


Hopsteiner®



2023 HARVEST REPORT

CELEBRATING 175+ YEARS

Hopsteiner has proudly helped brewers secure a broad range of public and proprietary hop varieties from across the globe. We work with breweries in all size categories to provide innovative products and technical knowhow to help you get the job done.

As a vertically integrated hop supplier - we grow, breed, process, and trade the choicest hops and hop products available as a true farm to pint supplier.

Beyond the farm, our capabilities include on-site quality assurance labs, pelletizing plants, hop extraction plants, a breeding program, distribution centers, and cold storage management.

We work in one of the most fascinating industries in the world and are delighted to share in this experience together. We are committed to providing the best products with the best service and invite you to grow with us.

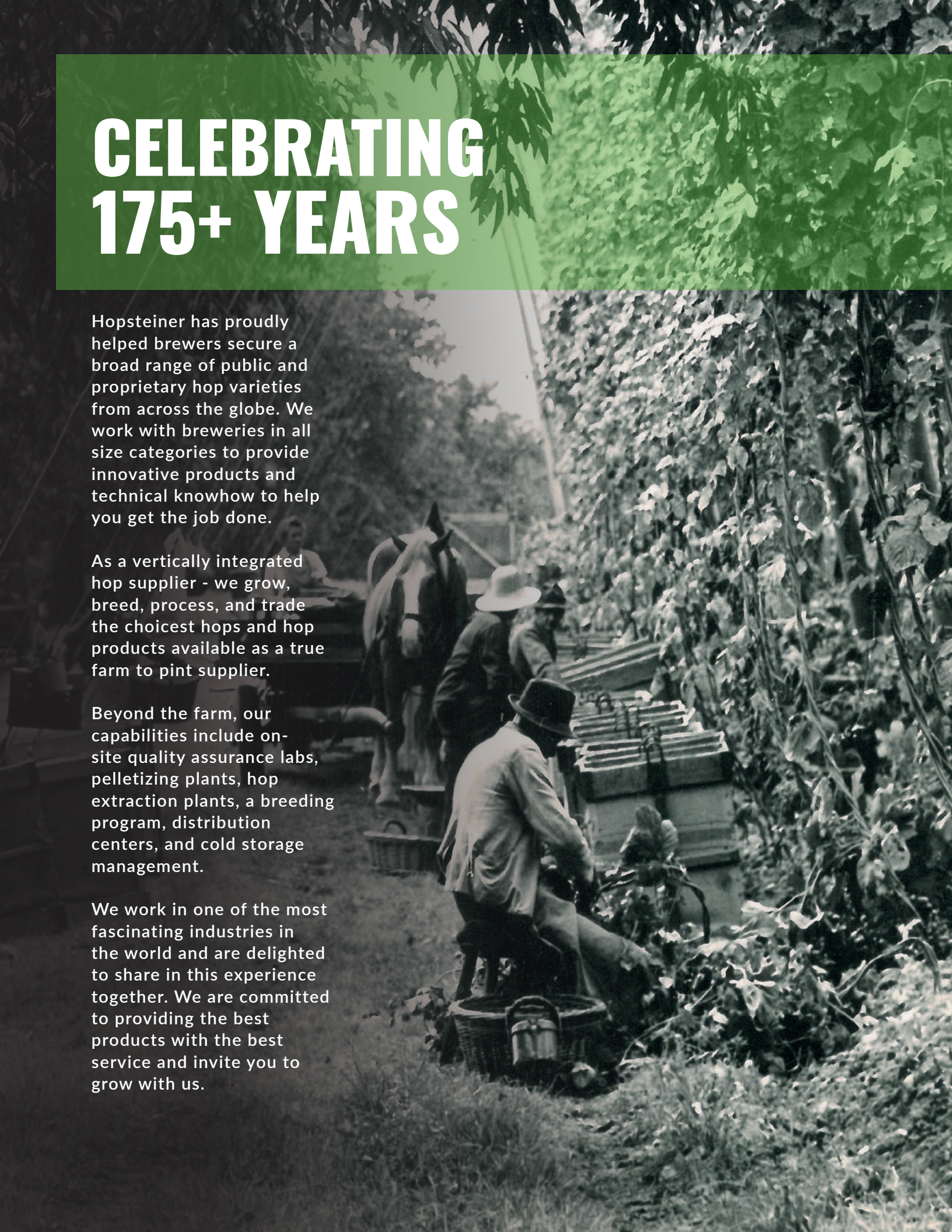
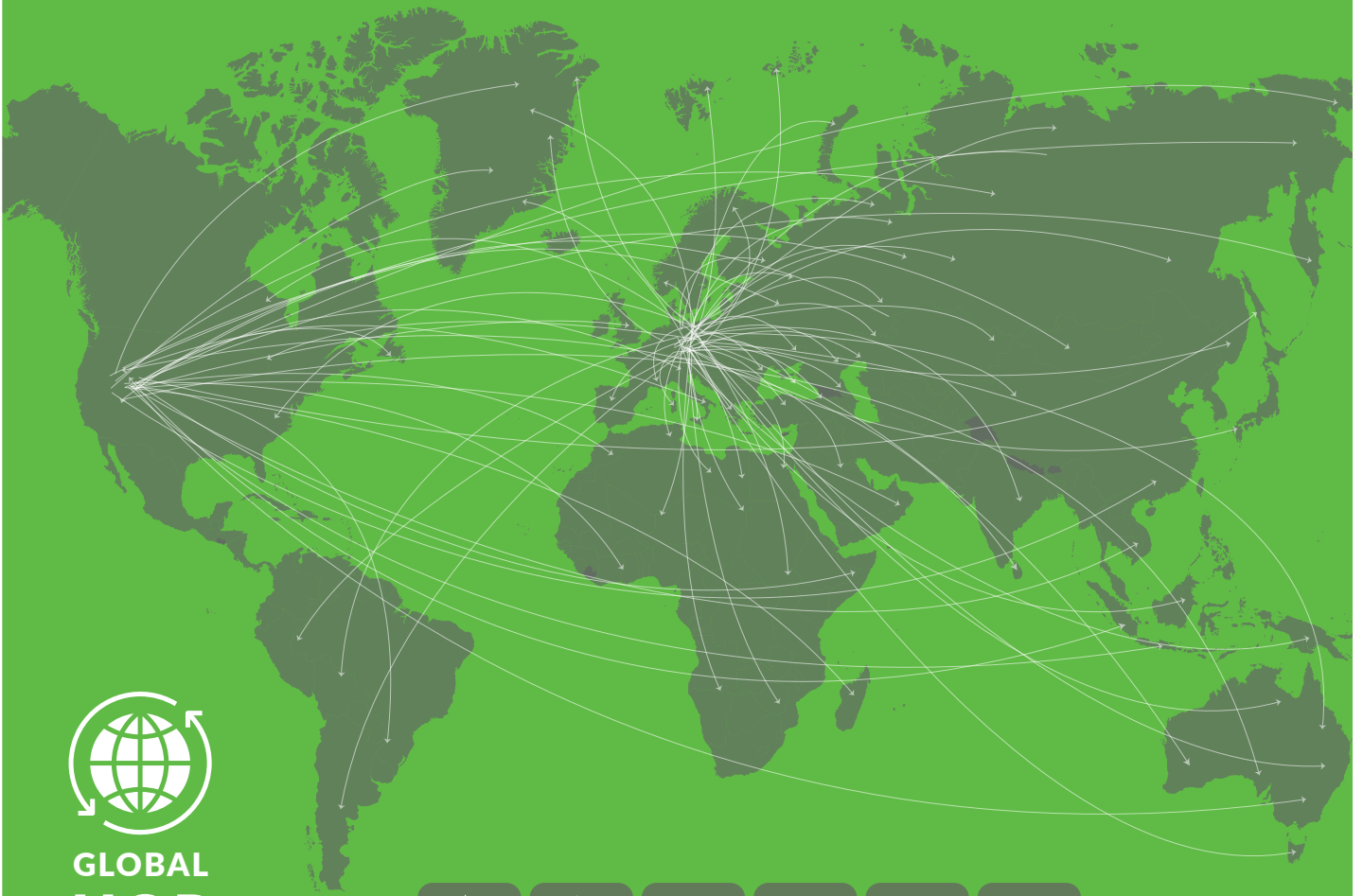


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GLOBAL
HOP
SUPPLIER



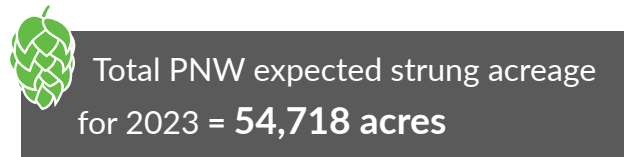
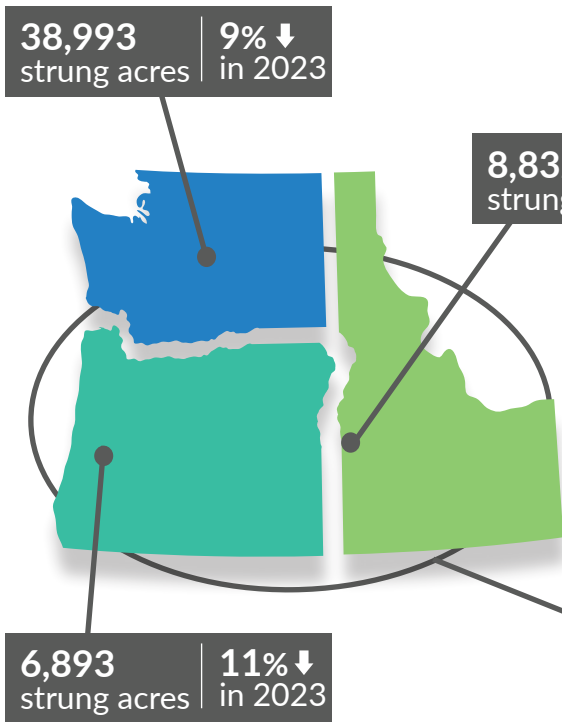
Hop Crop Forecast

After year-over-year acreage growth since 2011, the US faces a new challenge with an over-supplied market and is seeing a reduction in acreage. Total hop acreage peaked in 2021 with 60,892 strung acres across the Pacific Northwest (Washington, Idaho, and Oregon). The reduction began with a USDA-reported 59,785 acres in 2022 (a 2% decrease from 2021) [1]. As expected, this trend is continuing into 2023. Our trajectory was further endorsed after winter meetings with growers and participation in the Annual Hop Growers of America convention that took place in Santa Rosa, California this past January. As a result, we estimated acreage would decline in 2023 by 9%

lbs. per acre for a total production of 101.5 million lbs. [1]. For crop 2023, the yield estimate should return to 1,850 – 1,900 lbs. per acre range for a total production estimate of 102.5 million lbs. Obviously, a return to average production levels somewhat offsets the expected acreage reduction, further adding to the oversupply in the industry.

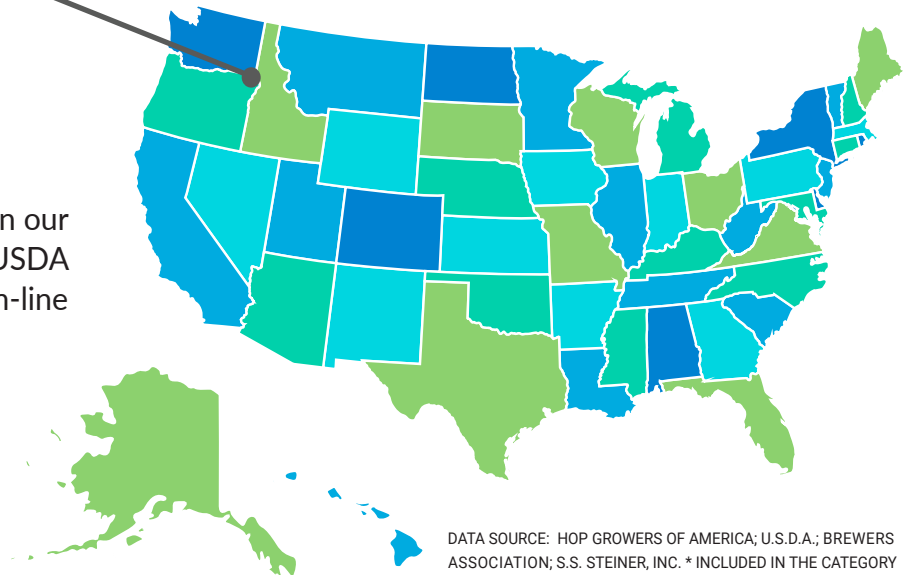
Washington State reduced acreage by 3% in 2022 and continued a reduction in acreage by 9% this season. That equates to roughly 3,769 acres coming out of the ground in WA. Washington State remains the largest growing region in the US, accounting for 71% or 38,993 acres. Idaho and Oregon are also seeing sizable acreage reductions by 5% and 11%, respectively [1]. Idaho will remain the second largest acreage ranking state with 8,832 total strung acres. Oregon sits at 6,893 total acres for 2023. The top five hop varieties with the most strung acreage will account for 53% of total US acreage in 2023 and the top ten will account for 88% of total US acreage.

Notable variety changes with acreage cuts of 25% or greater from 2022 to 2023 are as follows: Citra® (-27%) for 8,762 total acres, Mosaic® (-21%) for 5,157 total acres, Strata® (-25%) for 913 total acres, El Dorado® (-32%) for 793 total acres, Azacca® (-49%) for 447 total acres, Cashmere (-47%) for 451 total acres, Sabro™ (-59%) for 225 total acres, Comet (-34%) for 311 total acres



to an estimated 54,500 strung acres in our Spring Report. After receiving the USDA Report in July, our calculations were in-line with strung acreage predictions. According to the USDA Report, strung acreage declined by 8% to roughly 54,718 acres.

In 2022, the average hop yield decreased nearly 200 lbs. per acre, resulting in an average of 1,694



DATA SOURCE: HOP GROWERS OF AMERICA; U.S.D.A.; BREWERS ASSOCIATION; S.S. STEINER, INC. * INCLUDED IN THE CATEGORY "OTHER VARIETIES" TO AVOID DISCLOSURE OF INDIVIDUAL OPERATIONS

and others. Notable variety increases by 10% or greater for 2023 include CTZ (43%) for 6,478 total acres, Pahto® (32%) for 2,264 total acres, Eureka!™ (+13%) for 1,148 total acres and a new super-high alpha variety from Hopsteiner's advanced breeding program - Helios™ for 1,417 total acres,

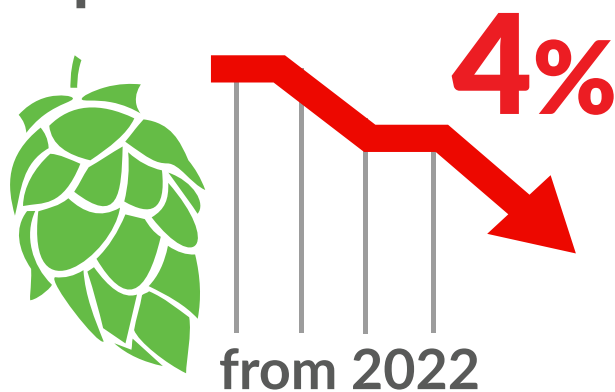
Helios™ is being grown in all three main growing regions of WA, ID, and OR and is expected to make its way into the top ten strung hop varieties list for 2024 with estimated acreage exceeding 1,000 acres. Note the decrease in acreage primarily comes from aroma varieties and increased acreage is largely alpha/bittering hop varieties. This change is a clear reflection of the stagnation in the craft beer market.

The market has not seen this type of change between alpha and aroma hops since 2018. Alpha varieties increase by 40% in acreage this season, while aroma varieties decrease by 20%. Dual-purpose varieties will also decrease approximately 11%. Further expanding on the three category types typically observed, we predict the USA acreage mix to follow a 26% alpha, 48% aroma, and 26% dual-purpose split, respectively, for 2023. Dual-purpose



Sultana hop yard taken at River Ranch in late June 2023

Hop Stock Down



varieties can be best categorized by hops with higher-than-normal alpha ranges (10%-15% AA), yet also offer aromatic characteristics to fit a multi-use function.

When comparing public vs proprietary acreage, public acreage strung is 39% of total acreage and proprietary makes up 61%. Of the predicted top ten most planted varieties of 2023, six of those ten account for proprietary varieties.

Continued increases of hop stocks as reported by the USDA mean that all players in the hop industry must work to reduce supply and return to a balanced

186 million lbs

Dealers/Growers = 159 million lbs

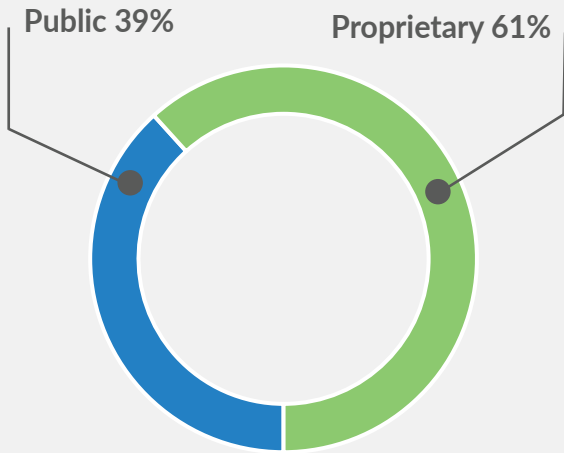
Brewers = 27 million lbs.

Since 2013, Hop Stocks have climbed 71 million lbs.

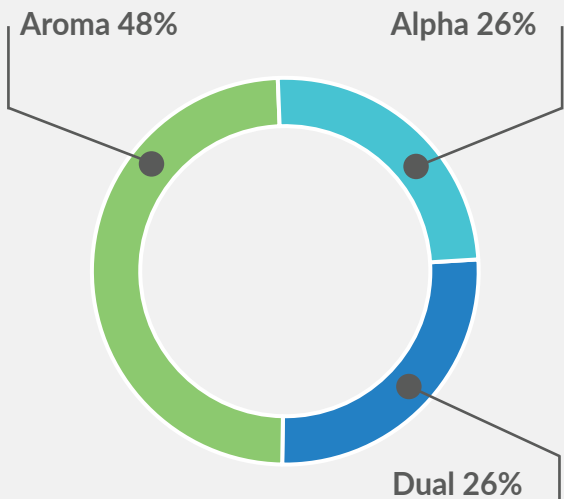
market. As a result, acreage decreases are expected to continue. Hop stock inventory held by growers, dealers, and brewers totaled 193 million lbs. in March 2022, up 4% from 2021[3]. Of this, stock held by dealers and independent growers totaled 160 million lbs. while brewers held 33 million lbs. Progress has been made in reducing this volume, however. Perhaps due to the small 2022 crop, the USDA reported on March 17, 2023, hop stocks dropped 4% from a year earlier. Growers and dealers reported holding 159 million pounds, while brewers reported holding 27 million pounds for a total of 186 million pounds [3]. This is still 56 million pounds above the 2020 stock volume and represents more than 1.5 times a normal crop volume.

Hop Acreage

Public vs Proprietary Acreage

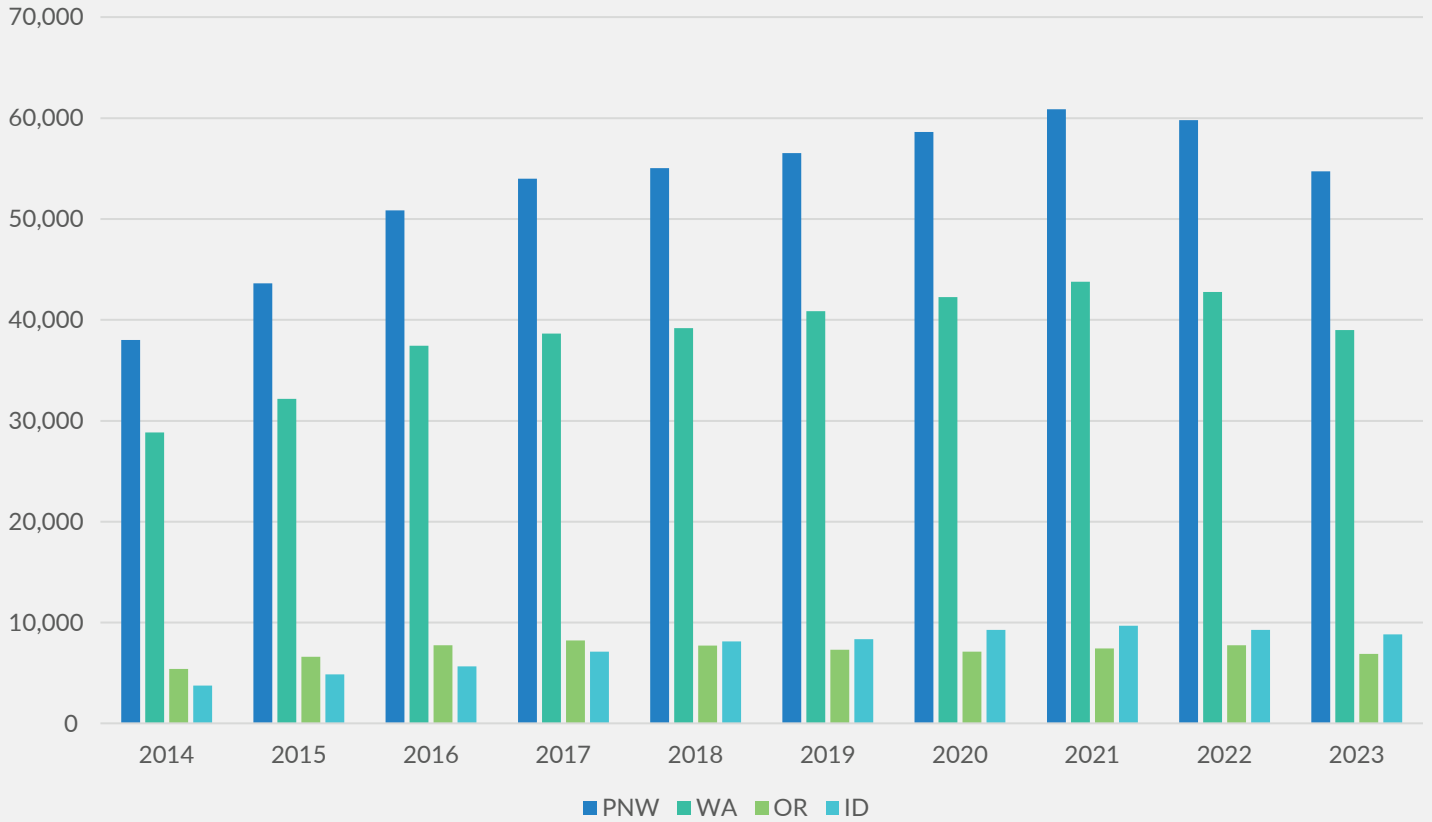


Hop Acreage Split

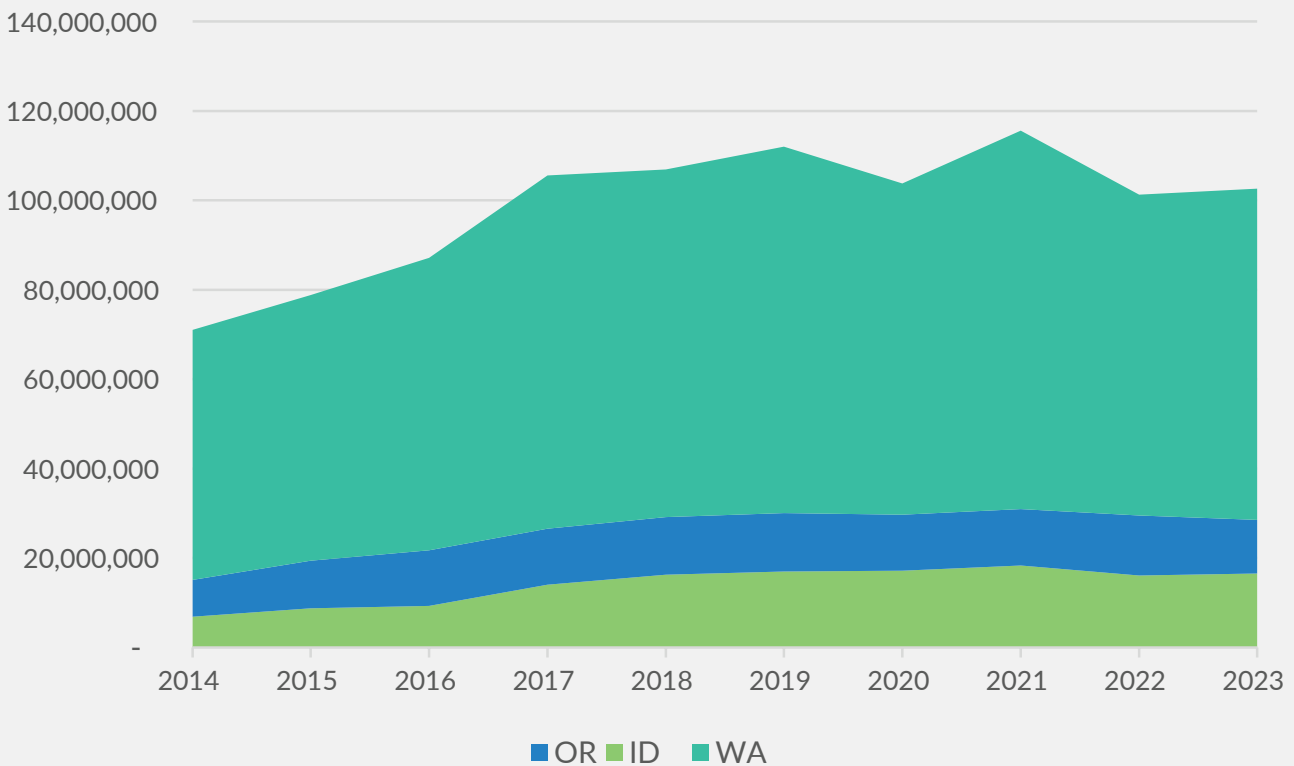


Variety	2022	2023	% Change
Citra®	12,044	8,762	-27%
Mosaic®	6,501	5,157	-21%
Cascade	5,107	4,320	-15%
COL/TOM/ZEU	4,518	6,478	43%
Simcoe®	4,462	4,229	-5%
Centennial	2,424	2,537	5%
Chinook	2,075	1,785	-14%
Amarillo®	1,913	2,195	15%
Pahto™	1,709	2,264	32%
Strata®	1,203	913	-24%
El Dorado®	1,165	793	-32%
Pekko™	1,084	1,032	-5%
Willamette	1,054	1,156	10%
Eureka™	1,014	1,148	13%
Apollo™	965	1,013	5%
Azacca™	871	447	-49%
Cashmere	857	451	-47%
Sabro™	548	225	-59%
Idaho 7™	540	444	-18%
Tahoma	483	488	1%
Comet	471	311	-34%
Nugget	460	395	-14%
Mt. Rainier	427	382	-11%
Saaz	380	380	0%
Palisade®	377	314	-17%
Super Galena™	368	368	0%
Ekuanot™	367	373	2%
Summit™	350	200	-43%
Cluster	293	202	-31%
Crystal	292	324	11%
Galena	220	220	0%
Bravo™	216	219	1%
Mt. Hood	213	240	13%
Loral™	199	179	-10%
Sultana™	179	108	-39%
Calypso™	171	179	5%
Ahtanum™	168	80	-52%
Hallertau	159	159	0%
Warrior	147	145	-1%
Lotus™	98	64	-35%
Northern Brewer	58	58	0%
Triumph	55	30	-45%
Sterling	35	45	29%
Golding	32	25	-22%
Liberty	28	25	-11%
Magnum	28	28	0%
Glacier	18	18	0%
Perle	15	—	---
Delta™	7	19	171%
Helios™	—	1,417	---
Experimental	—	—	---
Fuggle	—	—	---
Jarrylo™	—	—	---
Other	—	—	---
Sorachi Ace	—	—	---
Tettnanger	—	—	---
Vanguard	—	18	---
TOTAL PNW	59,785	54,718	-8%

US Hop Acreage History



US Hop Production History



PNW Climate Conditions

PNW Overview: The 2023 hop crops in the Pacific Northwest (PNW) experienced exceedingly low temperatures throughout early spring. In the month of May, temperatures were a series of highs and lows, with the lows falling well-below average in all three states (WA, OR, ID). Mixed weather continued throughout June and early July, causing some early bloom in aroma varieties. Inconsistent weather also brought the challenges of disease and insect pressure, but all potential issues were kept at bay with fungicide, and beneficial insect release, of miticide rotations. July brought relatively consistent and favorable weather compared to 2022 leveling out most varieties to normal conditions. It is still being determined how much early bloom will affect yield for early aroma varieties, but forecasts for all three states are favorable and consistent.



Lotus™ field with Mt Adams in the background

Reservoir Status: Snowpack and reservoir levels faced similar patterns in all three NW growing states this season. Washington, Oregon, and Idaho experienced a dry winter that posed concern until an unseasonably cold spring coated the NW with a surplus of snow. Unfortunately, as quickly as the snowpack accumulated, it just as quickly melted away. From May 1-18, 34+ million-acre feet of water from snow melted down to just 17+ million in Washington, a loss of nearly half the snowpack. Snow-fed rivers ran strong throughout May, with runoff rates reaching as high as 182%

of normal. Like in Washington, spring precipitation significantly increased stream flow and reservoir storage statewide in both Oregon and Idaho. Several reservoirs with low storage in late winter are now full or nearly full, granting a steady water supply for the remainder of the season in all three states.

Washington State: Washington State had a cooler-than-average start to its growing season, with winter weather extending through April. Temperature swings and heat spikes caused some minor plant stress and early bloom, along with an outbreak of powdery mildew in susceptible varieties but was ultimately contained with fungicide rotations. Mite pressure began to build earlier than usual due to the inconsistent weather, but beneficial insect release paired with miticide rotations have kept pressures at bay. Steady weather continues and crops that were behind schedule are now on track to come in at or above average.



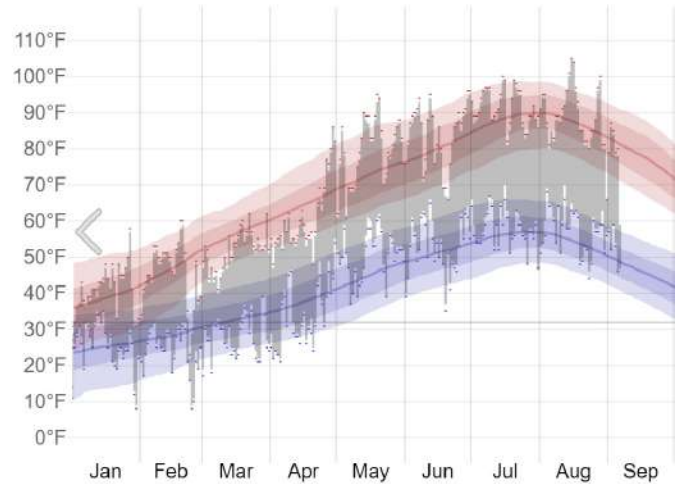
Powdery Mildew screening

Oregon State: Oregon State also experienced a cooler-than-usual winter and spring. Precipitation March through May was notably above average, boosting snowpack and reservoir levels. Temperatures in May were 1-3 degrees above

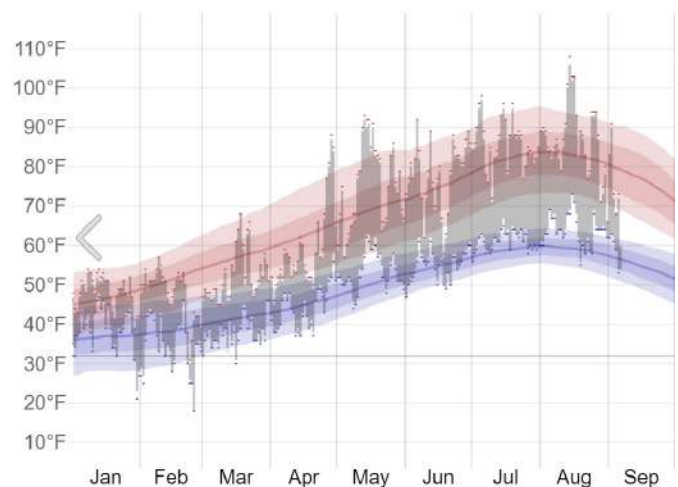
average, but the Willamette Valley experienced the same temperature swings seen in Washington. Late May brought considerably warmer weather, and that streak continued into June and July with some smaller peaks of highs and lows. Scattered showers brought downy mildew, but early fungicide rotations contained the infection. Alpha varieties were not affected. Mite pressure throughout the Valley did not surpass more than moderate levels.

Idaho State: Some fields in the Treasure Valley experienced delayed stringing in early spring due to severe wind and hail. Hailstorms were also noted in late May and June, causing some minor crop damage with sporadic early bloom in some varieties from cooler temperatures. Powdery mildew appeared in varieties with early bloom and was treated accordingly. Continuous passing showers throughout July become a challenge, causing downy mildew across several varieties, but has been mitigated. Mite pressure was relatively low with the help of preventative miticide applications. Overall growth in the valley is coming in average to above average in some areas, and we are on track for a bountiful harvest.

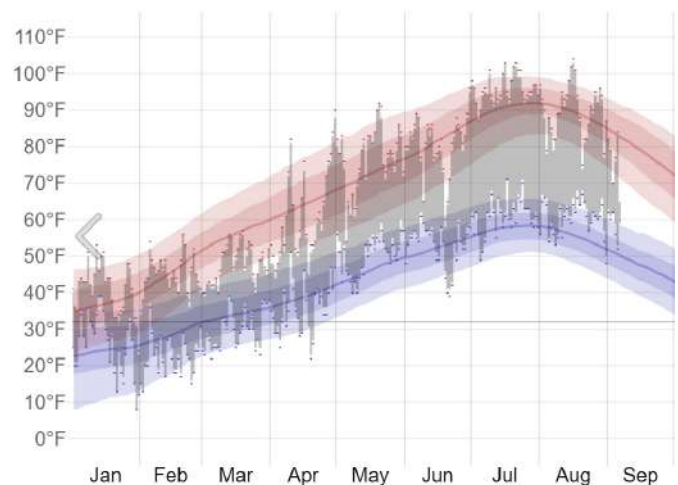
WA Growing Season Temps



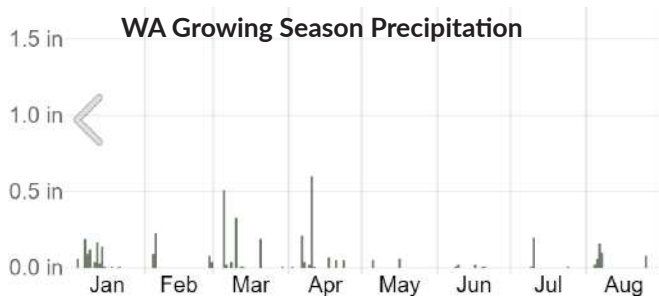
OR Growing Season Temps



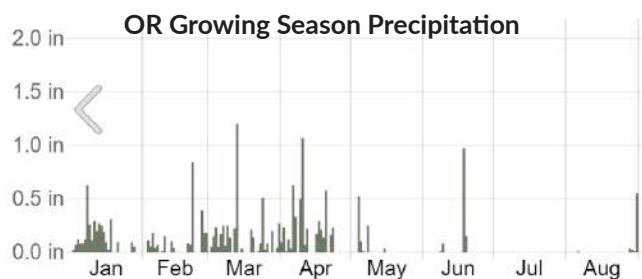
ID Growing Season Temps



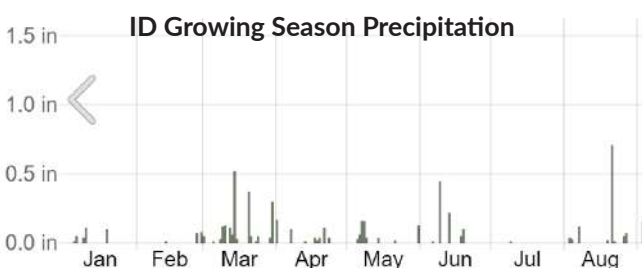
WA Growing Season Precipitation



OR Growing Season Precipitation



ID Growing Season Precipitation



New and Notable Developments at Hopsteiner

Since 1845, Hopsteiner has paved the way to a greener and more sustainable future for the hops industry. Our objective, to provide industry-leading advancements in farming and production. Each year our team works incessantly to innovate, optimize, and elevate all aspects of our processes.

New Labs

In 2023, our research department was fitted with a new pesticide lab and dedicated staff to analyze pesticide residue in order to test independently rather than relying on third-party services.



Pesticide Lab in Yakima, WA

Outsourcing these analyses meant waiting weeks or even months to receive results compared to just a few days. Using industry best practices, our chemists have developed hop-specific analysis methods that ensure end results are repeatable and accurate. The new Gas Chromatography-Mass Spectrometry Triple Quadrupole and Liquid Chromatography-Mass Spectrometry Triple Quadrupole (GC-MS/MS and LC-MS/MS, respectively) machines allow our team to test down to 0.01 PPM and confirm the pesticide residue levels. Our technicians in the pesticide lab work alongside our Quality Assurance, Research and Development, and Agronomy teams to develop effective integrated pest management

programs so growers can apply pesticides in a way that results in the greatest efficacy with the lowest residue levels.

Also recently complete is our new thiol laboratory. Our new GC machine can detect and identify hop oils, terpenes, and sulfur (thiol) compounds in hops. This advancement provides enhanced testing capabilities of the total oil composition found in each hop. Our goal is enhanced identification of new and unique hop aromas for our breeding program as well as to support and optimize harvest timing. The total oil sample produced is variety specific and a good indicator of authenticity per variety—another quality control measure that will allow us to archive results and build out a historical timeline for each. Benefits from the new GC machine come two-fold. Previous testing would consist of running the oil through a GC machine to break apart the individual oil compounds and was limited in its detection to know components (typically eight). This is a tiny fraction of the total available, as hops contain between 500-1,000



Thiol Lab in Yakima, WA

or more individual aroma compounds. Our new GC machine allows for testing down to the parts per billion and can measure oil, thiol, and terpene amounts. This allows our technicians to fingerprint a hop variety, or identify new, unique varieties.

Our laboratory at Hops Extract Corporation of America (HECA) continues to follow industry

standard testing for hop extract and all 30 of our downstream products. Technicians at the HECA laboratory now collect and sample larger batch sizes for better quality control measures.

The Hopsteiner harvest laboratory continues to improve both its pre-harvest and during-harvest testing with new equipment and sampling methods. The sampling process for all lots are the same to keep results consistent. Cone samples are dropped at the lab where alpha, beta, HSI, cone weight, and other variable tests are performed to ensure all varieties are of exceptional quality. All data collected before and during harvest is provided to growers to aid in their harvest timing decisions. After harvest, data is analyzed to assess each variety and find ways to improve yields.

Dedicated Research and Development

The Hopsteiner Breeding Program focuses on improving hop quality among commercially available varieties and continues to pursue disease-resistant traits for better overall agronomics. Our breeding agronomists have significantly improved field design for our experimental varieties, which allows for optimum growing conditions for each. An expansion of our experimental yards has allowed for more statistical power when selecting new varieties to advance. Previously, hops in the pre-commercial phase were planted in one location. We have now expanded to two separate locations, simulating different growing environments. In addition, a new greenhouse facility will be constructed to support propagation of commercial and experimental varieties for expansion of virus-free planting and streamline our seedling and germination processes.

Our research and development team attended the Plant and Animal Genome Conference last January. Hopsteiner Scientists continue to lead the industry in genomics and bioinformatics and will be publishing the hop genome this year. Over the last year, the team has been successful in identifying markers that correlate to aroma traits and disease susceptibility. Additionally, as a way to protect our proprietary plant material, we have genetically mapped each of our varieties, helping us focus on new variety development with the added biosecurity of our plant material.



Greenhouse marking for disease

Processing:

As Perennial Pioneers, we are continuously innovating. We systematically invest in hop growing and processing equipment with sustainability approaches in mind for improved efficiency and better overall product quality. Some of the latest quality-focused projects include our new dust abatement filter, recently completed at our hops extract facility where we process hops into extract. Processing hops can be a dusty job. In order to mitigate dust from spent pellets, we have implemented new filtration procedures to improve throughput and control fine dust particles for improved plant safety.

Magnets - we added additional magnets to our cleaning facilities that collect and sort lead materials for added quality assurance. Smart-detect metal detectors have also been added to remove any foreign objects potentially picked up while harvesting.



Jiffy pods with new experimental seedlings

New and Notable Developments at Hopsteiner (cont.)



New dust abatement filter

Small-Pack VFFS – Construction was completed recently on equipment that allows us to offer new small-pack options. Our VFFS packaging line will enable us to provide smaller packaging sizes for homebrew supply shops and growing microbreweries while improving quality and efficiency for small-pack orders.

Farms:

Much of our focus on farming advancements comes from our long-term sustainability goals. We emphasize efficiency and have developed systems with the preservation of Earth's natural resources in mind. Hopsteiner has been at the forefront of sustainable practices for many years and is continuously seeking alternative renewable resources.

Windscreens – We upgraded fans in our cleaning facilities with additional power for washing away leaf material. We use the gravity of our cones to sort out light leaf materials for improved leaf-to-cone ratios.

Precision Sprayer – Like all living organisms, hops have predators and diseases. In order to mitigate these pressures, chemicals are applied. New technologies have made it to chemical applications, allowing us to update our sprayers with smart apply precision using lidar systems that detect and only spray plant biomass. This technology is estimated to use approximately 30% less chemicals and labor typically needed per season.

Irrigation Monitoring – We are in the process of automating our irrigation system so that we have control from mobile devices. Each monitor is equipped with and powered by solar panels. This new system uses hundreds of soil moisture probes combined with satellites that monitor water use and plant stress, helping mitigate human error and allowing us to calculate more considerably.



Moisture prob in Lemondrop™ field

Hop Harvesting Combine – After a successful trial run last season, we are excited to fully commit our new combine to this year’s harvest. While our older model combine is still very effective, our latest model was designed with modular functionality in mind, fully equipped for better efficiency outputs with more safety and comfort features for personnel.



New combine

Organic Acreage and Bee Better Certification – Our team has been preparing new lands for organic hop yards while expanding more acreage into organically grown fields to help mitigate CO2 emissions. We are proudly now Bee Better certified. In an effort to protect and expand habitat for pollinators, we have planted a variety of crops in one of our organic fields that will support biodiversity conservation for regenerative agriculture practices.



New organic field being plowed out



New Combine 2022

Farming for the Future

Much of our focus on technological investments is rooted in our long-term sustainability goals. Farming is labor-intensive and costly, but innovative technologies have allowed us to operate more efficiently. We use precision spray systems in order to save up to 30% of the typical cost of chemicals and labor. Additionally, we have plans to invest in a fully automated irrigation control system that monitors water use and efficiencies, which will reduce water usage.

Hopsteiner's own farms have been harvested by first-generation combines for many years. We are pleased to advise that we have now developed a new, more efficient field harvester. This new innovative machine is multifunctional and can be used year-round. It provides higher reliability, less maintenance, improved picking and is significantly safer for employees.

Sustainable Practices are Fundamental

We have been able to leverage our success in growing organic hops to improve our conventional hop production. Each input is essential to a crop's success but may have a negative impact on the environment. Many commercial hop varieties vary greatly in agronomic traits such as yield, disease resistance, and nutrient use efficiency. These variations can have a significant impact on the total amount of inputs required for commercial hop production and ultimately influence overall production sustainability. Understanding how to grow our hops differently to accommodate the organic market has significantly improved our overall growing practices for regular hop crops.

Carbon Dioxide equivalent emissions (CO₂ equivalents), commonly called Carbon Footprint, are often used to quantify the environmental impact of crop production inputs. Greenhouse gas emissions are associated with the formulation, packaging, and application of these respective inputs. We measured these inputs by compiling hop production records, cone yields, and alpha-acid yields across multiple varieties to determine the Carbon Footprint

associated with each variety. What we found was remarkable.

Our data found significant differences between hop varieties based on the Total CO₂ Equivalents per hop pound produced. This study resulted in comprehensive data sets from total commercial hop production inputs and carbon footprints for multiple commercially available hop varieties that can be used by brewers to select better ingredients with more environmental value. We aim to provide brewers with a standard sustainability metric to assist in making more sustainable choices amongst available hop varieties.

Hopsteiner High Alpha variety development

While our catalog for unique aroma hops has broadened significantly, we are continuously working to develop successors to existing varieties. Since 2006, Apollo™ has been the benchmark standard USA bitter hop based on its alpha level, yield, and stability. Although Apollo™ was originally disease tolerant, it unfortunately lost its tolerance over time. In 2015, Hopsteiner released Eureka!™ as the next generation hop for the alpha market. Eureka!™ offered improved disease tolerance, higher yield potential and nearly equivalent alpha stability. Eureka!™ has developed into staple alpha hop variety, allowing US growers to participate in the global alpha market.

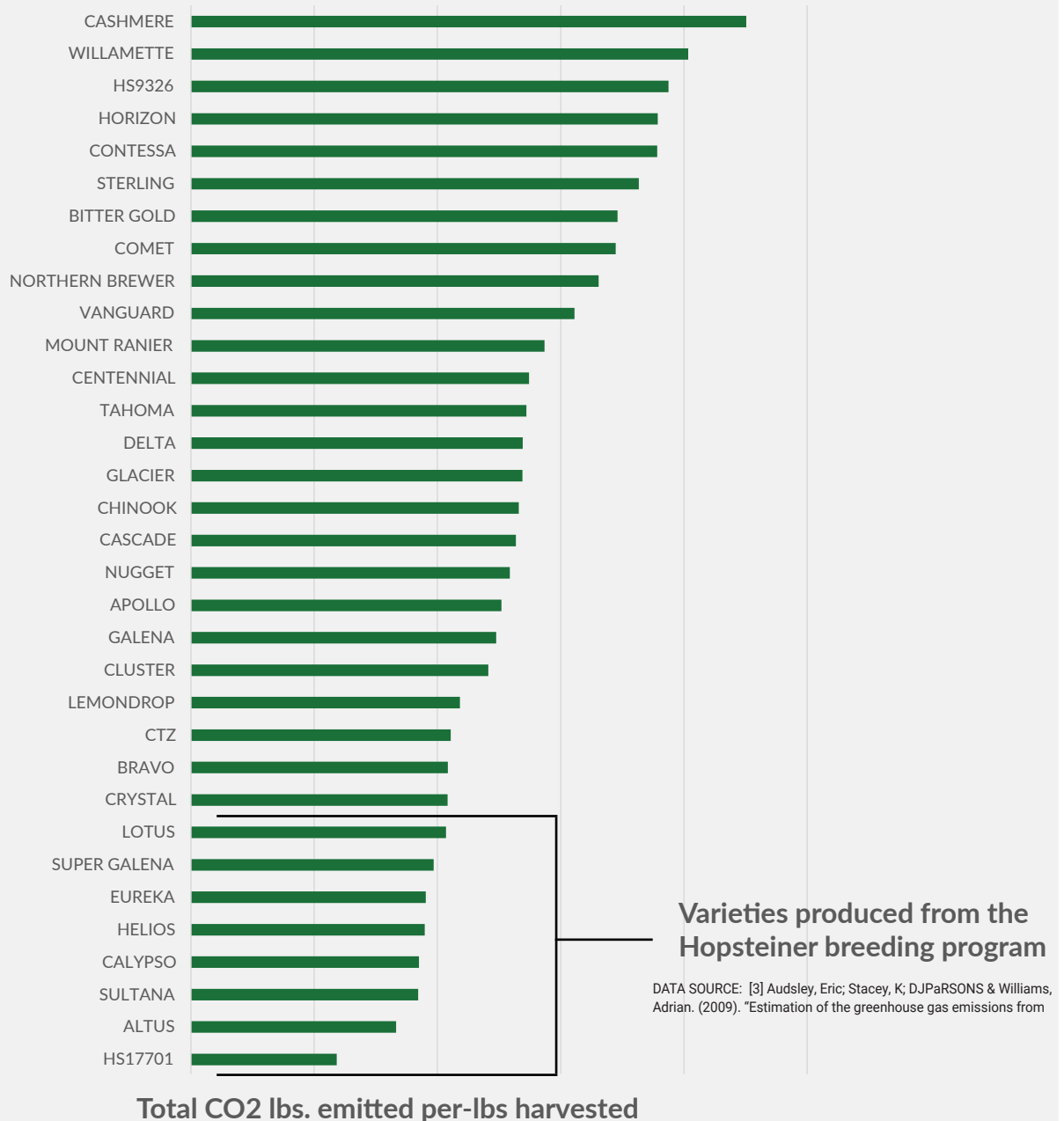


Eureka™ Hop Cones feeding kiln bed

Buoyed by this success, we then released experimental hop HS15619 in 2020 as the next generation of alpha hop. In 2022, this experimental hop was given the name Helios™. Helios™ raises the benchmark for agronomically sustainable hop varieties. Helios™ has the potential to match Apollo’s alpha acid, alpha stability, and it improves plant vigor with resistance to hop powdery mildew and downy mildew pathogens. Our mission is to reduce our dependence on chemical inputs through continual genetic gain. Helios™ takes the best attributes of both Apollo and Eureka!™ while maintaining one of the lowest carbon footprints on the market.



HOP VARIETY CARBON FOOTPRINT COMPARISON



VARIETY		AROMA	SPECS	RELEASED	REGION
APOLLO™		Lime, grapefruit, pine	α-acids %: 15-19 β-acids %: 5.5-8.0 Total oils: 0.8-2.5	2006	US
BRAVO™		Orange, floral, candied lime	α-acids %: 14-17 β-acids %: 3-5 Total oils: 1.6-2.4	2006	US
Super Galena™		Grassy, spicy, grapefruit	α-acids %: 13-16 β-acids %: 8-10 Total oils: 0.8-2.5	2006	US
Delta™		Earthy, ginger, citrus	α-acids %: 5.5-7 β-acids %: 5.5-7 Total oils: 0.5-1.1	2011	US
CALYPSO™		Stone fruit, pear, apple, melon	α-acids %: 12-14 β-acids %: 5-6 Total oils: 1.6-2.5	2012	US
<i>Lemondrop™</i>		Lemon, tangerine, green tea, melon	α-acids %: 5-7 β-acids %: 4-6 Total oils: 1.5-2	2014	US
EUREKA!™		Black currant, dark fruits, herbal, pine	α-acids %: 17-19 β-acids %: 4.6-6 Total oils: 2.5-4.4	2015	US
SULTANA™		Pineapple, pine, bright citrus	α-acids %: 13-15 β-acids %: 4-5 Total oils: 2.5-4	2016	US
LOTUS™		Orange, vanilla, berry, tropical fruit	α-acids %: 13-17 β-acids %: 5.5-6 Total oils: 2-2.5	2019	US
CONTESSA™		Light pear, green tea, light floral notes	α-acids %: 3-5 β-acids %: 5-7.4 Total oils: 0.8-1.9	2020	US
CALTUS™		Spicy, resinous, tangerine	α-acids %: 15-19 β-acids %: 4-5.2 Total oils: 3-4.4	2020	US
HELIOS™		Stone fruit, pine, spicy	α-acids %: 18-21 β-acids %: 4-5 Total oils: 1.5-2	2022	US

Salvo™

DARE TO BREW DIFFERENT

Looking for ways to improve aroma intensity?

Salvo™ is an aroma extract that delivers impactful variety specific flavor as a fractionated form of CO2 hop extract. In this product, bittering acids have been removed to explicitly enhance flavor and aroma with little to no added bitterness.

Salvo™ is best used as a late kettle/whirlpool addition to partially replace leaf or pellet hops, and since Salvo™ contains no vegetative matter, our flavor extract can help mitigate beer yield loss.

Altus™

El Dorado®

Apollo™

Cascade

Bravo™

Centennial

Calypso™

Chinook

Eureka!™

Comet

Helios™

CTZ

Lotus™

Nugget

Sultana™

Trident™

Super Galena™



HUGE
HOP FLAVOR

NO IBU
BITTERNESS



BIGGER
BETTER YIELDS



▼ Available in 1kg cans. Values are subject to change based on crop year.

References

DATA SOURCE:

[1] Northwest Regional Field Office. (2023, June 9). Press Release. United States Department of Agriculture. Retrieved from chrome-extension://efaidnbnmnnibpcajpcglclefindmkaj/https://www.nass.usda.gov/Statistics_by_State/Regional_Office/Northwest/includes/Publications/Hops/2023/HOP06_1.pdf.

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