Final Report

Analyzing Hops Varieties for High Altitude Production and Alternative Marketing Schemes

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PROJECT SUMMARY

This project will plan and scientifically evaluate 11 varieties of hops at the Old Fort at Hesperus (7600’ elevation) in response to the growing trend of “going local”. It will collect and summarize growth, viability, nutrient, production and quality measures. Potential producers and consumers will participate in three hands-on field days during the season, two traditional winter workshops and two open house networking and marketing opportunities. All information from these educational opportunities will be made available at local extension offices, the Old Fort location, website (www.tinyurl.com/oldforthops) and chronicled on Facebook page (www.facebook.com/oldfortathesperus)

Preliminary surveys found eight commercial breweries and brew pubs within a 70 mile radius of Hesperus that support the purchase of local hops. However, their needs currently far exceed the region’s ability to produce and appropriately deliver the product in a pelletized form. This project will develop alternative markets that can utilize fresh whole cone and dried hops in small quantities that home and craft brewers pay significantly more for, and smaller producers can supply. It is this opportunity that can make small acreage hops yards economically viable in Southwest Colorado’s high altitude environment

PROJECT PURPOSE

The Old Fort at Hesperus is located on 6300 acres approximately 17 miles southwest of the main campus of Fort Lewis College in Durango. Its vision is to maintain an interdisciplinary field station for education, research, and community partnerships in sustainable agriculture, cultural, natural and physical resources. The site has served as a meeting place for the Agricultural community since the early 1920’s when it was an educational institution (Fort Lewis College) and continued as a Colorado State University Agricultural Experiment Station from 1956 until June, 2010 when Fort Lewis College returned to manage the site. The Old Fort is located at 7600’ and has the land and water resources available to establish a high altitude hops yard. Additionally, the newly renovated historic library will be available to host field days and winter workshops on site.

In 2011, there were 29,787 acres of hops production in Idaho, Oregon and Washington State and only 120 acres in Colorado (National Hop Report, pp1). Due to the recent trend of “going local” more hops users are looking to procure their hops from within the state. Potential growers in the Four Corners region are also taking notice of this increased interest and have been contacting the Colorado State University (CSU) Extension offices in La Plata and Montezuma counties to find out more information about the varieties that grow well in their region (Parmenter and Hooten, personal communication). Establishing a hops yard requires significant
investment in trellising (upwards of $10,000/acre), irrigation and time (two to three years). Therefore identifying hops that grow in a dry, high altitude environment is critical to a grower’s success in the region. This project planted 11 different varieties of hops at the Old Fort at Hesperus to collect growth, viability, production and quality measures. It offered three hands-on field days during the project and two in-depth winter workshops to educate potential producers and share the results from the trial. All information from these educational opportunities was made available on site in Hesperus, on the Old Fort website (www.tinyurl.com/oldforthops) and through Facebook (www.facebook.com/oldfortathesperus)

The Four Corners region is fortunate to have eight commercial breweries and brew pubs within a 70 mile radius of Hesperus, CO. They purchased over $550,000 of pelletized hops in 2011 at an average price of $8.00/pound (Amber Beye, 2012 survey). Dr. Kevin Lombard, New Mexico State University researcher at the Agriculture Science Center in Farmington, NM began a small hops trial in 2008 with plant material from USDA-ARS hops germ-plasm center in Corvallis Oregon. He believes the barrier to local production is not only identifying varieties that perform well but also how to market the un-pelletized hops. According to Dr. Lombard, the local brewers will only use fresh hops once a year because it clogs their equipment. Three Rivers Brewery in Farmington retrofitted special equipment to utilize fresh hops produced at the Agriculture Science Center but other breweries have not followed suit. While the large brewers support the purchase of local hops, their needs currently far exceed the region’s ability to produce and appropriately deliver the product in a pelletized form. Given this information, this project will research and develop alternative markets that can utilize fresh or dried hops in small quantities. In doing the research for this project, we surveyed both commercial and home brewers to find out the amount of hops used annually, prices paid, sources, preferred varieties and forms. These surveys will be repeated at the end of the project to measure impact. This preliminary research indicated that home brewers are paying between $12 and $64/lb and are very interested in using locally produced hops. These consumers also utilize fresh whole-cone and dried hops varieties that smaller producers could supply. These higher prices could allow small acreage growers to have lower infrastructure investments (half-acre versus full-acre) with similar returns.

There have been three documented variety trials within the state since 2002 funded by a CSU SCBG: Desert Weyre grower grant (2002-03), CSU Horticulture Research Center in Fort Collins (2004-2009) and Western Colorado Research Center in Hotchkiss (Dr. Ron Godin). The focus of these trials was primarily identifying varieties that could over winter in Colorado. This project would utilize the information from these trials to identify initial varieties. However, the Old Fort Lewis at Hesperus sits at 7,600 feet along the La Plata River while the highest previous trial was at 5800’ in Hotchkiss. Dr. Ron Godin recently presented information at the CSU Extension Hops Growing workshop indicating that alpha levels of hops grown at altitude tend to be higher. Alpha acids provide bitterness while beta acids provide flavor needed for craft beers. Ali Hamm’s research at the Horticulture Research Center found that the production of aroma varieties are on the decline due to bitter varieties better brewing efficiency. Due to this decrease in production, breweries are willing to pay more for the aroma varieties as they are still in significant use with craft breweries. This trial will include both bitter (Chinook, Nugget, Magnum, Columbus, Northern Brewer, Horizon, Olympic) and aroma (Cascade, Centennial, Glacier, Sterling, Mount Hood and Williamette) varieties. Trials conducted at the Ag Science Center and Hotchkiss indicate that European varieties do not grow well in this region. Therefore, they will not be included in our trial.
This project will plant 13 varieties obtained from Summit Plant Labs since they offer certified disease free hops plants. The hops plugs have a height above the root ball that is approximately 4-10 inches, and a root mass that is 1 1/4” x 1 1/2” x 2 inches. First year hops transplanted mid-May in the field typically grow to heights of 10-20’ if trellised (http://www.plantlabs.com). Purchasing this type of plant material will increase the amount of growth and production data in Year 1. Since not all varieties are available from Summit Plant Labs, rhizomes may need to be purchased from other certified sources and will take longer to begin significant production. Because of the financial investment needed for infrastructure, it is critical to establish yards free from diseases that can significantly lower quality and yields, requiring the plants to be replaced within a few years. Three reps (four plants per replicate) of each variety will be established in a randomized split plot design with 3.5 feet between plants and 10-12’ alleys between rows. Fort Lewis College will provide the drip irrigation system and a 15’ trellis using 2 3/8” steel and three rows of high tensile wire. Plants will be established in May of Year 1. Once plants are tall enough to train, hemp string will be strung from the bottom of the trellis to the top in a “V” pattern to train the hops on and allow them to climb. Six bines per plant will be trained, clockwise, up the twine, with three bines per string. A hands-on field day will be hosted in Year 2 that will allow potential growers to learn about this process.

In mid June, a petiole sample will be taken from each replicate and analyzed for N, Zn, and B levels that are critical for cone production. Depending upon results, foliar fertilizer may need to be applied. Additionally, foliar measurements using a hand-held Minolta SPAD meter will be used to determine if Fe chlorosis is present. The SPAD 502 chlorophyll meter non-destructively measures light transmittance of the leaf in the red and infrared wavelengths at 650 and 940 nm, respectively yielding a numerical output that indicates leaf greenness. The SPAD meters, provided by Fort Lewis College, offer a less expensive and more rapid alternative to estimating chlorophyll content. Growth and maturity data will be collected for each replicate once plants are established. Yearly data will include date of emergence, density/spread after Year 1, date of cone set, and long term survivability (dead/alive). Temperature data sensors (www.embeddeddatasystems.com) will be placed in the hops yard to record daily min and max values year round. These data may relate to long term survivability and production at high altitudes. Each replicate will be harvested by hand and dried using a commercial drying oven provided by Fort Lewis College. The cone weights for each replicate will be recorded in both fresh and dry states. A sample of each replicate will have an alpha, beta, and oil analysis performed each year. This data will be shared at workshops and posted on the website.

The project team will work with commercial and home brewers in the region to create alternative marketing opportunities by inviting them to field days and workshops to interact with interested producers. We will host an Open House for these potential consumers in Year 2 and 3 so they can tour the hops yard, evaluate product samples and meet potential growers. These efforts should help expand the use of fresh and un-pelletized locally produced hops. Three hands-on field days will be offered during the growing seasons on trellising, evaluating nutrient needs, and harvesting. Winter workshops in year 2 and 3 will provide more in depth knowledge on establishing hop yards, soil and nutrient considerations, trellis alternatives, post-harvest handling and marketing alternatives. The project team will utilize the expertise of Dr. Ron Godin who is experienced in hosting in-depth hops workshop and continues to assist the hops industry by researching small scale harvesters and alternative ways to effectively pelletize
hops. The Project Director worked with Ron when he was at the Western Colorado Research Center and he contributed rhizomes for our initial trial in 2008.

PROJECT APPROACH

Activities Performed

Met with key Personnel.

The project team of Beth LaShell, Kevin Lombard, Ron Godin and Amber Bye met several times per year. We also included Jason Thomas (NMSU employee) in our meetings because he has been coordinating the hops trial with Kevin for the past few years. Because of the distance between us, we met in person four times, had three conference calls and numerous email threads. The team worked together to determine hops varieties, lay out the hops yard site, review trellis plans, discuss field day agendas, host field days, plan Spring workshops, review nutrient results, make nutrient recommendations and present at the Spring workshops.

Dr. Kevin Lombard received a grant from New Mexico to host a workshop in 2012 to bring hop growers and brewers together, and set up some hops trials in New Mexico. To enhance the project that was funded through CO Specialty crop program, we worked with Kevin to duplicate the variety trial in both Farmington, NM and Las Cruces, NM. This allowed us to compare the effect of altitude on production and acid levels, as well as maximize the dollars we received in this isolated region.

In 2014, Beth LaShell gave a presentation at the New Mexico Organic Farming Conference on growing hops. Dr. Lombard and Godin both attended the presentation and were on hand to answer questions.

I have worked with a lot of different project teams and this one is the best one I’ve ever worked with. We have a common vision for what needs to be done to advance hops production in the SouthWest and we truly enjoy working together. Additionally, we share the work load on big projects and so it makes working together very enjoyable.

Designed and Distributed Marketing Materials.

A project website was established at www.tinyurl.com/oldforthops. It houses educational information and allows participants to register for events. We used www.jotform.com to register for the free events and Fort Lewis College MarketPlace (www.tinyurl.com/oldfortmarketplace) to allow participants to register and pay online for our Winter Workshop.

Amber, the program assistant did a great job publicizing the project and encouraging local media to highlight our field days, workshops and results. Several articles appeared in the Durango
Herald and Cortez Journal and a video was produced by Durango TV in 2015. Links to the individual articles and video can be found in the Additional Information section of this report.

Flyers were developed to advertise Field Days, Winter Workshops, Tastings and Tapping Parties. They were distributed using the Project Team’s distribution lists, extension personnel, and home brewers clubs. They were also sent to local media as public service announcements. Because the project team was from a wide geographic region, we were able to draw participants from an area extending from the Front Range to Grand Junction and as far south as Las Cruces, NM.

Updates on the project and announcements of upcoming events are also posted on the Old Fort at Hesperus facebook page (https://www.facebook.com/oldfortathesperus)

**Developed Hops Yard (trellis, irrigation, plant layout).**

Our initial design was to have three replicates with four plants per replicate in a split plot. At one of our first meetings, Ron Godin suggested that we increase the replicates to four so that we would be sure to have three to analyze. He also suggested that we add a guard plant on each end of the variety replicate to decrease cross fertilization. Therefore, we modified the project to have four replicates with six plants per replicate including a guard plant on each side. This increased the number of plants needed for each variety from 12 to 24. In order to fit this design into the yard, we decreased the spacing between the plants to three feet. This change also affected the per plant amount of money that was available to purchase plants and do analyses.

**Trellis Construction.** Since we already had one row of established hops, four additional rows (one for each replicate) were created by tilling a 150’ strip into existing vegetation running North-South. Each of the rows are approximately 12’ apart. Because of the potential for weed pressure, a 5’ wide strip was tilled in each row so weed barrier could be laid. Rocks were removed and the soil was leveled. Because of the rocky soil, it was decided that metal poles (2 3/8 inch drill stem) would be used rather than wooden poles.

For the trellis, a row of four metal sleeves were placed approximately 50’ apart over two of the rows. Metal sleeves were pounded using a hydraulic pounder to allow the much longer 16’ pieces of 2 3/8” drill stem to be slid safely into place. Once the poles were leveled to the same height, they were welded in place. Two 4’ earth anchors were placed on each corner of the trellis to assist with supporting weight.

Each pole had a cap welded on the top to secure the 5/32 heavy cable that ran perpendicular to them. Four foot earth anchors were used to secure these cables on both the East and West sides of the trellis. A second lighter weight (1/8) cable was installed parallel to the rows. Two cables were placed above each row so that the hops can be trellised in a V-pattern to increase light to the base of the plant and increase production. They were attached to the heavier cable using cable clamps.

During construction of the trellis, Amber took pictures and created a document that was distributed at the Field Day including resources for establishing a hops yard trellis along with detailed instructions. Another useful web resource included Simple Earth Hops: (http://www.simpleearthhops.com/p/hop-trellis-parts-list.html). We made the powerpoint slides available in print format at the our field days and Spring workshops.
Bed Preparation. Soil samples were taken from each row and sent to Servi-Tech Labs for analyses. All of the rows had similar results with pH (6.3 to 7) and organic matter (4.2%). Because of the low soil nitrogen levels and the high requirements for hops, nutrient management was challenging. In addition to the typical analyses for P, K and Zn, we also recorded baseline levels for boron, sulfur, calcium, magnesium, sodium, iron, manganese and copper. Of these, Sulfur was the only mineral that was low.

We placed 3’ wide weed barrier in the center of each 150’ row using landscape fabric staples every foot. Once the fabric was laid, a modified weed burner was used to burn 6 inch holes every three feet. The burner was modified by placing a six inch coffee can on the end of the device.

A drip irrigation system was installed using 3/4” black poly to provide each hole with a 2 gph emitter. During installation, we learned that you need to turn the water on while installing the emitters because the black poly moves considerably when the cold water is turned on. In Years 1 and 2, we watered the plants about 30 minutes per week. However in Year 2, we saw a marked difference in the plant growth between the North and South ends of the yard. After ruling out light differences and soil nutrients, we determined that it could be water. Because the summer of 2014 was extremely dry and the hops plants were growing rapidly, their water requirements were much higher.

In 2015, we installed a water meter on the system and gauged the water not on time but gallons/plant delivered. For example, in July we delivered 1200 gallons of water three times a week. The total amount of watered delivered to the ¼ acre hops yard was 44,151 gallons during the season. Additionally, we had an extremely wet Spring and early Summer where we received 8.64 inches of rain between April 15th and July 15th. During this time, we did not need to water the hops very much. The combination of extra rain and the increased irrigation resulted in no difference in the North and South regions of the hops yard. In the arid West, water usage is definitely an area that merits further research and documentation.

Because of significant deer damage in Year 2, a wire fence was constructed around the hops yard to serve as a successful deterrent.

Obtained and Planted Disease Free Rhizomes

As described in the original proposal, it was important to obtain disease-free rhizomes when establishing the yard at the Old Fort. More hops yards are experiencing a decline in production around year 5 that can be attributed to apple mosaic virus. It is very expensive to replace the hops every five years and there is even some preliminary research that indicates the virus stays in the soil. Therefore, we decided to purchase our stock from Summit Labs because their sterile
techniques and clean rootstock ensure that none of their hop products carry any hop fungal diseases, including Hop Powdery Mildew, Verticillium Wilt, and Downy Mildew. Additionally, all hop tissue cultures at Summit Plant Labs have tested negative for the following diseases: Hop Stunt Viroid, Apple Mosaic Virus, Hop Latent Virus, Hop Mosaic Virus, American Hop Latent Virus, and Arabis Mosaic Virus (Source: http://www.plantlabs.com/clean-stocks/hop-field-transplants/hop-diseases/ accessed on 11/2/15)

We learned that Summit Labs does not grow all of their advertised varieties each year. It is primarily based upon pre-orders and perceived demand. Therefore, we had to adjust the trial varieties based on availability. We were able to obtain nine varieties from Summit Labs and two from Simple Earth Hops in Wisconsin. Because we ordered 1000 plantlets from Summit, they were only $3.00 each while the rhizomes obtained from Wisconsin were over $8.00 each. Since there was such a large price break, we teamed with Dr. Lombard on his project and put together an order for 1,000 plantlets which saved us a considerable amount of money. To meet this minimum, we ordered 30 plantlets of nine different varieties including Vanguard, Teamaker, Chinook, Cascade, Centennial, Crystal, CTZ, Nugget and Williamette for our project in addition to 60 plantlets of these varieties for replicate trials in Farmington, NM and Las Cruces, NM. NMSU paid for the plantlets in the New Mexico trials.

While researching disease free availability, we learned that many of the plant sources do not currently test their material. Therefore, we were hesitant to purchase untested rhizomes. The Galena and Mt Hood varieties from Simple Earth Hops were available in small quantities, so we didn’t have enough to completely plant all of the replicates. We divided the eight rhizomes (4 Mt Hood, 4 Galena) we received to propagate a few extra for the trials. Fortunately, they have done well and as this project continues past 2015, we will be digging from our existing rhizomes to complete the replicates.

Initially, we considered sourcing our plant material from the hops yard in Farmington, NM because they obtained their plants from USDA. However, USDA could not guarantee they were disease free either. As a result, Dr. Lombard used some of his consulting fees to test the all the plants in his hops yard along with the original plants we had prior to this new variety trial. We were very fortunate that he did this testing as all of the old varieties at the Old Fort along with many of the ones from USDA germ plasm tested positive. The only 100% negative tests came from the Summit Lab plant materials. Below is the summary of the paper he published as a result of this study:

Hops Virus Testing: Significance and Implications for Establishing Hop Production in New Mexico and Southwest Colorado

Research Report 788
Kevin A. Lombard, Beth LaShell, Franklin J. Thomas, Jason French, and Todd Bates

Summary
Some agricultural producers in New Mexico and southwestern Colorado view hops (Humulus lupulus and H. lupulus var. neomexicanus), used in bittering and flavoring beer, as a potential specialty crop for local craft brewing needs. Regional trials in northwestern New Mexico and southwestern Colorado indicate adaptability of some cultivars to a high-altitude, high-desert climate, where diurnal temperature swings are extreme and soil pH can exceed 8. There have
been reports, however, of viruses infecting rhizomes commonly used to establish hop yards, and this prompted an examination of potential plant infection by viruses in research plots located at the New Mexico State University Agricultural Science Center at Farmington (NMSU-ASC Farmington) and Ft. Lewis College Old Fort at Hesperus, CO, experimental farms. In 2014, hop rhizomes collected from research plots were tested for the presence of *Apple mosaic virus* (ApMV), *American hop latent virus* (AHLV), *Strawberry latent ringspot virus* (SLRSV), *Tobacco necrosis virus* (TNV), and *Arabis mosaic virus* (ArMV). In one study established in 2008 at the NMSU-ASC Farmington with non-certified virus-free material, 50% of ‘Cascade’ entries tested positive for ApMV and 17% were co-infected with ApMV and AHLV. *Strawberry latent ringspot virus*, *Tobacco necrosis virus*, and *Arabis mosaic virus* were absent in tested rhizomes. Certified virus-free and *H. lupulus var. neomexicanus* entries were free of the five viruses we tested for. Establishing hop yards in New Mexico and Colorado with certified virus-free rhizomes or plantlets is critical to avoid the risk of reduced yields and viral transmission into unaffected hop plantings.

**Plant rhizomes.**

We placed our order with Summit Labs in January, expected them in May but they did not arrive until mid June. On June 19th, we planted 210 plantlets and 18 propagated plants. The plantlets were much larger than we anticipated but in very good shape. The temperatures were close to 90 degrees with no clouds or moisture so we were very concerned about how the plants would take the extreme heat when transplanted. The holes were pre-irrigated before planting and kept very wet for a couple of weeks. Hops are tough! Even the plants where the foot long bines dried up survived. We did use six extra plants to ensure that each hole had at least one hops plantlet. Initially we covered the newly planted hops with agribon fabric thinking that it would protect them from the direct sunlight. After two days, we removed all of the fabric because the hops were getting too hot under the fabric.

Since planting, we have done a survivability survey each Spring and Fall. As of Spring, 2015, we had a 91% survivability rate (208/228) and plan to fill in the missing spots with rhizomes in the Spring, 2016. Because of the varying number of plants in each replicate and variety, a production per plant was calculated to fairly compare them.

**Train bines**

Because the plantlets were planted late in 2013, we did not train any of the hops in Year 1. In Year 2, most of the hops emerged by April 7, 2014 and were ready for training by the middle of May. Because of our trellis design, two coir lines were hung above each of the plants. They were tied to a single bent rebar stake so the coir was in a v-shape. Three bines were trained in a clockwise direction around each of the coir lines and all other bines were removed. With the assistance of the program assistant, several student interns and other volunteers, all of the bines were trained by mid-June. In Year 3, the hops emerged even earlier because of the warm Spring. We used the same training procedure but had everything trained by May 25th. After training and pruning, Amber continued to remove the bines that insisted upon growing back.
Host Field Days

We hosted four hands-on workshops over the course of the project at the Old Fort. We included topics that were of interest to potential growers and/or brewers. In our original proposal, we included incentives for home brewers to attend the field days but found out that most of them are intrigued with how hops are grown but are not as interested in learning how to do it. For each field day, we developed a flyer for advertising that was distributed through list serves, public service announcements in the local papers and Facebook.

Field Day 1- October 1, 2013. Topics included establishing a hops yard, importance of obtaining disease free plant sources, how to take a soil sample and interpret the results. 23 people attended the Open House from 4 pm until 7 pm. The event began with a tour of the hops yard where we showed the components of trellis construction. They could also see how the varieties were randomly planted within the four replicates. There were two larger scale growers present who shared how their trellis was different and the lessons they learned while building it.

Leaves were collected for a demonstration of how a SPAD meter gives different readings based on the color of the leaf. We explained that we would be using the SPAD meter to collect data and try to correlate it to nutrient levels.

After the tour, Kevin led a discussion on the importance of disease free stock as well as a demonstration of how to take a soil sample. Several soil sample results from hops yards were distributed showing the different soil types in the region.

Lastly, we held an open round table discussion about what topics should be included in the Winter workshop. Surveys indicated that attendees found the information very useful and are concerned about harvesting and marketing issues that will arise with small scale production.

Field Day 2- June 21, 2014. As a hands-on activity, we measured all of the heights, collected SPAD meter readings, discussed training bines and clipped petioles on a sample half of the plants for the nutrient testing. There were producers, potential producers, home brewers, student interns and staff in attendance (12 people). Other potential producers are very interested in the varieties that do well at altitude so they stop by periodically.

Field Day 3- August 24, 2015. Our second hands-on workshop for 2014 was held when we harvested and picked all of the hops. We reviewed harvest readiness indicators with participants, explained the process for keeping the varieties and replicates separate. We had 15 people attend this workshop and they included student interns, restaurant owners, home brewers and potential producers. They assisted with harvest, picking, weighing and bagging of fresh hops.

Field Day 4- July 28, 2015. For 2015, we hosted a field day along with the Old Fort at Hesperus Open house. The entire project team was in attendance from 1 until 6 pm. In addition to answering questions on the hops varieties and trellis system, petiole samples were collected for a late season test of nutrient levels.

Monitor Nutrient Levels of plants

Hops are known to require a large amount of Nitrogen (150-250 lbs per acre) especially during cone development. So, in addition to soil testing, we monitored the nutrient levels of the growing
hops by taking petiole samples for lab testing, recorded corresponding SPAD meter readings and applied foliar spray when needed.

**Take Petiole samples and send to lab for testing.**

We contacted Servi-Tech labs to obtain the proper procedure for petiole testing of hops plants. They provided us with draft documents outlining the proper procedure. Since petiole testing is not a common procedure for most labs, we worked with their technicians to collect and obtain appropriate samples. Samples should be taken approximately 5-6’ above the ground and they recommend you collect 20-30 petioles (stems without leaves). However, they need 40 grams of dry weight in order to run samples so more petioles are needed if they are small. Once collected, the petioles should be placed in non-bleached paper bags and dried as soon as possible before shipping. Petioles should not be put in the refrigerator or stored in plastic bags.

In 2014, we collected 60-70 petioles per replicate but because of the large variances in the growth of our hops, the final weights of the samples varied greatly. We also were not able to start collecting at 5-6’ because some of the bines were not that big. By combining all of the replicates, we were able to have enough material to run the petiole tests on 9 of the 11 varieties (Mt Hood and Galena were not included).

In 2015, our plants were much more uniform in size (due to increased and more even watering). However, since we knew that they needed 40 grams of dry weight, we collected petioles based on weight (400 grams wet weight) and not numbers. We collected petiole samples on June 22nd after applying three foliar spray treatments. Additionally, we collected petiole samples at the Field Day on July 28th once the plants had begun to produce cones.

Through the process of developing a procedure, Servi-tech lab personnel were very patient and helpful. We hope that our experience will help them develop better documents for petiole collection and analysis.

**Use SPAD meter to obtain chlorophyll values**

We used two SPAD 502-Plus meters to collect readings on the same day that we collected petioles (June 21, 2014, June 22, 2015, July 28, 2015). Participants were able to use the meters at the 2014 Field Day and the 2015 Open House event. They assisted us by using the SPAD meter to collect readings from 30 leaves per replicate before they were placed in the bag for petiole samples. Once collected, the meter returned an average of the 30 leaves that was recorded for later use.

Once we received the petiole analyses, we compared the SPAD averages to the Nitrogen values. In 2014, the Crystal variety had the highest SPAD average and also the highest, but still deficient, Nitrogen value as well. The Teamaker variety had the second highest SPAD average and the lowest Nitrogen value. This variety was selected for its medicinal properties and has returned additional out of the ordinary values for brewing hops (ie: 0 % Alpha Acids).
In 2015, the relationship between SPAD readings and Nitrogen levels continued to be inversely proportionate on many varieties. All of the SPAD readings decreased for the eleven varieties tested while our Nitrogen levels nearly tripled. We believe that because we increased early Nitrogen levels, there was more plant growth (petioles) produced but since we were still deficient, the average SPAD readings did not increase. Unfortunately, there is no other data available correlating SPAD readings with any nutrients in hops so we’ll continue to collect data to determine how the SPAD readings are related to nutrient levels. Once our Nitrogen levels are adequate, we should see the correct correlation.

Apply foliar spray if necessary

The requirements for hops growth is best explained in the Nitrogen Uptake and Utilization by Pacific Northwest Crops publication by Dan M. Sullivan, John M. Hart and Neil W. Christensen that was published in 1999 and reviewed in 2013. It is available for viewing at https://catalog.extension.oregonstate.edu/pnw513. Below is an excerpt explaining hops utilization of Nitrogen through the season;

**Hops**

**Biomass.** Hops exhibit the same initial slow Phase I growth through the first half of June as do grass seed crops during the winter months. Spring growth produces long shoots with little leaf area. This growth depends primarily on rootstock reserves. Only 10 percent of total biomass is accumulated through mid-June. Phase II growth from mid-June until the latter part of July is linear and rapid. Maximum biomass accumulation occurs by the end of July.

**N uptake.** Nitrogen uptake and biomass accumulation occur at similar rates. Only 10 percent of total uptake is accumulated through mid-June. The 30-day period from mid-June to mid-July is the period of rapid uptake. The N uptake rate is 3 to 4 lb/a/day near the end of June. By the end of July, the crop has accumulated 80 to 150 lb N/a in the trained biomass.

**Management.** Apply nitrogen fertilizer by early June to mid-June so it will be available during the period of rapid uptake. A single N application in April was as effective as split applications in western Oregon trials. Consider yield levels when determining N fertilizer rate. Cones contain 5 to 6 lb N/bale or one-third to one-half the total amount of N harvested in the biomass. Most yards are harvested by removing vines, leaves, and cones. After the cones are removed from the vines, the leaves and stems generally are returned to the yards. Leaves and stems contain approximately 40 lb N/t of dry material. Reduce N fertilizer inputs where hop vine residues are applied. N status can be assessed by tissue testing. Collect hop petioles when hops are between three-fourths of the way to the wire and just reaching the wire. This amount of growth generally occurs by mid-June in the Willamette Valley. Choose petioles from mature leaves on the main vine, 5 to 6 feet from the ground. Have the petioles analyzed for nitrate-N. Small-scale N rate experiments and large-scale field demonstrations have shown no yield increase if additional fertilizer is applied when petioles contain more than 4,000 ppm.

Regional research at NMSU Ag Science Center indicates that hops need 200-250 lbs of Nitrogen per acre. Initially, we applied compost to our soil and side dressed the plants in year one with compost that was 56% organic matter and 1.22% Nitrogen. Results from Year 2 (2014) petiole sampling revealed that our plants were starving for Nitrogen when compared to the data provided by Servi-Tech labs:
Our values ranged from 270 ppm to 3270 ppm with two of the varieties (Mount Hood and Galena) not producing enough petioles to constitute a sample. We immediately prepared a foliar spray using GreenGanic liquid fertilizer (8-7-7) that provided 3 lbs N per acre and applied it three times in ten days (July 19 – 28). Since foliar spraying can be 10 times more efficient than soil application, we saw an incredible response of growth and production.

Dr. Ron Godin was not surprised with these values even though the plants were green and appeared to be healthy. They just weren’t growing very rapidly. He called it “silent starvation” because by the time we might see the yellowing chlorosis, it would be too late. As a project collaborator, he had recommended that we do the petiole samples to test for minerals and nutrients. Of the minerals we were most concerned about (B, MG and ZN), Boron levels were well within the recommended range but both MG and ZN were low. Interestingly, our phosphorus and potassium levels were almost double the standard value. The biggest variation for the different varieties came from the MN and FE values.
Because of these somewhat concerning values in 2014, New Mexico State University developed a Nutrient Management recommendation for our region utilizing a fertigation pump on our drip line. Since we were in the middle of a variety trial, we decided to continue with the foliar spaying until the initial trial ended. As we continue the trial into 2016, we plan to install the pump to administer more nitrogen.

We began noticing a difference in the growth of plants in early June, 2014. The plants on the South end of the yard were significantly larger than the same varieties on the North end. We divided each replicate into three quadrants and pulled soil samples from each of them. We tested for
Nitrogen and Phosphorus. Initial results showed there was no significant difference between the soil types with a range of 3 to 5 ppm N and 76 to 133 ppm of P. Secondly, we tested the compost that we had used in Fall, 2013 to see how much N we were adding. While the organic matter was 56%, the % Nitrogen was only 1.22. This test also provided us with secondary nutrients (P, S, K, Ca, Mg and NA) and macronutrients (Zn, Fe, Mn, Cu, B).

We also utilized Fort Lewis College Environmental Health professor, Dr. Phil Shuler’s expertise and lab to test the yard for heavy metals (Arsenic, Lead, Chromium and Copper) as a precaution. None of the values were out of character for this region, so we concluded that water was our primary limiting factor in 2014.

In 2015, we applied the same foliar spray three times (June 9, June 20/27 and July 1). Petioles were collected on June 22nd. Our average Nitrogen levels for petioles nearly tripled with a range of 1530 to 6180 mg/kg. While we made significant progress, we are still well below the 15,000 mg/kg sufficient levels recommended by Servi-Tech. In fact when we did a second set of petiole samples on July 28th, our nitrogen levels had fallen to near zero. Most likely, the cones developed between the two collection dates and used up all of the nitrogen.

The Petiole samples indicated that we were also low on Zinc and Boron so an additional foliar spray was done on July 29/31st that included these minerals along with additional Nitrogen. Zinc sulfate and Borax (10% Boron) were added to the Greenganic mixture. The Zinc Sulfate was very difficult to dissolve for the foliar spraying. Even after soaking it in warm water, the screen filters on the sprayer were still removed for application.

While there is a strong interest in growing organic hops, the amount of Nitrogen needed by the plants makes this difficult. Compost alone cannot supply the Nitrogen needed by hops and the use of organic foliar sprays may not be cost efficient. We will continue to explore this conundrum in 2016.

Harvest hops and collect production data

2014. We recorded burring dates which began on July 15th and did variety sampling to determine which ones were ready for harvest. Jason Thomas from NMSU visited our yard several times and provided us with a map along with his comments on harvest readiness. He trained Amber and I on using lupulin color and smell to determine readiness. We noticed that even within a replicate, there was a lot of variation on harvest readiness. For example by our harvest date, some of the cones had started to open up and were past ideal harvest condition. Originally, we were going to try and harvest each replicate as it became ready but the amount of labor that would be necessary was too much. Therefore, we harvested everything on August 24th.

Our harvest began at 9 am in the yard with 15 people assisting with cutting down the bines or picking the hops directly. We prepared brown paper bags (both lunch size and grocery size) with variety, replicate and plant number. If the plant was less than six feet tall, we harvested the cones directly into the bags. Taller plants were cut
down, marked with flagging tape (variety, rep, plant number) and transported to our equipment shop. All plants were harvested by 11:30 am. Once transported to the shop, we set up tables and screens for volunteers to remove cones and place them in the bags. We finished removing all cones by 4 pm so it took 105 hours to harvest our cones.

Weights of wet cones were recorded for each replicate. We had significant differences between replicates and noticed a marked difference between North and South end of the trellis. For example, CTZ was our heaviest producer at 5930 total grams but the replicates were 160, 20, 3300 and 2450 grams for replicates 1 through 4, respectively. Replicates 1 & 2 of the CTZs were on the Northern half of the yard so they were affected by the uneven watering. Because of the lower production numbers, many replicates were combined for analyses.

2015. The first burring date was recorded as July 7th so our harvest was ahead of schedule. To more accurately determine harvest readiness, Amber collected cones and examined the lupulins under a microscope to more accurately evaluate them. Additionally, she used dehydrators to dry the cones to 0% moisture to determine their starting moisture values. Amber began collecting cones on August 11th and recording her observations.

She determined that the Chinnoks and Mt Hood’s lupulins were full and clear and should be harvested on August 16th. This early harvest also gave us the opportunity to try out our new drying system and monitoring protocol (see drying hops below).

Since all of the hops bines were much larger this year, they were all removed from the yard after being marked with variety and replicate. Every plant in the yard produced some cones in 2015. Once harvested, they were taken to the covered shop and placed on tables and screens for harvesting. Cones were harvested by hand and placed in paper bags by replicate. Total wet harvest weights were recorded prior to loading the hops in to the drier. Varieties were separated into different draws and replicate were separated on the trays.

The additional nine varieties were harvested on August 25th when it was determined they were ready. The same harvesting and drying procedure was followed. Total harvest time for 2015 was 119 man hours.

As you can see from the Production Data table, all varieties increased their weights in 2015. Vanguard and Williamette had the largest yield increases with a 496% and 354%, respectively.
Because of this increase, we were able to provide Carvers Brewery with 1814 grams of fresh Chinook cones and we had 160% more dry hops to distribute to brewers after the samples were sent in for analyses.

For the two years of data, our highest production/plant was consistently CTZ (349 g and 343 g, respectively) with Cascade, Chinook, Crystal and Nugget all performing above average. Our poorest performers were Centennial, Mt Hood, Teamaker and Williamette. The Vanguard and Galena varieties showed a marked improvement in 2015 and need additional evaluation to determine if they are adaptable to high altitude.

Production Data for 2014-2015 Harvest
(All weights in grams unless otherwise stated)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Year</th>
<th>Total Production</th>
<th>Production/plant*</th>
<th>Total Dry Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cascade</td>
<td>2014</td>
<td>2920.0</td>
<td>139.0</td>
<td>981.0</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>4916.0</td>
<td>234.1</td>
<td>1851.0</td>
</tr>
<tr>
<td>Centennial</td>
<td>2014</td>
<td>640.0</td>
<td>27.8</td>
<td>185.0</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>913.1</td>
<td>39.7</td>
<td>328.0</td>
</tr>
<tr>
<td>Chinook</td>
<td>2014</td>
<td>2960.0</td>
<td>141.0</td>
<td>1005.0</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>5086.9</td>
<td>242.7</td>
<td>1500.0</td>
</tr>
<tr>
<td>Crystal</td>
<td>2014</td>
<td>3280.0</td>
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</tr>
<tr>
<td></td>
<td>2015</td>
<td>4988.5</td>
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<td>CTZ</td>
<td>2014</td>
<td>5930.0</td>
<td>348.8</td>
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</tr>
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<td></td>
<td>2015</td>
<td>7558.0</td>
<td>343.5</td>
<td>2596.0</td>
</tr>
<tr>
<td>Nugget</td>
<td>2014</td>
<td>4390.0</td>
<td>243.9</td>
<td>1400.0</td>
</tr>
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<td></td>
<td>2015</td>
<td>6775.0</td>
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<td>2048.0</td>
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<td>Teamaker</td>
<td>2014</td>
<td>1470.0</td>
<td>73.5</td>
<td>471.0</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>1931.0</td>
<td>96.6</td>
<td>1090.0</td>
</tr>
<tr>
<td>Vanguard</td>
<td>2014</td>
<td>470.0</td>
<td>19.6</td>
<td>181.0</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>2330.0</td>
<td>97.1</td>
<td>589.0</td>
</tr>
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<td>Galena</td>
<td>2014</td>
<td>690.0</td>
<td>86.3</td>
<td>190.0</td>
</tr>
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<td></td>
<td>2015</td>
<td>1290.0</td>
<td>161.3</td>
<td>340.0</td>
</tr>
<tr>
<td>Mt. Hood</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2014</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>110.0</td>
<td>27.5</td>
<td>30.8</td>
</tr>
<tr>
<td>Williamette</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2014</td>
<td>432.0</td>
<td>19.6</td>
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</tr>
<tr>
<td></td>
<td>2015</td>
<td>1528.0</td>
<td>69.5</td>
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<td>Averages</td>
<td>2014</td>
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<td>115.6</td>
<td>683.0</td>
</tr>
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<td></td>
<td>2015</td>
<td>3403.2</td>
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</tr>
<tr>
<td>Averages (pounds)</td>
<td>2014</td>
<td>51.1</td>
<td>2.8</td>
<td>16.5</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>82.5</td>
<td>4.1</td>
<td>18.9</td>
</tr>
</tbody>
</table>

*Due to the various number of plants per replicate and variety, production per plant was calculated to fairly compare varieties.*

Send samples out for alpha, beta and oil analysis

After drying the samples, we sent 225 grams of material to Alpha Analytics for testing.

2014. We tested 10 of the eleven varieties (Mt Hood didn’t produce any cones) and were able to test two replicate combinations for Nugget and CTZ. For the eight remaining varieties, harvested product from all replicates were combined for testing.

The test values were received in approximately a week after they were shipped. Our values for % alpha acids and % beta acids were slightly higher than expected but definitely in line with the type of hops (aroma, bittering, high beta). We also received a complete oil analyses for each of the samples which we shared with other producers at the Winter Workshop. Our Teamaker variety (0% Alpha) surprised the lab and they called because they thought their equipment was broken! As a medicinal hops with high Beta Acids, it has been very popular with a local herbalist who made tinctures, salves and pillows with it.

2015. Our staggered harvest allowed the hops to be in more ideal harvest condition. Since our production weights were much greater, we were able to have at least two replicates to test on seven of the varieties. Nugget analyses on all four reps showed a range of alpha acids from 12.5 – 14.8 with very little difference in beta acids. Cascade and CTZ both had three replicates tested with Cascade’s results being very similar while CTZ showed a range of 14.8 to 17.9 on alpha acids and no difference on beta acids. Crystal, Chinook, Vanguard and Williamette each had two replicates individually tested. This left Centennial, Mt Hood, Galena and Teamaker with only one combined test because of lower production numbers.
## Old Fort Values for Alpha Acids, Beta Acids, HSI and Oil % (2014-15)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Year</th>
<th>Alpha Acids</th>
<th>Beta Acids</th>
<th>Hops Storage Index</th>
<th>Oil%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cascade</td>
<td>2014</td>
<td>8.6</td>
<td>6.4</td>
<td>0.222</td>
<td>1.33</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>10.9</td>
<td>6.1</td>
<td>0.199</td>
<td>0.55</td>
</tr>
<tr>
<td>Centennial</td>
<td>2014</td>
<td>10.4</td>
<td>4.4</td>
<td>0.238</td>
<td>1.79</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>11.7</td>
<td>4.3</td>
<td>0.206</td>
<td>1.73</td>
</tr>
<tr>
<td>Chinook</td>
<td>2014</td>
<td>12.2</td>
<td>4.3</td>
<td>0.236</td>
<td>1.50</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>11.2</td>
<td>3.7</td>
<td>0.215</td>
<td>2.20</td>
</tr>
<tr>
<td>Crystal</td>
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<td>6.5</td>
<td>0.222</td>
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<tr>
<td></td>
<td>2015</td>
<td>6.9</td>
<td>6.8</td>
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<td>0.59</td>
</tr>
<tr>
<td>CTZ</td>
<td>2014</td>
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<td>7.0</td>
<td>0.227</td>
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<tr>
<td></td>
<td>2015</td>
<td>16.5</td>
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<td>0.208</td>
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<tr>
<td>Nugget</td>
<td>2014</td>
<td>13.3</td>
<td>5.6</td>
<td>0.231</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>13.8</td>
<td>5.2</td>
<td>0.208</td>
<td>0.67</td>
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<tr>
<td>Teamaker</td>
<td>2014</td>
<td>0.0</td>
<td>14.6</td>
<td>0.171</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>0.1</td>
<td>9.6</td>
<td>0.135</td>
<td>0.33</td>
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<tr>
<td>Vanguard</td>
<td>2014</td>
<td>4.9</td>
<td>7.8</td>
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<td>0.80</td>
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<tr>
<td></td>
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<td>7.1</td>
<td>10.0</td>
<td>0.197</td>
<td>0.79</td>
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<tr>
<td>Galena</td>
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<td>12.7</td>
<td>9.3</td>
<td>0.215</td>
<td>1.32</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>13.0</td>
<td>10.4</td>
<td>0.189</td>
<td>0.56</td>
</tr>
<tr>
<td>Mt. Hood</td>
<td>2014</td>
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<td>NA</td>
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</tr>
<tr>
<td></td>
<td>2015</td>
<td>6.3</td>
<td>6.7</td>
<td>0.203</td>
<td>0.57</td>
</tr>
<tr>
<td>Williamette</td>
<td>2014</td>
<td>6.0</td>
<td>4.3</td>
<td>0.241</td>
<td>1.32</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>7.5</td>
<td>4.0</td>
<td>0.217</td>
<td>1.26</td>
</tr>
</tbody>
</table>

| Averages  | 2014 | 9.3         | 7.0        | 0.223              | 1.35 |
|           | 2015 | 9.5         | 6.7        | 0.197              | 0.98 |
Top Bittering (high alpha acids) Hops Varieties (based on two-year average)

1. CTZ  
2. Nugget  
3. Galena  
4. Chinook  
5. Centennial

Top Aroma (lower alpha acids and higher oils) Hops Varieties (based on two year average)

1. Chinook  
2. Centennial  
3. Williamette  
4. CTZ (highest Oil% but also high alpha acids)

Top Beta Acid Hops Varieties (based on two year average)

1. Teamaker  
2. Galena  
3. Vanguard

Each year we also submitted test samples from New Mexico State University’s hop yard in Farmington, NM to compare the same varieties but at a much lower altitude. We saw that both the alpha and beta acids were significantly higher than those found in Farmington yard. It is difficult to compare production values since we have different nutrient management schemes at the two yards.

**Comparison of Old Fort and Farmington Yards- Alpha, Beta, HSI and Oil %**

<table>
<thead>
<tr>
<th>Variety</th>
<th>Year</th>
<th>Old Fort Alpha Acids</th>
<th>Old Fort Beta Acids</th>
<th>Old Fort Hops Storage Index</th>
<th>Old Fort Oil%</th>
<th>NM Alpha Acids</th>
<th>NM Beta Acids</th>
<th>NM HSI</th>
<th>NM Oil%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cascade</td>
<td>2014</td>
<td>8.6</td>
<td>6.4</td>
<td>0.222</td>
<td>1.33</td>
<td>7.3</td>
<td>5.7</td>
<td>0.217</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>10.9</td>
<td>6.1</td>
<td>0.199</td>
<td>0.55</td>
<td>8.0</td>
<td>8.3</td>
<td>0.189</td>
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</tr>
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<td>Centennial</td>
<td>2014</td>
<td>10.4</td>
<td>4.4</td>
<td>0.238</td>
<td>1.79</td>
<td>7.4</td>
<td>2.9</td>
<td>0.253</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>11.7</td>
<td>4.3</td>
<td>0.206</td>
<td>1.73</td>
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<td></td>
</tr>
<tr>
<td>Chinook</td>
<td>2014</td>
<td>12.2</td>
<td>4.3</td>
<td>0.236</td>
<td>1.50</td>
<td>12.4</td>
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<td>0.73</td>
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<td>Crystal</td>
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<td>7.7</td>
<td>6.5</td>
<td>0.222</td>
<td>1.04</td>
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<td>5.6</td>
<td>0.215</td>
<td>0.66</td>
</tr>
<tr>
<td></td>
<td>2015</td>
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<td>6.8</td>
<td>0.188</td>
<td>0.59</td>
<td>4.9</td>
<td>7.0</td>
<td>0.178</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Collect dry weight data

2014. Once harvested and weighed, the hops were placed in a drying oven at New Mexico Ag Science Center in Farmington, NM within 24 hours. They were dried to approximately 32% moisture prior to vacuum sealing. Dried hops were placed in a cooler until ready for shipping. Dry weight values from each variety are shown on the previous table.

2015. We utilized our new drying oven designed and built by Jason Franklin (NMSU researcher) that had eight large drawers on a metal frame. There are two box fans built into the top of the unit that pulls air up through the hops. Once the hops are loaded onto the trays, the unit is wrapped in tarps and the fans are turned on.

To determine the appropriate moisture, we utilized the Online Calculator for Drying Hops resource at http://sroc.cfans.umn.edu/People/Faculty/VinceFritz/Hops/HopDrying/index.htm

In order to dry the hops to our goal of 15% moisture we first had to determine the moisture coming out of the field. Once all of the hops were harvested from a replicate, a sample was taken to determine its moisture content. The sample was placed in a cloth lingerie bag and weighed before being placed in a commercial dehydrator. The sample was weighed every hour until it reached 0% moisture as there was no more change in weight. At the same time, we placed a similar sample bag in the drying oven. Using the online calculator, it returned the end weight of the bag in the drier for the target moisture level. The average drying time for the hops to reach 10% moisture was 24 hours.
The combination of the new drier and the online calculator for drying hops gave us a much more consistently dried product.

*Create and distribute marketing samples and surveys to brewers*

In 2013 we did not produce any cones so we didn’t begin to distribute marketing samples and surveys to brewers until 2014.

Once the analyses was completed, Amber shared the results with several local brewers and the home brew clubs. One of the goals for this project is to increase the use of local hops in our rapidly growing brewing industry. There is definitely some good interest in using fresh or whole cone hops in special craft brews.

During both our 2014-15 harvests, we were contacted by Taos Mesa Brewery who was interested in purchasing 30# of fresh hops. They had attended the Winter Workshop and are interested in supporting regional hop production. Since most of our research hops were already spoken for, we had him contact Paul Black at Pine River Hops. In 2015, Steamworks (local Durango Brewery) also contacted us about purchasing 70# of fresh hops. He also was able to get the hops he needed from Pine River Hops.

Amber has been an excellent promoter for our variety trial. She attends the home brewers monthly meetings to give them an update on our progress and invite them to events. She attended the San Juan Brewfest the day before our harvest and talked with Jeff at Carvers Brewery, Kris at Steamworks, and Randy at Riff Raff.

In 2014, she made a lot of contacts with local brewers including the following:

- Met with Linda at Ubru to talk about hops for homebrewers. Was told that if we could pre-measure to 4 oz and have analysis homebrewers would be more likely to use it.
- Met with Dewayne, owner of Mancos Brewing Company. Said he would be interested in trying any of our hops.
- Met with Jeff, head brewer at Carvers and discussed use of hops and tapping party.
- Met with Randy and Jason, owners and head brewers at Riff Raff Brewery and dropped off hops. Talked about naming it after Old Fort Lewis and the survey to fill out. I will email him and stop by on November 25th to drop off surveys and check in.
  - Brewed 4 different beers in 5 gallon batches from our Crystal, Chinook, Cascade and Nugget varieties with Jeff and Cody at Carvers
  - Took hops and surveys to Dewayne at Mancos Brewery
We used several different surveys to gather information from craft brewers, home brewers and consumers of beer made from our hops. Here are links to the surveys that Amber created and distributed:

- Survey for brewers: https://www.surveymonkey.com/s/PB3LD7V
- Survey for Carvers drinkers: https://www.surveymonkey.com/s/J5V8B57
- Survey for Riff Raff drinkers: https://www.surveymonkey.com/s/QKXFZZ8
- Survey for Mancos drinkers: https://www.surveymonkey.com/s/Q853QYT

Amber worked with local brewers to create events that not only promoted our project but also the beers made from local dried hops. The first event was at Carvers Brewing Company on December 5th when they hosted a Tapping Party for the four different beers they created using the same recipe from Crystal, Chinook, Cascade and Nugget. Attendees could order a flight and try them all. Over 100 people attended and Carvers sold $605.25 in beer including 32 taster flights, 24 single taster glasses, 27 pints and 2 draws (10 oz). Mancos Brewery made a red IPA from our hops (Crystal, Chinook, Cascade and Nugget) and tapped the keg on December 12th. He reported that it was very good and people came out just to try it and wants to work with us again next year. Riff Raff also created a brew using citrus, black pepper and licorice along with our hops. According to surveys, tasters found it intriguing and enjoyed it.

In 2015, Carvers used fresh Chinook hops to create an Old Fort Pale Ale for a September 9th tapping party. The 5 gallons of ale was gone in a couple hours as people stopped by for dinner and a beer. We were very pleased with the amount of people who stopped by just to try the Old Fort Pale Ale.

Amber distributed 18.9 pounds of dried hops to commercial and home brewers this Fall after we received the analyses. The brews have not been tapped yet but I’m sure they will be great.

Plan, Schedule and Promote Winter Workshops

The project team of Beth LaShell, Kevin Lombard, Ron Godin and Amber Bye planned the both of the winter workshops and once again included Jason Thomas (NMSU employee) in our meetings because he has been coordinating the hops trial with Kevin for the past few years. Because of the distance between us, we met in person once, had a conference calls and used email extensively.

Each year, we hosted the workshop at Fort Lewis College in early March. In 2014, we focused on the areas of general hops knowledge, trellis construction, marketing issues related to whole cones, the importance of disease free rhizomes and an overview of the Old Fort Hops trial. In 2015, we focused on interpreting hops analyses, brewer’s perspective, harvesting issues including small scale alternatives for picking and drying.

Presentations are archived on www.tinyurl.com/oldforthops under announcements. Or they can be directly accessed through this link: https://www.fortlewis.edu/oldfort/CurrentProjects/HopsVarietyTrial/HopsResources.aspx

The 2014 What’s Hop’n winter workshop that was held on Saturday, March 22, 2014 from 9 am until 5 pm in the Student Union building on Fort Lewis College’s campus. The event was
advertised with posters, brochures, email list serves, website information and PSAs. The program included continental breakfast, lunch and beer samples. Pre-registration was $22 per person and $27 at the door. Thirty one people pre-registered and we had seven walk-ins. Participants included academics, growers, home brewers, brewery owners and potential growers. They traveled from New Mexico and Arizona to attend the workshop. Our diverse program included:

Dr. Ron Godin—The Science of Hops

Dr. Godin had shoulder surgery and was unable to travel to Durango so we used Google Hangouts to bring him to the workshop. It worked really well and allowed us to keep our program intact. Dr. Godin received the highest rating from the participants (4.96/5).

Paul Black and John Lyle—Producer’s Trellis Designs

Paul and John are both local growers who designed and built their own trellis system that are very different. The attendees really appreciated the information and pictures provided by the presenters. Their evaluation ratings were 4.4 and 4.24/5 rating, respectively. Some growers appreciated the small-scale perspective and others did not.

Dr. Kevin Lombard—4-Corners Production Realities (4.16/5 rating) and Equipment Options for Small-Scale Growers (3.8/5 rating)

Dr. Lombard highlighted his recent visit to the Northwest hops growing region. He provided us with photos of trellis systems, picking operations, drying, pelleting and storage schemes. We discussed the challenges with converting large scale equipment to our small acreage situations.

Beth LaShell & Amber Beye—Old Fort at Hesperus Variety Trial (4/5 rating)

Our primary focus was to show the group the progression of the Variety Trial at the Old Fort. We covered site selection, soil analyses, trellis construction, variety selection and the importance of disease free root stock. Participants found the presentation useful but would like to have more data on each of the varieties.

Jason Thomas—Testing Rhizomes for Viruses

Jason covered the process for collecting rhizomes for the disease testing that would be done at NMSU. He also described the different diseases that could potentially affect hops production and how they should be dealt with. Because virus transmission is not understood in many of the diseases, particularly apple mosaic virus, we had a good discussion about all of the different theories.

Three Rivers Brewery—Using Whole Cones in Brewing

The former head brewer at Three Rivers Brewery in Farmington began working with Dr. Lombard and Jason Thomas to develop a way to use whole cones in the brewing process. He shared his steel mesh bag that holds the cones while they are in the brew tank. This keeps them from clogging the equipment. Since the brewer was unable to attend, Jason provided pictures of how the brewery uses whole cone hops as well as a transcript of an interview.
Animas Alers– Beer 101 demonstration
For those of us that are not brewers, the Animas Alers demonstration was very educational and for the many brewers in the audience, it was a lot of fun. The group set up a top tier beer stand in the ballroom of the Student Union and brewed an extra IPA using a kit from Ubru, a local homebrew shop in Farmington, New Mexico.

We broke the program periodically to allow them to give us an update on their progress. They also allowed the audience to taste the brew at various stages. Additionally, one of their members provided us with a pony keg of red IPA that he had brewed for us to enjoy with lunch.

The 2015 What’s Hopn winter workshop was held on Saturday, March 21, 2015 at Fort Lewis College Student Union. Advanced registration was $25 and $30 at the door. Because we used the FLC Marketplace website, most of our participants registered ahead of time. We had 50 people attend the workshop and 33 of those folks were new to the workshop. We had people from the Front Range and as far south as Las Cruces, NM. Our program included:

Dr. Ron Godin - Interpreting a Hops Analyses for both brewers and growers (4.74/5)
   Ron is always a popular speaker because of his extensive experience with growing hops and educating potential producers. This was a technical presentation that received great ratings

Cody Looman – Carvers Brewing Company - Brewer’s Perspective I - (4.04/5)
   Cody gave a nice overview of how Carver’s utilizes local hops along with some of the challenges. He discussed the brewing process for the December, 2014 Tapping Party that was hosted at Carvers.

Riff Raff Brewery; Pagosa Springs, CO - Brewer’s Perspective II - (4.39/5)
   Randy Schnose gave a passionate and animated presentation on the importance of local hops especially in the tourist economy that we see in both Durango and Pagosa Springs. He also provided a sixth barrel of beer to be served at lunch.

Paul Black – Pine River Hops - Picking Hops with a modified apple sorter - (4.52/5)
   Following a short video, the group went outside to see the modified apple sorter that Paul had brought to the workshop on a trailer. In addition to being a nice break in the program, people really appreciated being able to see the equipment and ask questions.

Jason Franklin - Small Scale Dryer Demonstration
   Since Jason was delivering our small scale dryer, he described to the participants how it was built and can be used to dry hops.

Dr. Ron Godin - Mechanics of a Wolf Picker - (4.36/5)
   Ron gave a short presentation on how the popular Wolf Picker works. It was a great comparison to the modified apple sorter we had seen over lunch.
Aaron Melin—Front Range Hops- Pelletizing Hops - (4.26/5)

Because not all local brewers can utilize fresh hops in their brewing process, we invited Aaron to talk about his business of pelletizing hops. In addition to explaining the process, he also explained how growers in the 4-Corners region could benefit from working with Front Range Hops.

Dr. Anna Marija Helt, Clinical Herbalist and Aromatherapist - Alternative Uses of Hops - (4.0/5)

Dr. Helt’s presentation was very well received as she passed around hops pillows, allowed people to taste tinctures and explained the science behind the herbal properties of hops.

Beth LaShell and Dr. Kevin Lombard - Old Fort/NMSU Variety Trial Updates - (4.1/5)

An update of the Old Fort variety trial was presented along with handouts on production and analyses results. Dr. Lombard talked about the need for regional cooperation especially for equipment as well as the continued need for hops research and education in the 4-Corners region.

**Summarize Yearly Data**

In the summer of 2013, we established eleven varieties of hops in 4 replicates. Because of the importance of disease-free stock, nine varieties (Cascade, Centennial, Chinook, CTZ, Crystal, Nugget, Teamaker, Vanguard, Willamette), were obtained from Summit Labs in Fort Collins, CO and two were obtained from a WI breeder (Mt Hood and Galena). Varieties were selected based on their availability from these sources.

Our varieties were categorized as follows:

Aroma Type: Cascade, Centennial, Crystal, Vanguard, Willamette, Mt Hood
Bittering Type (high alpha acid): Chinook, CTZ, Nugget, Galena
High Beta: Teamaker

Because our disease-free plantlets arrived late (June 18), our varieties did not produce any cones in 2013. We recorded survival rates of the 228 plantlets in the Fall, 2013, Spring, 2014 and Fall, 2014. We had a 95.6% survival rate from planting to Fall observation and a 97% winter survival rate of those plants. From spring to Fall, 2014, 98% of the plants survived leaving us with a 93% survival rate of those we planted (208/228).

Since the inception of this project, the importance of disease free rhizomes has greatly increased. As part of our consultation partnership with New Mexico State University personnel, we provided samples from our hops yard for their study. All of varieties established in 2009 from an untested yard in Paonia had at least one virus. They also tested the plantlets we received from Summit Labs and they were all clean. Dr. Lombard completed an excellent peer-reviewed publication (link available in Additional Information section) entitled, “Hops virus testing: Significance and implications for establishing hop production in New Mexico and Southwest Colorado.”
Production data collected and summarized in this report include emergence data, burring dates, harvest readiness, wet cone weights, dry cone weights, production per plant. Analyses data included alpha acids, beta acids, hops storage index, and % oil. More extensive oil analyses is available upon request for each of the varieties tested.

**Significant contributions and role of project partners in the project:**

**Beth LaShell** - As project director, I coordinated project team work on hops yard infrastructure, variety selection and meaningful production data collection. Coordinating the use of Fort Lewis College equipment and employees to establish the rows and build the framework for the trellis occurred in the Fall, 2012 and we made changes and upgrades to the trellis each year. In addition to accounting activities, hosting team meetings and publicizing the project, I update the website, Facebook and resource listing. Once the team identified a dates and topics for the Winter Workshops, I coordinated speakers, made catering arrangements, created resources for handouts and registered people for the event. In February, 2014, I made a presentation at the New Mexico Organic Farming conference on the project. It sparked a lot of interest in hops and we hope to have an entire track on hops production in the near future.

**Amber Beye** – As program assistant for the hops project, Amber was responsible for on site development of the hops yard, planting and caring for rhizomes, maintaining irrigation system, and recording data. She assisted with developing information documents on hops varieties and hops yard establishment. She has contributed several facts sheets for Field Days and continues to promote the project to home brewers. Once we had cones to harvest, Amber met with local brewers to get them to try our hops. Because of her effort, Carvers Brewing started 4 batches (Crystal, Chinook, Cascade and Nugget) of 5-gallons each in 2014 and did a wet hop brew in 2015. Additionally, she has provided sample product to Mancos Brewery, Riff Raff and several home brewers to promote whole cone hops brewing. Her efforts to market a different type of hops has been successful and we appreciate all of her hard work.

**Dr. Kevin Lombard** – As a horticulturalist with personal research experience involving hops, Kevin has been a key member of the project team. In addition to attending all of our project meetings, he included a colleague Jason Thomas to help with the project. Kevin and Jason assisted us with determining harvest readiness, drying cones and interacting with Alpha Analytics. They also assisted with field days, Winter Workshops and designed a nutrient management plan for our yard. In 2014, we utilized their small-scale drying oven and they monitored the drying of our hops. In 2015, they built us a similar unit so we would not have to transport freshly harvested hops to Farmington. One of their most important contributions was the completion of a peer-reviewed article entitled, “Hops virus testing: Significance and implications for establishing hop production in New Mexico and Southwest Colorado.”.

**Dr. Ron Godin, Colorado State University Extension, Tri River Area Agronomist**

Ron continues to help producers develop high altitude hops yards in the region so we are fortunate to have him on our project team. In addition to attending meetings, he has served as a
technical consultant on many of our questions related to hops yard construction, varieties and nutrient management. He received the highest evaluations at our Winter Workshops and provided the participants with a sounding board for many kinds of questions related to hops production. He has been an invaluable partner in this successful project.
GOALS AND OUTCOMES ACHIEVED

1. Increase the number of hops varieties being appropriately evaluated at high altitudes

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Bench mark</th>
<th>Actual -2013</th>
<th>Actual-2014</th>
<th>Actual-2015</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establish replicated hops trial at Old Fort</td>
<td>0</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>13 in three years</td>
</tr>
<tr>
<td>Analyze growth and survivability data</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Once/year for 3 years</td>
</tr>
<tr>
<td>Analyze each replicate for Zn, N and B nutrient levels</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>Once/year for 3 years</td>
</tr>
<tr>
<td>Obtain Chlorophyll values for each replicate</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>Once/year for 3 years</td>
</tr>
<tr>
<td>Analyze alpha, beta and oils for each replicate</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>Once/year for 3 years</td>
</tr>
<tr>
<td>Record production data for each replicate</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>Once/year for 3 years</td>
</tr>
</tbody>
</table>

The hops yard was established at the Old Fort with 11 varieties of disease free hops much later than anticipated in 2013, therefore they did not produce cones so production data was not available for year one. In 2014, all eleven varieties remained in the trial and we were able to collect data from all of the varieties but not all of the replicates. We did not have enough sample material to do a nutrient analyses or alpha, beta and oils for each replicate so we averaged the values we did receive.

In 2014, we also investigated sources of disease free rhizomes to increase the number of varieties and replace some of the missing Mt Hood and Galena plants. We found very few yards that could provide clean plants and since Summit Labs has increased the minimum number of plants to 1,000, we remained at 11 varieties.

In 2015, our production per variety increased so that we could test all four replicates on the Nuggets, three replicates on Cascade and CTZ, two replicates on Crystal, Chinook, Vanguard and Williamette but still only one combined test for Centennial, Mt Hood, Galena and Teamaker. Data included in the tables found in this report are combined averages of the replicates.

2. Use hands-on training to increase hops production knowledge

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Bench mark</th>
<th>Actual-2013</th>
<th>Actual-2014</th>
<th>Actual-2015</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Host 3 field Days</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>
Over the course of this project, we hosted 4 field days featuring hands-on activities. The first field day was held in October, 2013 and focused on soil sampling, trellis construction and SPAD meter usage. The second field day was held on Saturday, June 21, 2014 (summer solstice) and was attended by twelve people. Attendees assisted with collecting petiole samples, operated the SPAD meter and measured the height of the hops. The third field day was held on August 24, 2014 and was attended by 15 people. Attendees assisted with harvesting, picking and sorting hops. The fourth field day was attended by over 50 people as part of our 2015 Open House series at the Old Fort. Participants learned about petiole sampling, burring and had the opportunity to interact with the entire project team.

3. Topics will include trellising, evaluating nutrient needs and harvesting

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Benchmark</th>
<th>Actual-2013</th>
<th>Actual-2014</th>
<th>Actual-2015</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record attendees at Field Days</td>
<td>0</td>
<td>23</td>
<td>12,15 (27 total for 2014)</td>
<td>50</td>
<td>20,30,30</td>
</tr>
<tr>
<td>Use surveys to assess before and after knowledge</td>
<td>0</td>
<td>12</td>
<td>8,12</td>
<td>0</td>
<td>20,30,30</td>
</tr>
<tr>
<td>Identify additional commercial hop yards in 4C Region</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4 by end of project</td>
</tr>
</tbody>
</table>

Our 2013 field day focused on trellising while the two field days in 2014 provided attendees with an opportunity to learn about data collection and harvesting. While we were pleased with the variety of attendees, we would like to have higher attendance. Our goal for 2014 was 30 people attending field days and we had a total of 27 at the two combined days. Fall dates are definitely better attended because growers aren’t as busy but we believe in the value of hands-on activities. We hosted a field day in July, 2015 that coincided with our Old Fort open house. The hops were burring at the time and we also collected petioles for a late season analyses. Because it was part of a bigger event, we attracted a lot of new people who had not seen the yard before. Unfortunately, because of the varied audience at the larger Open House, we did not utilize surveys effectively.

The most successful hops yard in the 4C region is Pine River Hops in Bayfield. They have two acres and 1600 plants. Paul Black has shared many of his lessons learned at our field days and workshops. Many of our participants had or installed small yards (5-50 plants) that were used to create a home brew or craft brew. These smaller growers have been contacting us about getting disease-free rhizomes from our yard. We hope to be able to provide this plant material beginning in 2016. There are two other larger yards (Ignacio and Cahone) that are in the start-up phase as this project ends. This project also attracted potential growers from the Front Range and Grand Junction area. One of our attendees at the Winter Workshop was working on a 10 acre hop yard this summer. We are looking forward to hearing about their progress at our 2016 workshop.
4. Use more traditional training methods to increase base knowledge

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Benchmark</th>
<th>Actual-2013</th>
<th>Actual-2014</th>
<th>Actual-2015</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Host two Winter Workshops</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

The first Winter Workshop was held on Saturday, March 22, 2014 with 38 people in attendance. The second Workshop was held Saturday, March 21, 2015 with 50 people in attendance. These workshops were definitely the highlight of the year because we got to share our results and enthusiasm about hops production with a wide variety of folks.

5. Topics will include establishing hops yards, soil and nutrient considerations, trellis alternatives, post harvest handling, marketing alternatives and research results

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Benchmark</th>
<th>Actual-2014</th>
<th>Actual-2015</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record attendees at Winter Workshop</td>
<td>0</td>
<td>38</td>
<td>50</td>
<td>40, 50; respectively</td>
</tr>
<tr>
<td>Use surveys to assess before and after knowledge</td>
<td>0</td>
<td>25</td>
<td>29</td>
<td></td>
</tr>
</tbody>
</table>

The 38 people who attended the 2014 workshop were growers, home brewers, commercial brewers, potential growers and even a mobile canning business owner. Attendees were from Durango, Cortez, Dolores, Bayfield, Pagosa Springs, Farmington (NM) and Taos (NM)

In 2015, we had 50 growers, home brewers, commercial brewers, potential growers and several support business owners. Attendees were from Durango, Cortez, Bayfield, Pagosa Springs, Boulder, Fort Collins, Farmington, NM, and Las Cruces, NM,

6. Create both traditional and alternative marketing opportunities

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Benchmark</th>
<th>Actual-2013</th>
<th>Actual-2014</th>
<th>Actual-2015</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Document private meetings as well as attendance at Field Days and Winter workshops.</td>
<td>0</td>
<td>1 Riff Raff</td>
<td>4 Carvers, Taos Mancos UBrew</td>
<td>5 Carvers, Steamworks Riff Raff Mancos Taos</td>
<td>4 relationships</td>
</tr>
<tr>
<td>Record attendance of craft and home brewers at Open House in Year 2 and 3</td>
<td>0</td>
<td>4</td>
<td>4 + 5 (9 total)</td>
<td>9 (18 total)</td>
<td>20 participants by</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------------</td>
<td>---</td>
<td>---</td>
<td>---------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Follow-up survey to record amount of locally produced hops purchased.</td>
<td>0</td>
<td>NA</td>
<td>115</td>
<td>240 Pine River Hops harvest sent to Denver to be pelletized; May return to local brewers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>500 pounds by Year 3</td>
<td></td>
</tr>
<tr>
<td>Follow-up survey to record prices paid for locally produced hops.</td>
<td>$0</td>
<td>NA</td>
<td>$15-30/lb for fresh cone</td>
<td>$14/lb for large purchases and $32 for home brew</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$12/lb</td>
<td></td>
</tr>
<tr>
<td>Follow-up survey of home brewers to identify source of hops.</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>5 using local hops</td>
<td></td>
</tr>
<tr>
<td>Follow-up survey of breweries to identify source of hops.</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>1 increasing use of local hops</td>
<td></td>
</tr>
</tbody>
</table>

**BENEFICIARIES**

Beneficiaries of our project, “Analyzing Hops Varieties for High Altitude Production and Alternative Marketing Schemes” include a wide variety of interested parties. We certainly reached potential growers as expected and utilized the established grower’s expertise to build some great long term relationships. Our second Winter Workshop had 33 new participants with some of them traveling over six hours to attend. I also believe that at least two local land owners benefited because they decided that hops production was too much of a financial investment and too labor intensive. Otherwise, they may have spent $20-30,000 to establish a yard that they couldn’t manage and harvest.

Because of our research on the importance of disease free rhizomes, potential growers should financially benefit by not having to replace diseased plants every five years. A representative from Summit Plant Labs attended our Winter Workshop and was able to see the enthusiasm for hops production in 4C region.
Initially, we saw the local breweries as potential customers for our product but they have become a much larger part of this project. Their willingness to try whole cone hops in both wet and dry form has been amazing. They also have helped us promote the project and really want us to succeed.

LESSONS LEARNED

We learned that hops production is much more complicated than most people think. The design and construction of the yard and trellis could be the first stumbling block. Fortunately, we had access to the necessary equipment and expertise to get the trellis built in a reasonable amount of time and have the ability to update it as needed. Some of the small farmers who are exploring hops production may not have these resources.

Locating verified disease free rhizomes continues to be challenging but it is so important to long term financial viability. We spent time researching hops varieties that had been tried in other high altitude areas so we felt good about our choices. Locating these choices took some time and Summit Labs was instrumental in getting our yard established. Honestly, the planting and establishment of the hops plants was the easiest part of the project. They are a really tough plant and have survived extreme heat when planted, cold winter temperatures (-24) and both drought and floods with great results.

Our primary challenge has been nutrient management, particularly Nitrogen with some issues with Zinc and Boron. Hops really are a heavy feeder and that is going to make organic production of hops extremely difficult in the Rocky Mountain soils. Nutrient issues were exasperated by uneven watering in 2014 most likely caused by a slight grade in the yard from North to South.

As our production levels increase, we are learning more about the labor and equipment requirements associated with large scale production. While hand picking hops is a necessity for our hops yard, it is certainly time consuming. With eleven varieties planted within a 150’ row, using a mechanical harvester would be challenging. However, as our production levels increase with appropriate nutrient management, utilizing a mechanized picker is definitely something we’ll be exploring. Other equipment that needs to be developed for small to mid size yards include wagon/trailers/lifts that allow you to safely and efficiently access the top of the trellis along with driers. We believe that developing an equipment cooperative that would serve producers throughout the 4C region is the next logical step.

CONTACT PERSON

Beth LaShell; Coordinator, Old Fort at Hesperus; 970-385-4574; lashell_b@fortlewis.edu
ADDITIONAL INFORMATION

Old Fort at Hesperus website:

Facebook page: www.facebook.com/oldfortathesperus

HomeBrewing News:
http://homebrewingnews.com/articles/fort-lewis-hops-project

Program Assistant Website:
https://amerbeye85.wordpress.com/2013/03/28/the-old-fort-lewis-hop-variety-trial/

Newspaper Articles:

7/11/13- Time to Hop to It
http://www.durangoherald.com/article/20130711/NEWS01/130719883/Time-to-hop-to-it--

10/12/13- Braving the Cold to learn more about what makes hops tick
http://www.durangoherald.com/article/20131012/NEWS01/131019821/0/defaultnewsajax/Braving-the-cold-to-learn-more-about-what-makes-hops-tick-

8/8/14- Hops Harvest in Cortez Journal
http://www.cortezjournal.com/article/20140828/NEWS01/140829831/-1/News01/Hops-harvest-

11/17/14- Local hops research expands to local breweries
http://www.cortezjournal.com/article/20141117/NEWS01/141119857/-1/News01/Hop-research-expands-to-area-breweries-

11/29/14- Get a Taste of local hops research
http://m.durangoherald.com/article/20141119/NEWS06/141119490/0/Services/Get-a-taste-of-local-hop-research-

Promotional and Educational Material

What’s Hop’n- July, 2012:

What’s Hop’n – July, 2012 Program Summary
http://aces.nmsu.edu/hch/hopsresearch.html

7/8/13- NMSU Hops Variety Trial to Expand to Higher Elevations
2014 New Mexico Organic Farming Conference- Hops Handout
https://www.fortlewis.edu/Portals/178/NMOFC_Hops_Handout.pdf

2015 What’s Hop’n Winter Workshop Brochure

Hops Virus Testing- Significance and Implications for Establishing Hop Production in New Mexico and Southwest Colorado- Research Report
http://aces.nmsu.edu/pubs/research/horticulture/RR788/welcome.html

8/14/15- Durango TV- Researchers Hop to It

Online Calculator for Drying Hops
http://sroc.cfans.umn.edu/People/Faculty/VinceFritz/Hops/HopDrying/index.htm

Pine River Hops YouTube Video
https://www.youtube.com/watch?v=KdpAPsDuzC4&feature=youtu.be

USDA Hops Variety Descriptions
http://www.freshops.com/hops/usda-named-hop-variety-descriptions