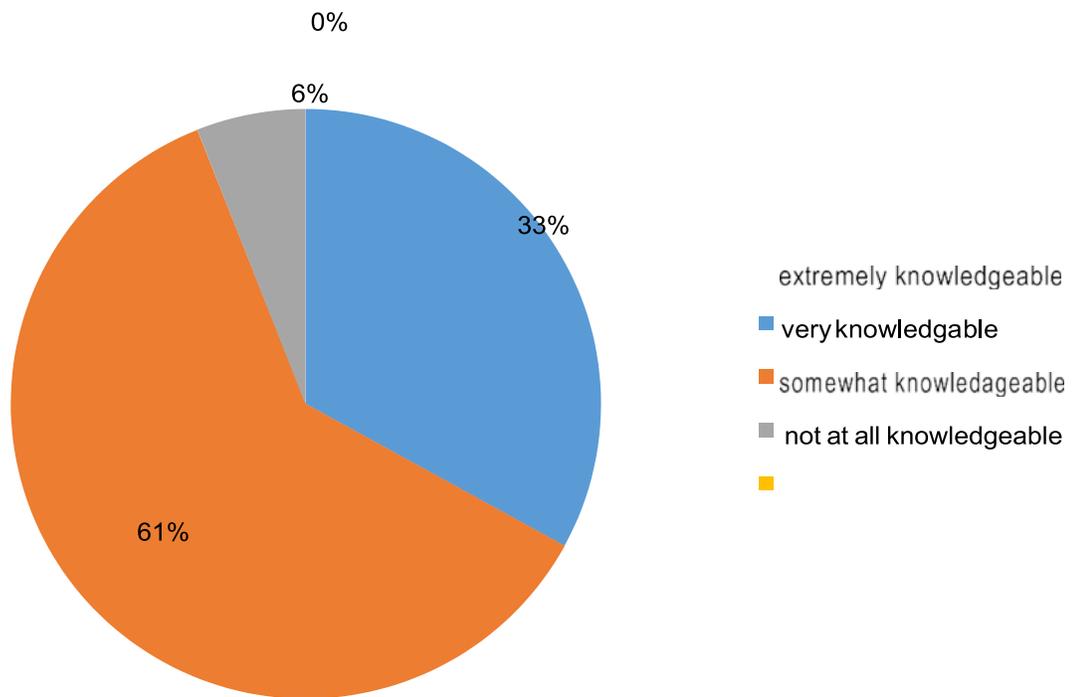
Goals and Outcomes Achieved

Goal #1: A 50% increase in awareness among participants of how to use DPLC in value-added products. Post event survey results: A follow-up online survey to CIA event attendees was sent after the event. Eighteen people responded to the questions. Prior to the course 6% of respondents rated their knowledge of pulse crops as

very knowledgeable compared with 61% after the course. The following are the results of the survey as well as comments from the attendees.



Rate your knowledge of pulse crops after this course.



Goal #2: Conduct ongoing foodservice trade media outreach throughout the year, to continue relationships and place tips and recipes. Create content that resonates with consumers and drives conversation.

Maxwell PR staff and Jessie Hunter Director of Domestic Marketing continued to reach out and work with the program attendees after the event. This resulted in enhanced promotion of pulses through social media, blog posts, media stories, and tradeshows such as the Food and Nutrition Conference and Expo October 15-18 2016 and the International Foodservice Editorial Conference October 26-28, 2016. CIA attendees continue to share posts inspired by the learnings of the event in September. For example, Meggan Hill shared a spicy chickpea salad sandwich pic on Instagram with the hashtag #PulsePledge, reaching her 8K followers. Melissa of Bless this Mess blog posted a canned beans pic on Instagram (5.7K), also using the Pulse Pledge hashtag.



Goal #3: Conduct Facebook and Twitter advertising, namely promoted posts of tips and recipes to gain fans and increase engagement Increase traffic to the USADPLC website. Develop educational weekly FB posts throughout the year, and identify influencers on Twitter and Instagram, and begin engaging. By offering exclusive access to the CIA’s world-class kitchens and providing attendees with educational and sharable experiences, media and blogger attendees plastered social media with pulse-related content during the event, with more than 160 total posts. Although our 40 attendees weren’t required to post from the event by contract, they did – and repeatedly – Tweeting more than 60 times and posting more than 100 photos on Instagram. Content ranged from recipe photos to images captured from the various workshops and events. Altogether, social media posts from the event reached nearly 7 million viewers, all linking back to either #pulsepledge or #lovepulses.

This event kicked off the International Year of Pulses media outreach successfully. As part of additional outreach and marketing programming sponsored by the USA Dry Pea and Lentil Council media reach continued to build throughout the year.

Progress on meeting social media outreach goals as of September 30, 2016 are found the following table:

Metric	September 30	Goal by EOY
Ambassadors Engaged	20 (10 in September)	20-25
Dedicated Blog Posts	100 (10 in September)	120-135
Recipes Developed	88 (9 in September)	100
Social Media Mentions	390 (36 in September)	250
Consumers Reached	78 million (8M in August)	70 million
Metric	September 30	Goal by EOY
Influencers Engaged	222 (6 added in September)	50-100
Consumers Reached	152.4 million (3.2M in September)	80 million

Elaboration on measured outcome elaboration:

Get placement in 30+ editorial calendars

Total media coverage in the United States (excluding IFEC articles): 420 articles, 3,002,683,191 reach

Reach 100+ foodservice trade publications at IFEC.

International Foodservice Editorial Council (IFEC) annual conference had 160 foodservice trade publications and brand representatives

Identify and place 8 stories coming out of meetings:

We have or are scheduled to have stories in the following publications:

Total placements as a result of IFEC: 20 articles, 3,067,612 reach.

Food Management (3 stories)

Baking & Snack (3 stories)

Progressive Grocer (2 stories)

Snack Food and Wholesale Bakery (2 stories)

Grocery Headquarters

Food Navigator (5 stories)

Food Technology

Prepared Foods (3 stories)

30,000 likes on the USADPLC Facebook page.

During the grant reporting period, we changed our Facebook tracking targets from page likes to fans.

By the end of December 2016 US Pulses had 239,970 fans compared to 166,426 in December 2015.

5,000 followers on Twitter

December 2015 3565 Twitter Followers

December 2016 7,922 Twitter Followers

· 40% of overall traffic to the website driven from social media channels

Beneficiaries

The primary beneficiaries of this project will be the region's 1,100 Pacific Northwest (PNW) pulse farmers. PNW growers harvested 238,982 metric tonnes of dry peas, lentils, and chickpeas in 2014 according to USDA-NASS. The 1,100 growers ship product to 20-22 processors that include over 5,000 jobs in WA/ID. Production of dry peas, lentils, and chickpeas

has more than doubled in the past 5 years and there is tremendous opportunity for market growth both internationally and domestically.

Improving nutrition in a variety of food channels reduces costs to Idaho State and the US. Developing additional markets improve demand, leading to more regional jobs and overall prosperity. For example, hummus in the U.S. has grown from \$100 million in 2003 to an estimated \$700-\$800 million market in 2013, and that is only penetrating 15-20% of U.S. households. In the same decade, Idaho State production has grown from 15,000 acres to over 80,000 acres with gross revenue of \$600/acre. The increase in acres has brought over \$39 million annually to WA growers.

Pulses serve as an excellent rotational crop due to their ability to fix nitrogen in the soil and help breakdown grain disease cycles by increasing the yield of wheat and other major cereals. Pulse acres

have also expanded into Colorado, Nebraska and Kansas as producers realize the rotational benefits and value of including these crops in their farming operations.

Lessons Learned

Offering media and bloggers the opportunity to get inside of the exclusive CIA kitchens was a huge draw –many noted they were honored to have been invited.

Many attendees commented on how valuable Cynthia Sass' presentation was, making it clear that the nutritional benefits of pulses are an important gateway for reaching our target consumer. Demonstrations from the CIA chefs created "ah-ha" moments for attendees and were extremely valuable in illustrating the versatility of pulses – that they can be used in all sorts of applications beyond soups and stews. We anticipate this knowledge will carry through in upcoming coverage. Hands-on time in the kitchen was invaluable, but many attendees commented that by the end of the event, they were too worn out to attend the market basket "free time" session, which had been very enticing to them in the beginning. When working with this sort of audience (non- traditional chefs/recipe developers) in the future, we would recommend condensing the schedule with this in mind, as originally discussed.

For the number of support staff the budget allowed (1 Maxwell staffer), the audience was very large – for future events of this size, we would recommend budgeting for additional support staff. This will allow for better event flow and attendee support in making introductions, facilitating conversations and assisting with event direction such as guiding break-out group division based on attendee needs, etc. Beyond keeping the group size small, we would recommend separate sessions for media attendees and sponsors in future events. This provides a buffer zone for media/blogger contacts from the feeling like they are being sold to/pitched during the event, and allows them to better engage with the content and their media peers. However, hearing the perspective of the growers and pulse industry representatives provides important content on how pulses are grown, harvested, and processed.

Based on a pulse industry commissioned report from Euromonitor in 2016, the forecast for Compound Annual Growth Rate (CAGR) by volume, for the dry form, in 2015-2020 will be 5.2% for dry peas, 18.0% for lentils, and 11.3% for chickpeas. When compared to the Euromonitor's reference category CAGR of 3.7%. This forecast is positive for indicating growth in the pulse industry, particularly dry peas, lentils, and chickpeas. Find additional information from this report including predictions for CAGR in ten food categories in the table below:

Future growth will remain strongest in dips, snack bars, snacks and pasta

2015 – 2020 Forecast CAGR of pulse volume across downstream categories in retail



	Project Downstream Category	Beans	Peas	Lentils	Chickpeas	Passport Ref. Category*
These highly mature categories will continue to have modest growth.	Dried pulses	1.6%	5.2%	18.0%	11.3%	3.7%
	Frozen pulses	1.2%	2.2%	5.0%	2.5%	-0.4%
	Shelf stable pulses	2.1%	4.1%	15.0%	13.0%	-0.2%
	Pulses in sauce	2.0%	2.7%	7.0%	6.3%	-0.2%
	Soups	2.5%	5.3%	7.1%	5.5%	0.6%
Brands in categories where pulse is still a newly emerging ingredient will see high levels of product innovation.	Dips	8.5%	6.5%	17.0%	16.5%	1.9%
	Snack bars	3.2%	30.0%	5.0%	8.0%	2.0%
	Snacks	18.0%	27.3%	26.5%	15.5%	2.0%
	Pasta	14.5%	12.0%	28.0%	22.0%	0.4%
	Others	5.0%	28.4%	18.0%	13.0%	N/A
	Total	2.2%	8.2%	16.9%	13.7%	N/A

* Category growth obtained from Euromonitor's Passport database. See appendix for definitions of reference categories.

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