IMPACT OF REGIONALITY ON HOP FLAVOR AND QUALITY

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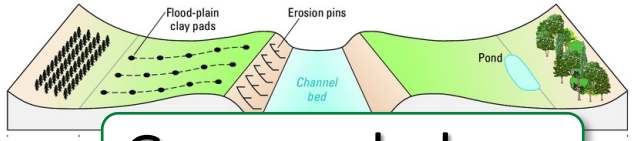
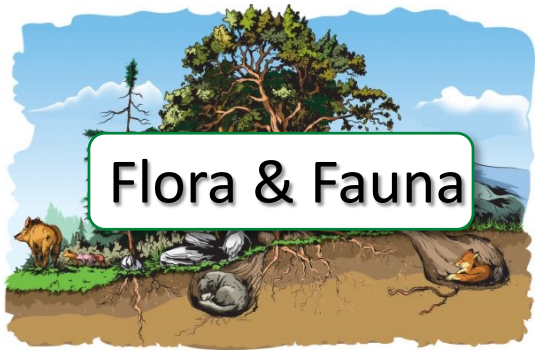
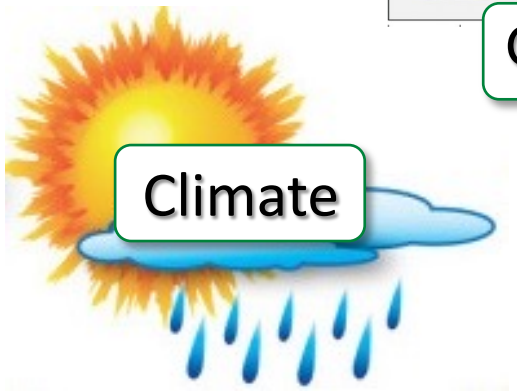
Regional identity or Terroir



Geomorphology



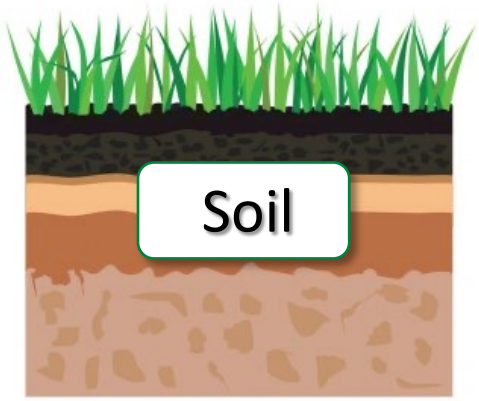
Flora & Fauna



Climate

Variety

Terroir



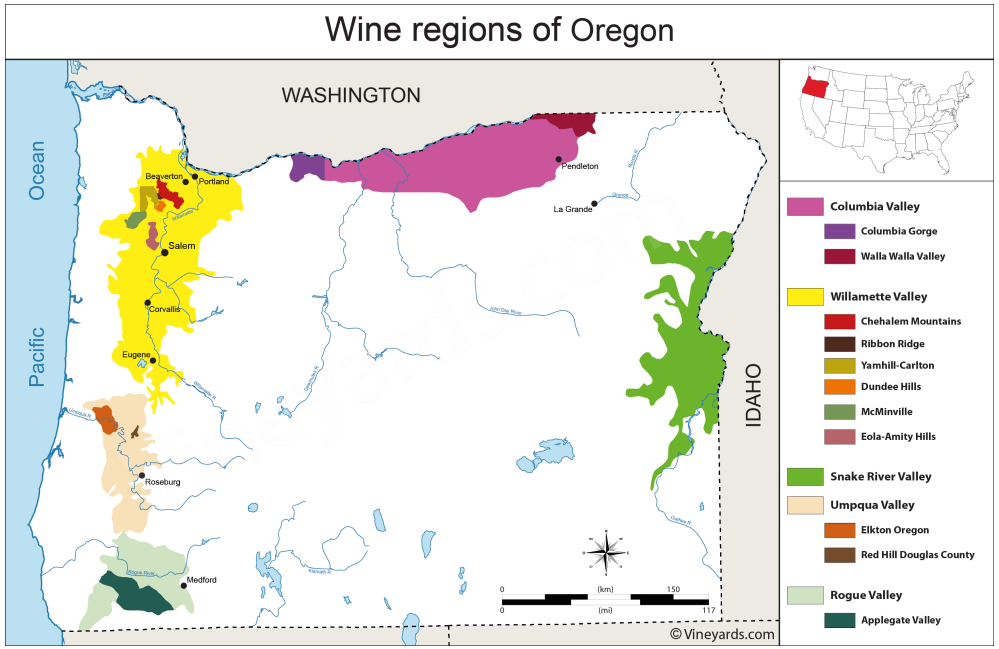
Soil

Management

Unique quality traits of products from a specific region[1]

Examples of terroir

- Wine grapes
  - Used to established American Viticultural Areas, and equivalents in other countries
- Coffee
  - Single origin coffee
- Tea
  - Geographical Indications



DARJEELING

Previous work on hop terroir

- Cascade, Mt. Hood, Golding, and Nugget cultivar hops from UK, USA, and Nova Scotia, Canada
  - Barry, et al. 2018. A preliminary investigation into differences in hops' aroma attributes. Int. J. Food Sci. Technol. 53:804-811
- Amarillo grown in Idaho and Washington
  - Van Holle, A., et al. 2017. The brewing value of Amarillo hops (Humulus lupulus L.) grown in northwestern USA: A preliminary study of terroir significance. J. Inst. Brew.
- Cascade and Comet grown in Yakima Valley and Hallertau
  - Forster, A.; Gahr, A. A Comparison of the Analytical and Brewing Characteristics of Cascade and Comet Hop Varieties as Grown in Yakima (USA) and Hallertau (Germany). Brew. Sci. 2014, 67, 137–148
- Cascade grown in Italy (9), Slovenia, Germany, USA (2)
  - Rodolfi, M. et al. Changes in Chemical Profile of Cascade Hop Cones according to the Growing Area. J. Sci. Food Agric. 2019, 99, 6011–6019
- Experimental cultivars grown in Yakima and Kootenay river valley
  - Morcol, T. B.; et al. (*Humulus lupulus L.*) Terroir Has Large Effect on a Glycosylated Green Leaf Volatile but Not on Other Aroma Glycosides. *Food Chem.* 2020, *321*, 126644–126651

Challenges to carrying out terroir studies

- Controlling many different variables
  - Hop maturity
  - On-farm and post harvest processing
  - Agronomy / grower practices
- Lack of a balanced design
  - Don’t have all soil types and all weather/climate combinations
- Insufficient sample size
- Need multiple years

Recent OSU Regional Identity Studies - Hops

2019 – Oregon

- Single grower – Coleman Ag
- 3 hop varieties
  - Simcoe, Mosaic, Strata
- Multiple fields within Oregon
- Multiple samples within each field
- ~ 60 observations

2020 – Oregon & Washington

- 23 growers, 41 fields
- 2 hop varieties
  - Cascade and Mosaic
- 10 fields within each state
- Single samples within each field
- 41 observations

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PEER-REVIEWED SUBMISSION

First Steps Toward Understanding the Regional Identity of Oregon

Elizabeth Verhoeven and Thomas H. Shel

1. Oregon State University, Co
2. Coleman Agriculture, St. Pa
3. Red Hill Soils, Corvallis, OR,

Regional identity, or terroir, and quality characteristics of c place of origin, and it is well- sents preliminary evidence of vars, Centennial (two locatio were managed similarly in th collaborative effort among Or campus and Marion County E Hop Breeding Program, Col Soil chemistry and morpholo ing season, and regional clim

JOURNAL OF THE AMERICAN SOCIETY OF BREWING CHEMISTS
https://doi.org/10.1080/03610470.2021.1968271

Examining Chemic Grown in the Will

Karli R. Van Simaeys[a], Weaver[c] and Thomas

[a]Food Science and Technology, Gervais, OR, U.S.A.

ABSTRACT

The influence of growing re (Mosaic®, Simcoe® and Stra from each site were analyz GC-FID to quantify selecte samples from each field ar influence on chemical diffe fields within the same vari IPAs also showed significar

JOURNAL OF THE AMERI
https://doi.org/10.1080/03

Potential De Grown in th

Karli R. Van Sima and Thomas H.

[a]Food Science and Te Gervais, OR, U.S.A.

ABSTRACT

The influence of varieties (Mosaic each of eleven climate, and ma soil characterizat influence on che to differences in

JOURNAL OF THE AMERICAN SOCIETY OF BREWING CHEMISTS
https://doi.org/10.1080/03610470.2021.1977902

Check for updates

Investigating Diastatic Pote

Arnbjørn Stokholm Shellhammer[a]

[a]Deptartment of Food S Agriculture, Gervais, OR,

ABSTRACT

To investigate pote of hops (Mosaic®, fields managed by Willamette Valley. F and eleven fields management data (Coleman Agricultur for soil sampling, a they were at similar an HPLC method. T soil, and weather d fertilization practice hop diastatic pow (*Podosphaera macul* will allow farmers t the effects that bre

JOURNAL OF THE AMERICAN SOCIETY OF BREWING CHEMISTS
https://doi.org/10.1080/03610470.2022.2089010

OPEN ACCESS Check for updates

Exploring the Regional Identity of Cascade and Mosaic® Hops Grown at Different Locations in Oregon and Washington

Michael Féchir[a], Garrett Weaver[b], Curtis Roy[c] and Thomas H. Shellhammer[a]

[a]Oregon State University, Corvallis, OR, 97331, U.S.A.; [b]Coleman Agriculture, Gervais, OR, 97331, U.S.A.; [c]Yakima Chief Hops, Yakima, WA, 98902, U.S.A.

ABSTRACT

The impact of the growing environment on the aroma of agricultural products such as wine, coffee, or tea has been investigated in detail, leading to the concept of regional identity; however, there have been only limited studies examining regional variation in hops. A systematic investigation of Cascade and Mosaic® hops from the 2020 harvest year grown at 39 different locations in Oregon and Washington was performed using chemical/instrumental and human sensory analyses, which revealed significant between-state and within-state differences for both varieties, suggesting substantial regional and subregional identity effects. A subset of 14 hop samples was selected to produce standardized single-hop beers (IPA) in pilot scale. Sensory evaluation of the beers revealed similar regional-dependent results as observed for the hops with slightly stronger fruity, citrus, and tropical notes but weaker herbal, grassy, and woody notes in the beers compared to hops, suggesting that the regional identity effect was observable in beer.

Abbreviations: DAD: diode array detector; GC: gas chromatography; FID: flame ionization detector; HPLC: high performance liquid chromatography

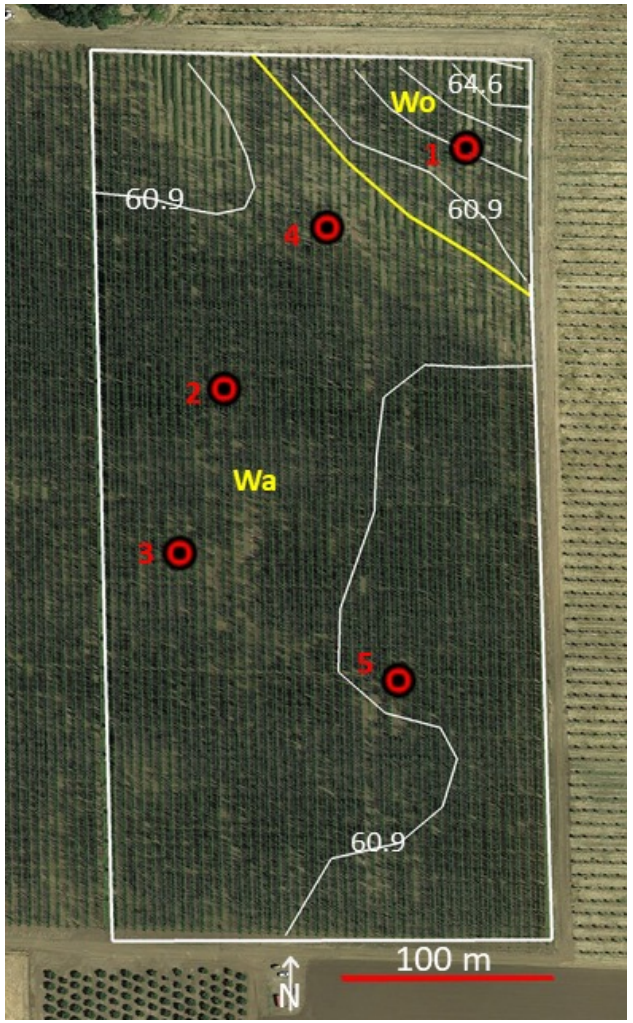
KEYWORDS

Humulus lupulus; Cascade and Mosaic® hops; terroir; regional identity; check-all-that-apply; hop chemistry

General approach for OSU studies

Site Selection

- Work with hop grower and a soil scientist
- Sites chosen to represent different soil types within a field
- GPS markers placed where soil cores were taken
- Hops later harvested from these individual sites



Example of hop field

Red dots represent soil core location

Yellow labels represent soil types; Wa = Wapato and Wo = Woodburn

Field sampling and tagging (late May/early June)

Soil assessment

Soil assessment – Andy Gallagher

- Soil composition – 5 ft soil cores
  - Texture - silt, sand, clay
  - Soil series & parent material
  - Depth to water table
- Subsurface soil chemistry
  - Water holding capacity
  - Cation exchange capacity
  - N, P, K, S, Mg, Ca, Na
  - Micronutrients – Zn, Fe, Cu, B
  - pH

Weather/Climate & Management

Weather and climate data
Collected from **PRISM climate data**

Information collected for each field:

- Growing season minimum and maximum temperatures
- Growing season precipitation
- Growing degree days
- 30-year annual average temperature, average minimum, average maximum
- 30-year annual cumulative precipitation

Management data
Information collected for each field:

- Insecticide applications
- Fungicide applications
- Fertilizer applications (Nitrogen, Phosphorus, Potassium, Sulfur)

Harvest – OR Cascade

Harvest – OR Mosaic (2020 wildfires)

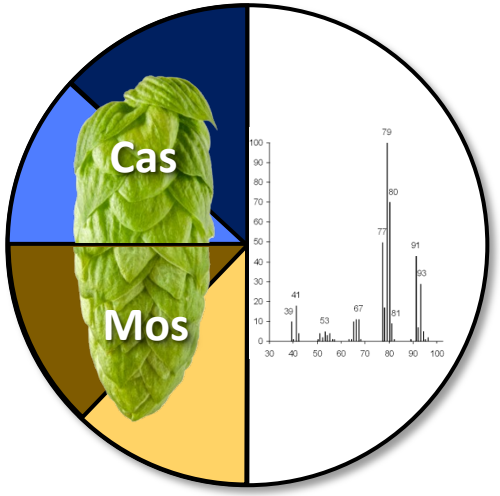
Drying at Coleman Ag Alluvial Farm

Processed using OSU pellet (and hammer) mill

Chemical hop analysis

Hop characterization

- Total α-acids (HPLC)[3]
- Total β-acids (HPLC)[3]
- HSI (UV spectrophotometer)[4]
- Total amount of hop essential oil (steam distillation)[5]



Quantitation of selected hop oil compounds (GC-FID)[6]

- 3-carene
- (E)-β-caryophyllene
- caryophyllene oxide
- p-cymene
- farnesene
- geranial
- geraniol
- geranyl acetate
- geranyl butyrate
- α-humulene
- humulene epoxide I
- humulene epoxide II
- limonene
- linalool
- methyl geranate
- methyl heptanoate
- 3-methylbutanoic acid
- myrcene
- neral
- nerol
- α-pinene
- β-pinene
- terpinen-4-ol
- α-terpineol

Hop aroma evaluation – methods

Sensory panel

- 12 individuals experienced in hop and beer sensory
- Training with food references and reference products

Projective mapping (PM)[7]

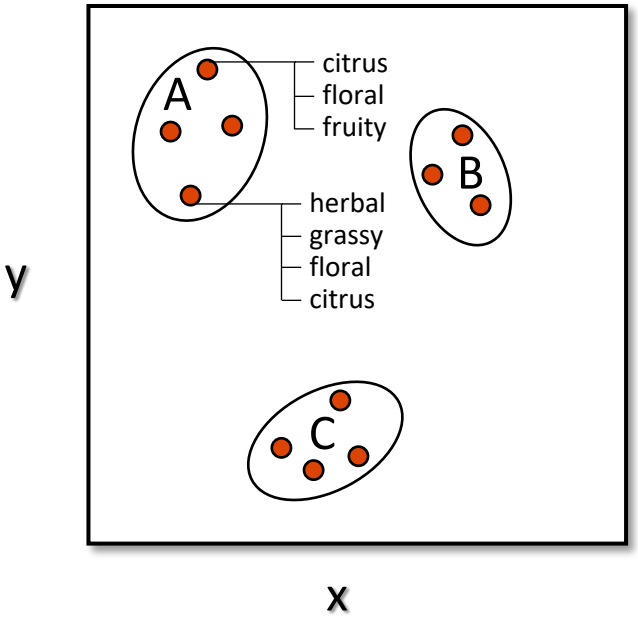
- 22”×22” board to place samples based on overall aroma differences/similarities
- Digitization via Compusense software using chrome books

Check-all-that-apply (CATA)[8]

- Definition of a lexicon of aroma attributes based on ASBC Hop Flavor Map
- Evaluation of frequency for each sample and attribute

Sample preparation

- Ground hop pellets
- 4 g ground material in black plastic cups sealed with lids
- 3 digit random blind codes
- Randomized order of sample presentation for each panelist



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Impact factors on hop quality – variables

hop chemistry (n=29)	hop sensory (n=14)
total hop oil	burnt
hop storage index	citrus
α- and β- acids	DMS
dry matter	floral
24 aroma compounds	fruity
	grassy
	herbal
	melon
	resinous
	sweaty
	sweet aromatic
	tropical
	vegetal
	woody

hop quality (outcomes)

Harvest year 2019

Assessing variation **within fields** and **between fields** in **Willamette Valley**

Field Selection

Simcoe®

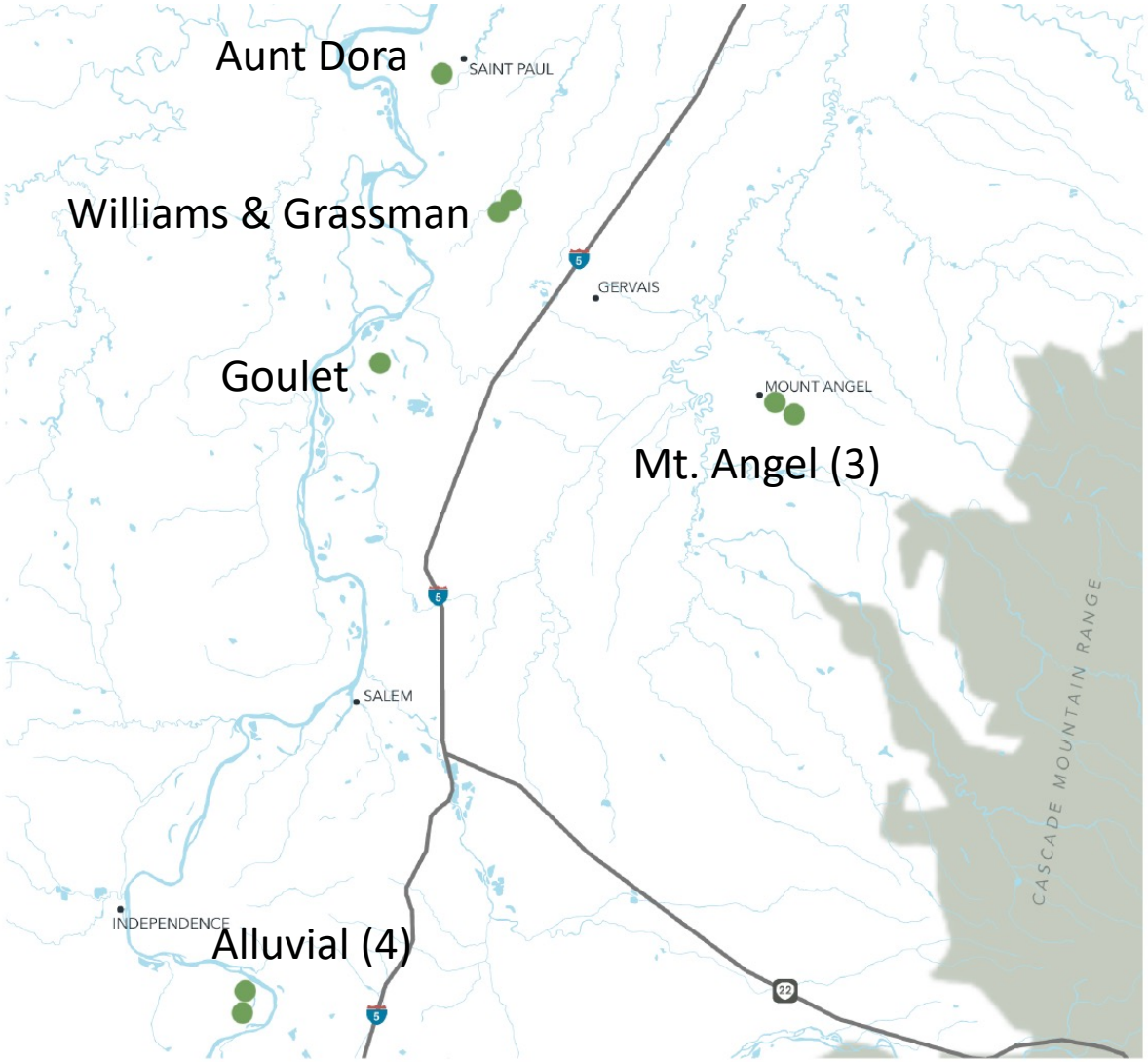
- Mt. Angel 82
- Mt. Angel 83
- Alluvial 23
- Grassman 42
- Aunt Dora 9

Mosaic®

- Mt. Angel 86
- Alluvial 33
- Williams 44

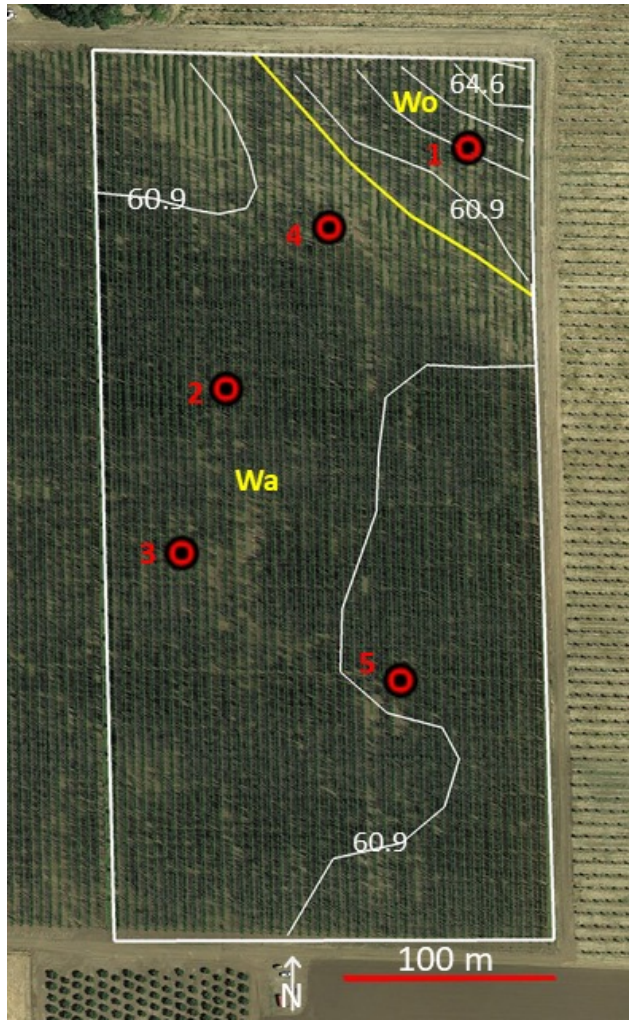
Strata®

- Alluvial 49
- Alluvial 50
- Goulet 73



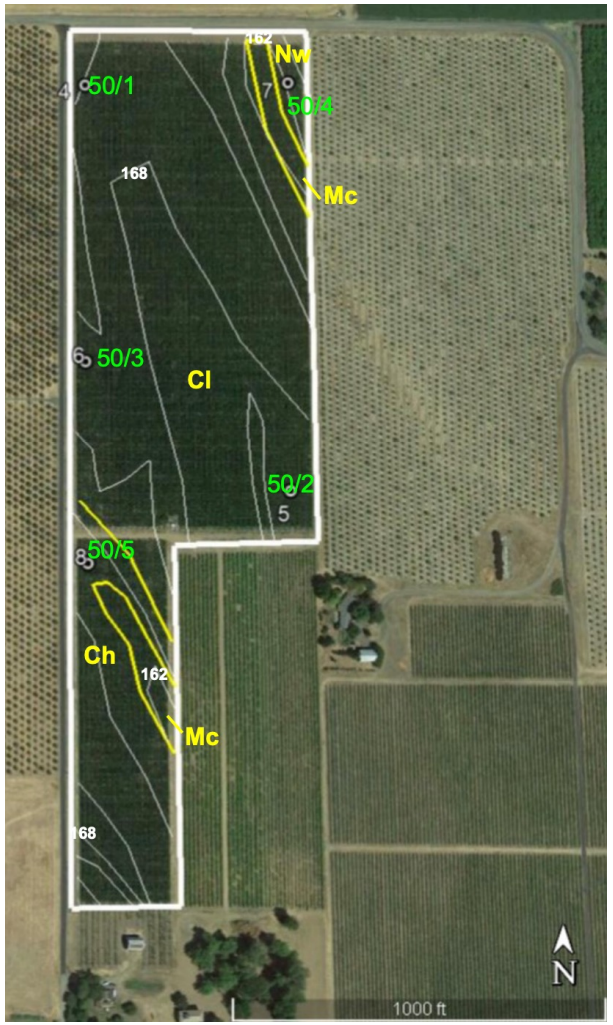
Site Selection

MOS – Field 86, Mount Angel

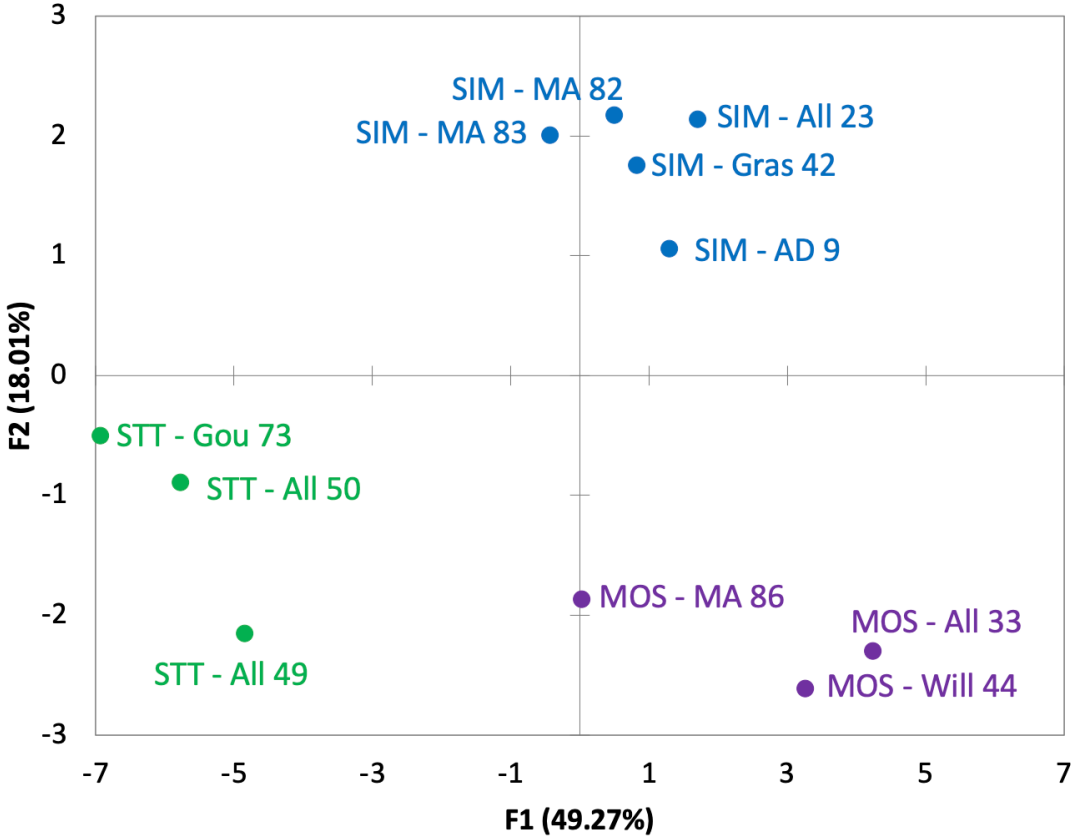


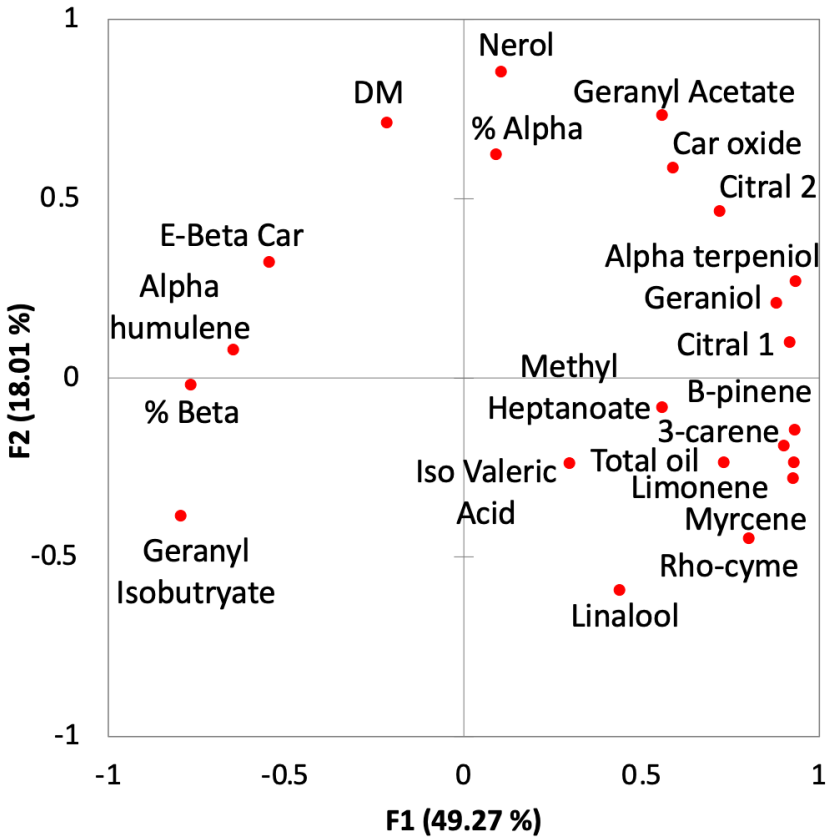
MOS – Field 44, Williams
SIM – Field 42, Grassman

STT – Field 50, Alluvial



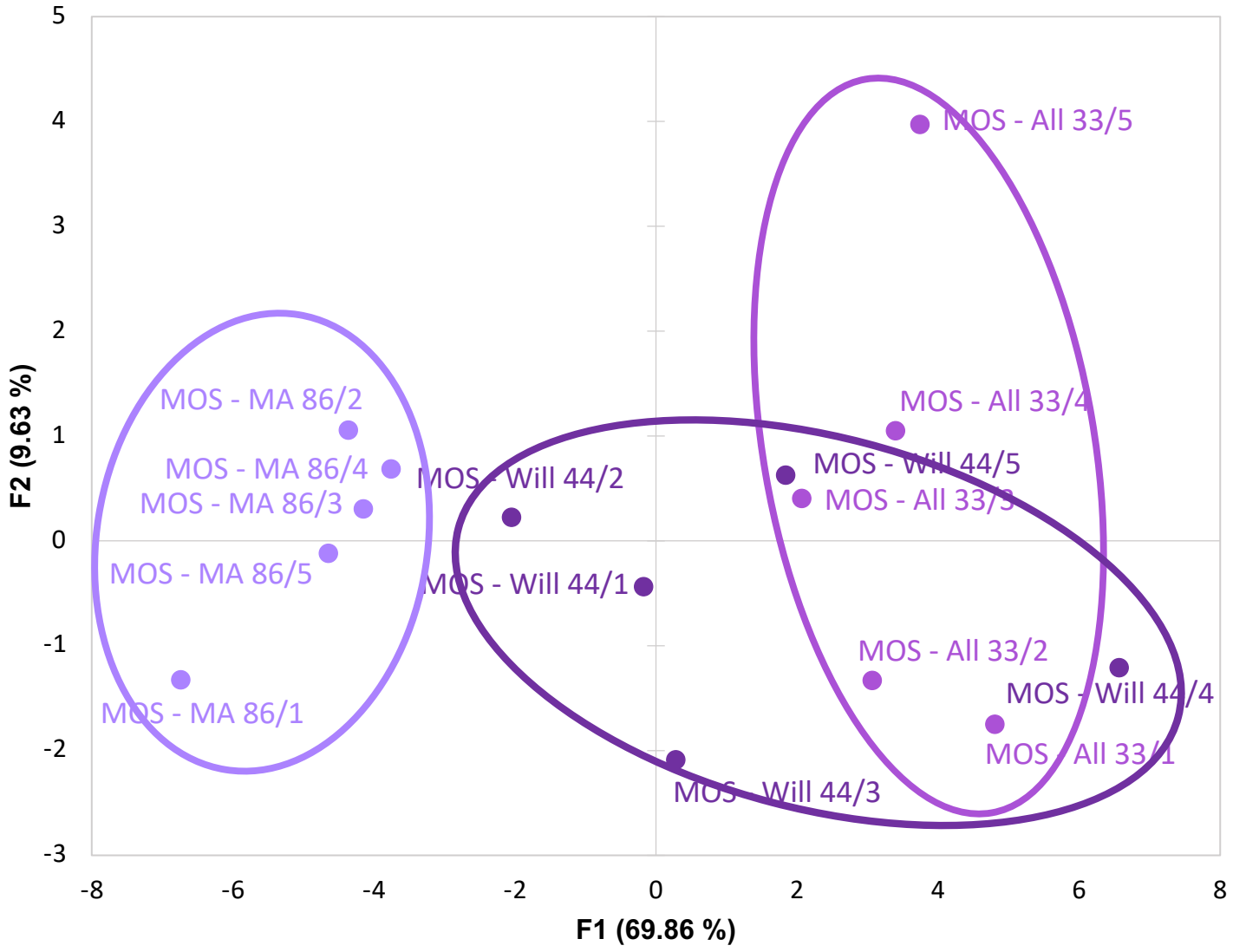
Chemistry Analytes





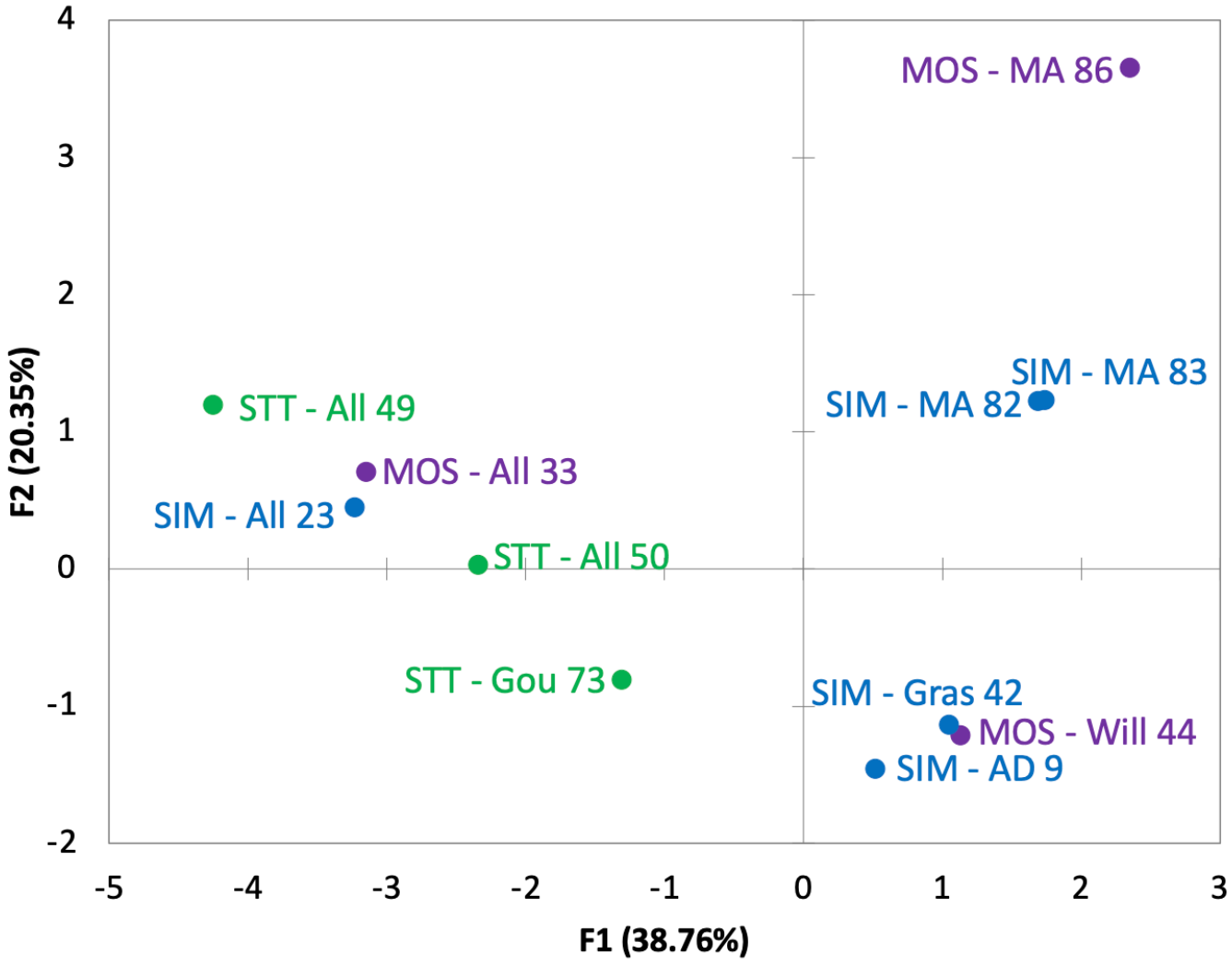
- Principal Component Analysis of chemistry analytes
- Averages of sites within each field

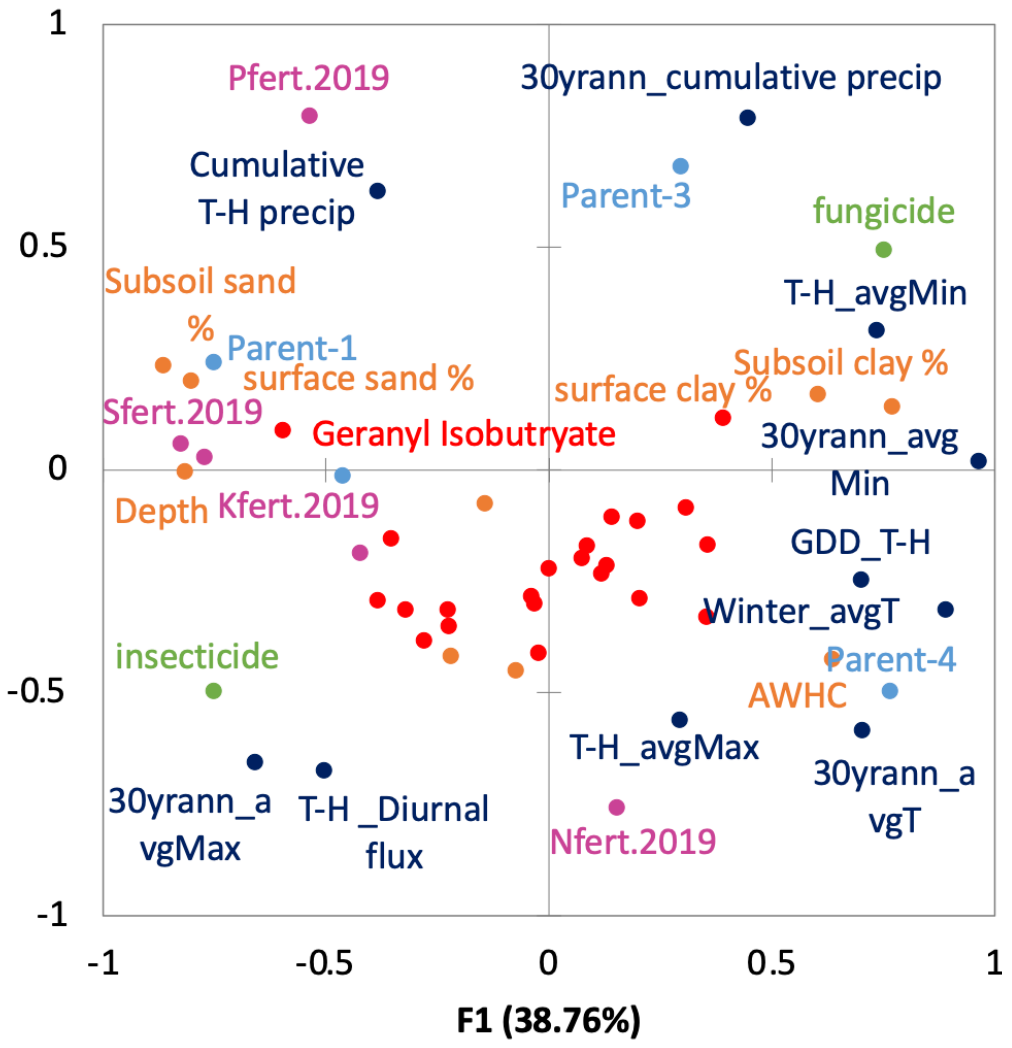
Chemistry Analytes - Mosaic



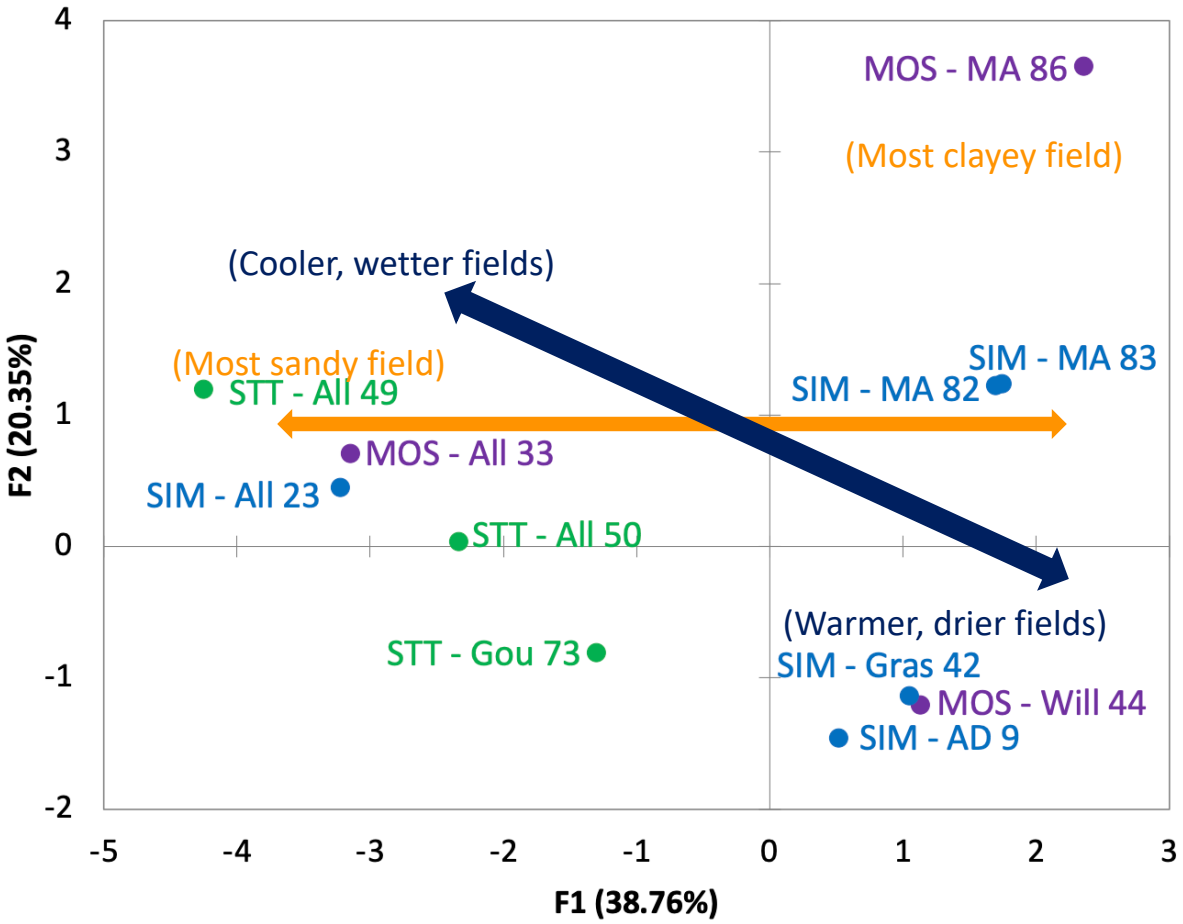
- All Mosaic fields and sites
- Demonstrates variation between fields and within fields
- What is driving this variation in chemistry?

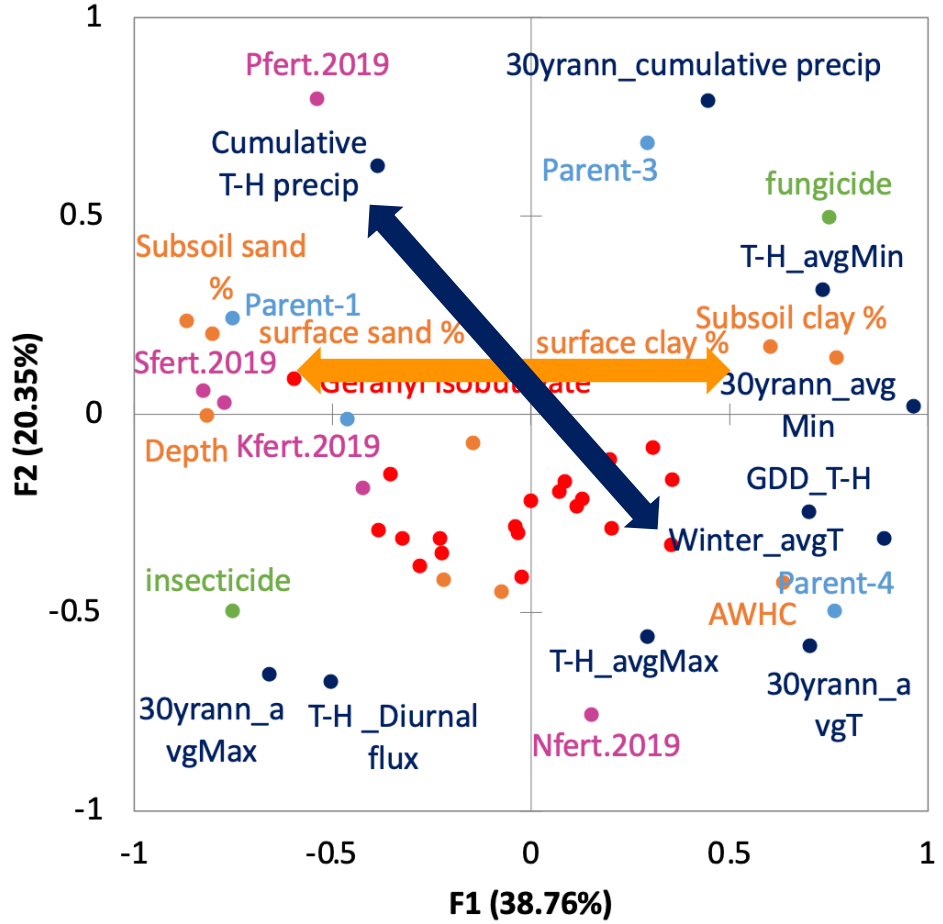
Multiple Factor Analysis – Field Level





Multiple Factor Analysis – F1 vs F2



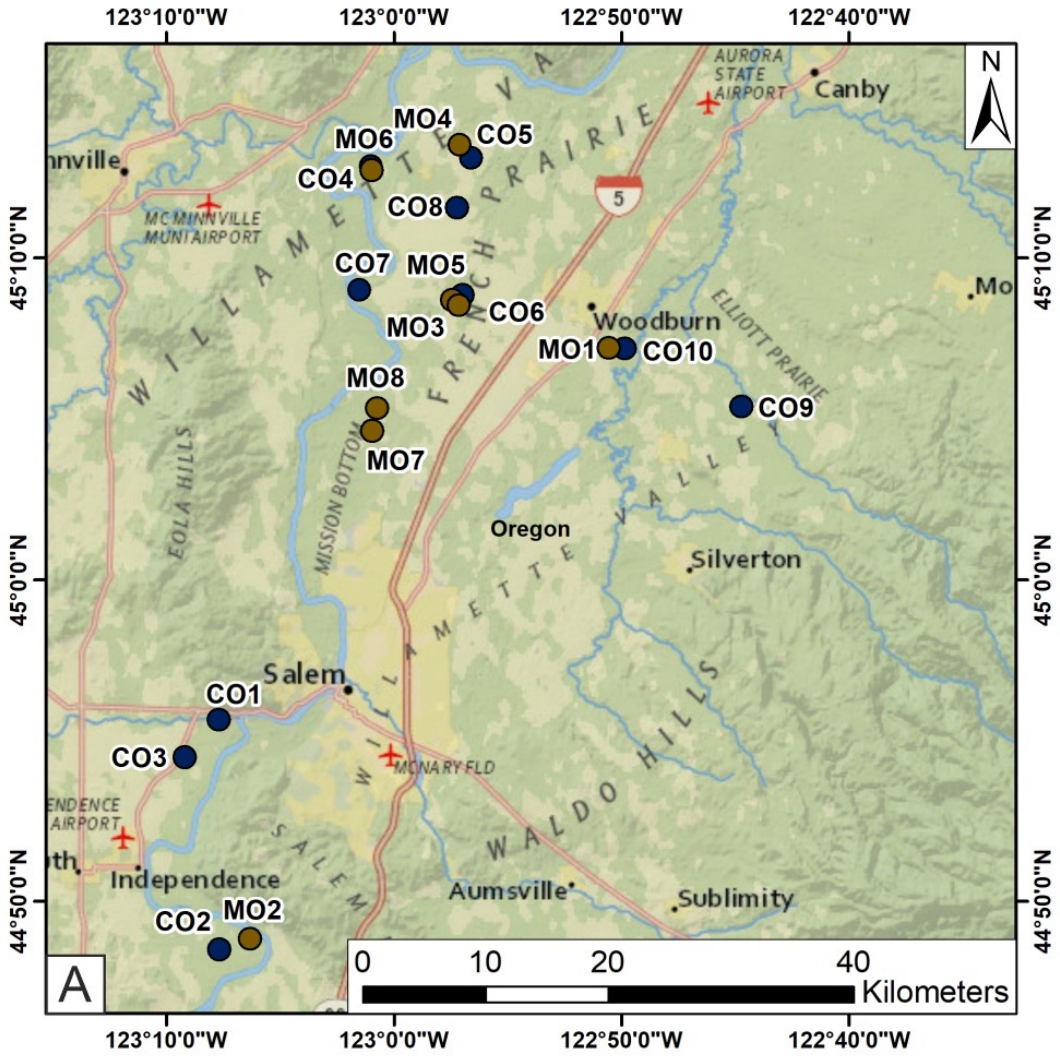


Parent Material 1 - coarse river alluvium (loamy sand and sandy loam)
Parent Material 2 - silty and loamy river alluvium
Parent material 3 - clayey alluvium
Parent Material 4 - Ice-Age Flood silts

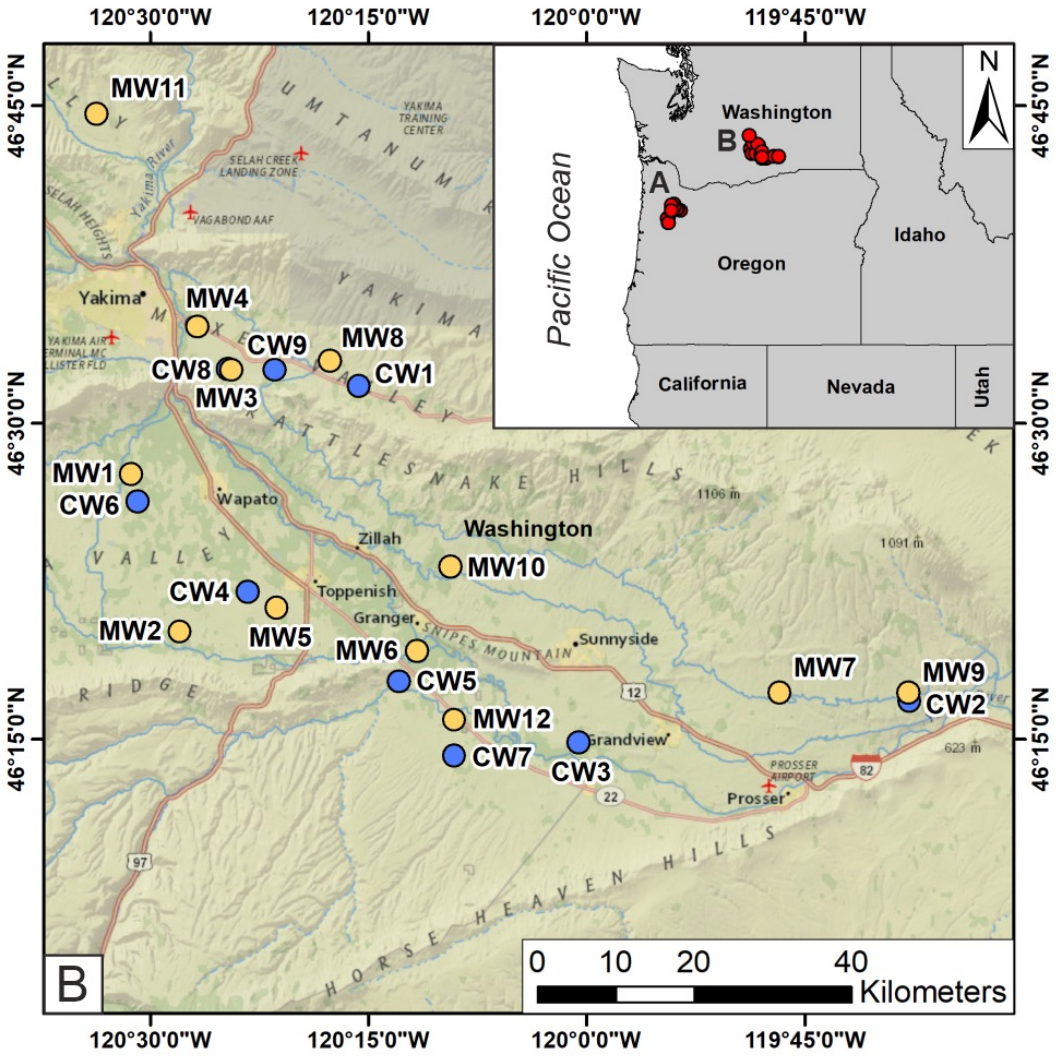
Harvest year 2020

Assessing variation **within** and **between Willamette** and **Yakima Valleys**

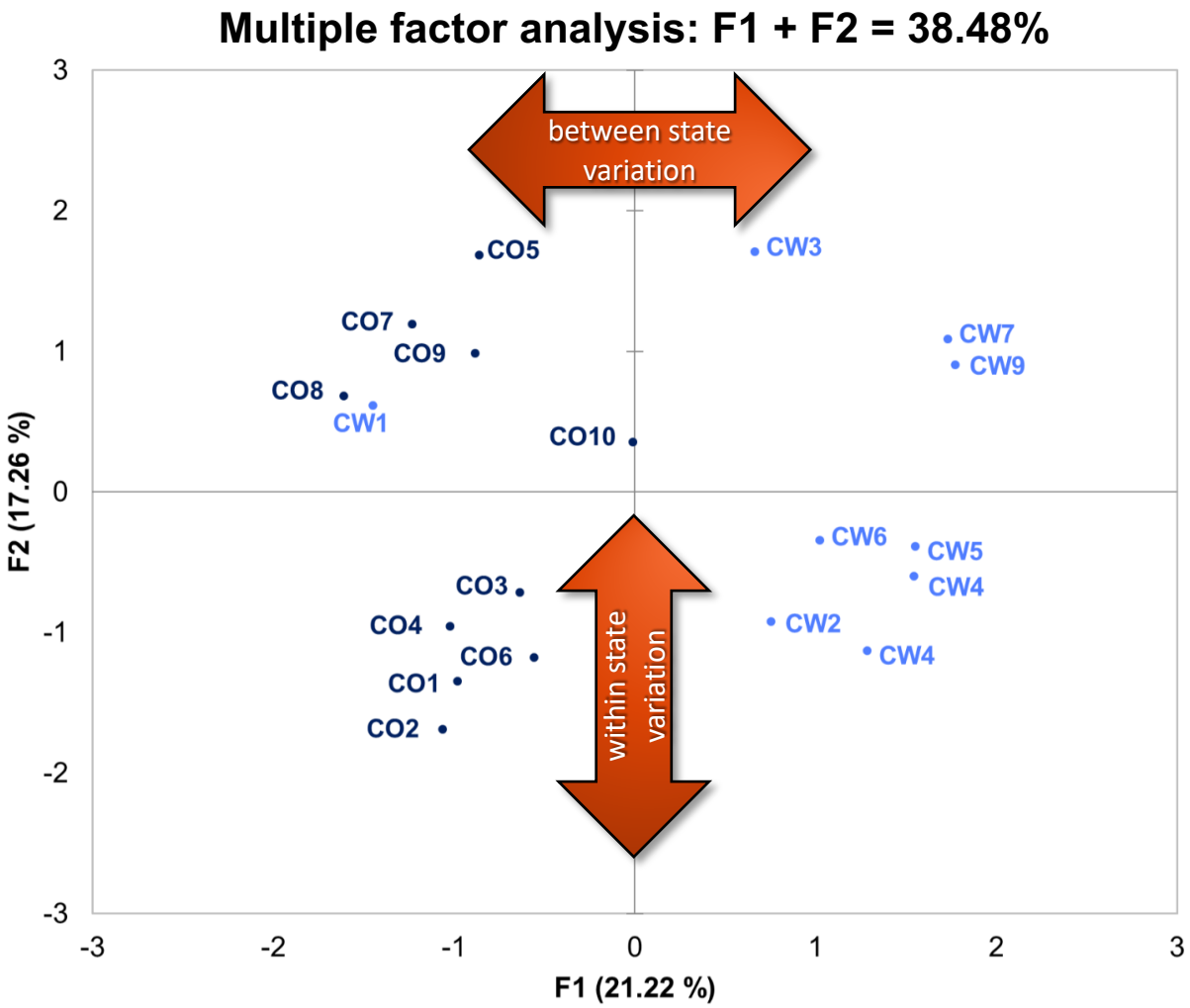
Willamette Valley OR

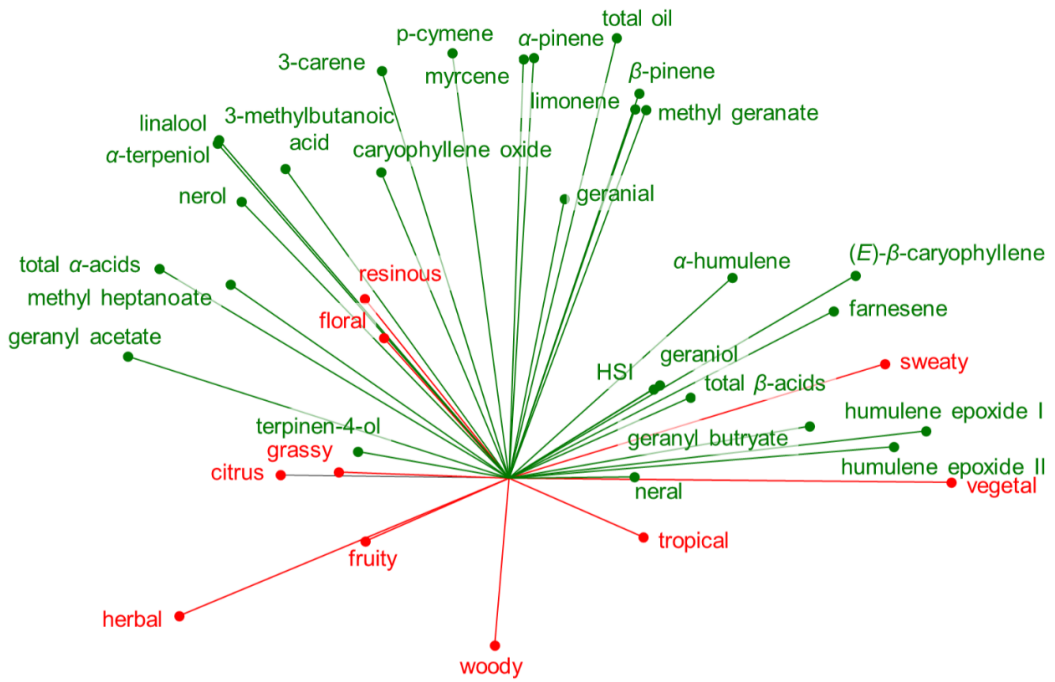


Yakima Valley WA

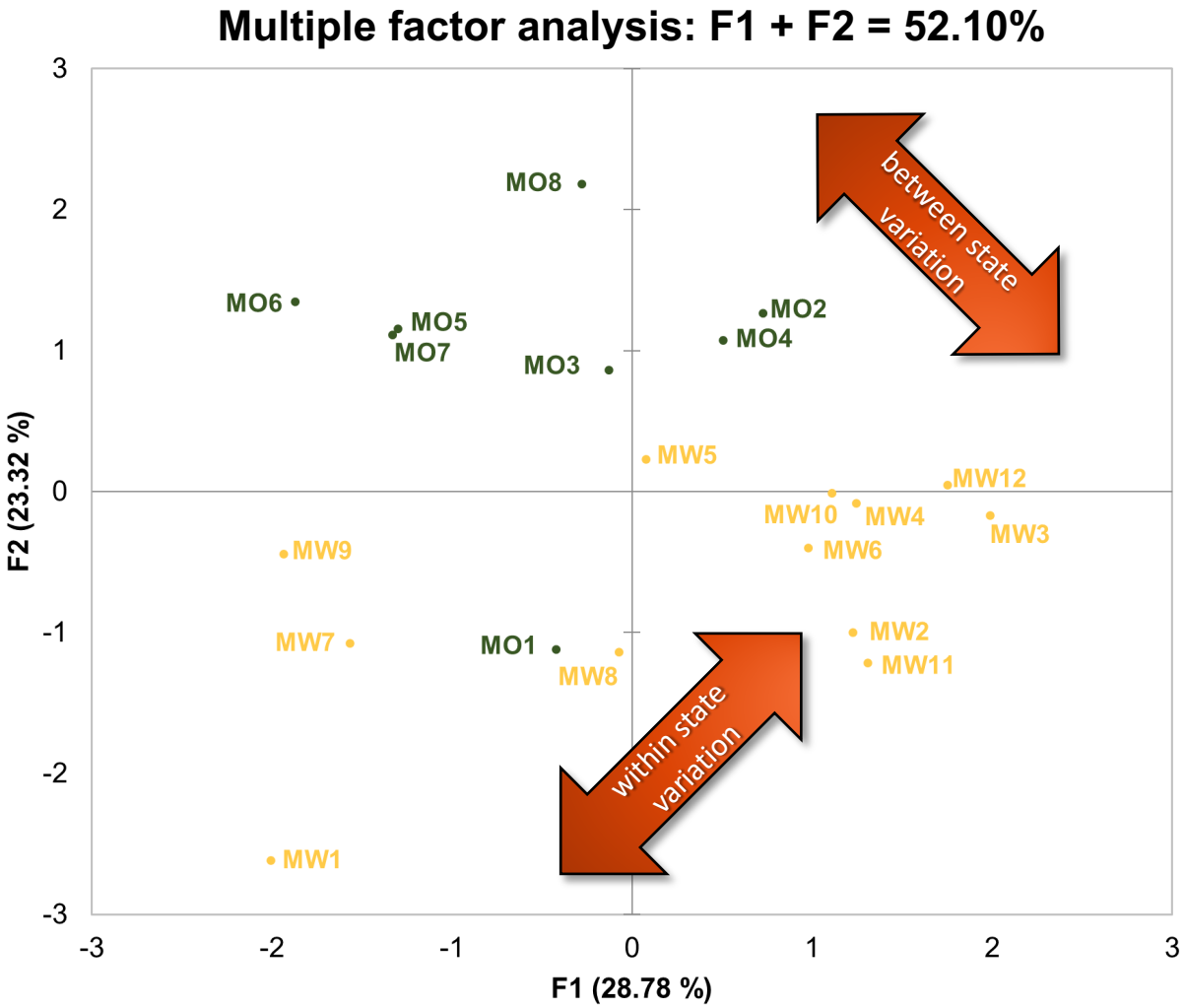


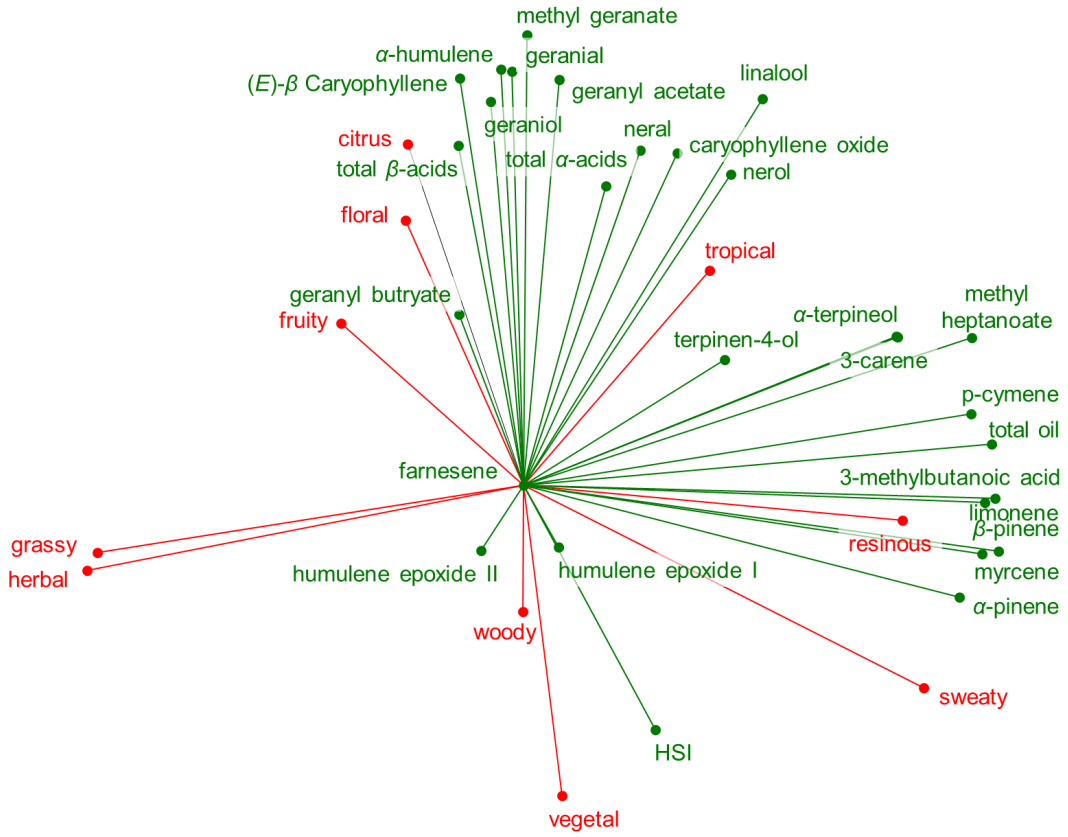
Hop regional identity – Cascade chemistry & sensory



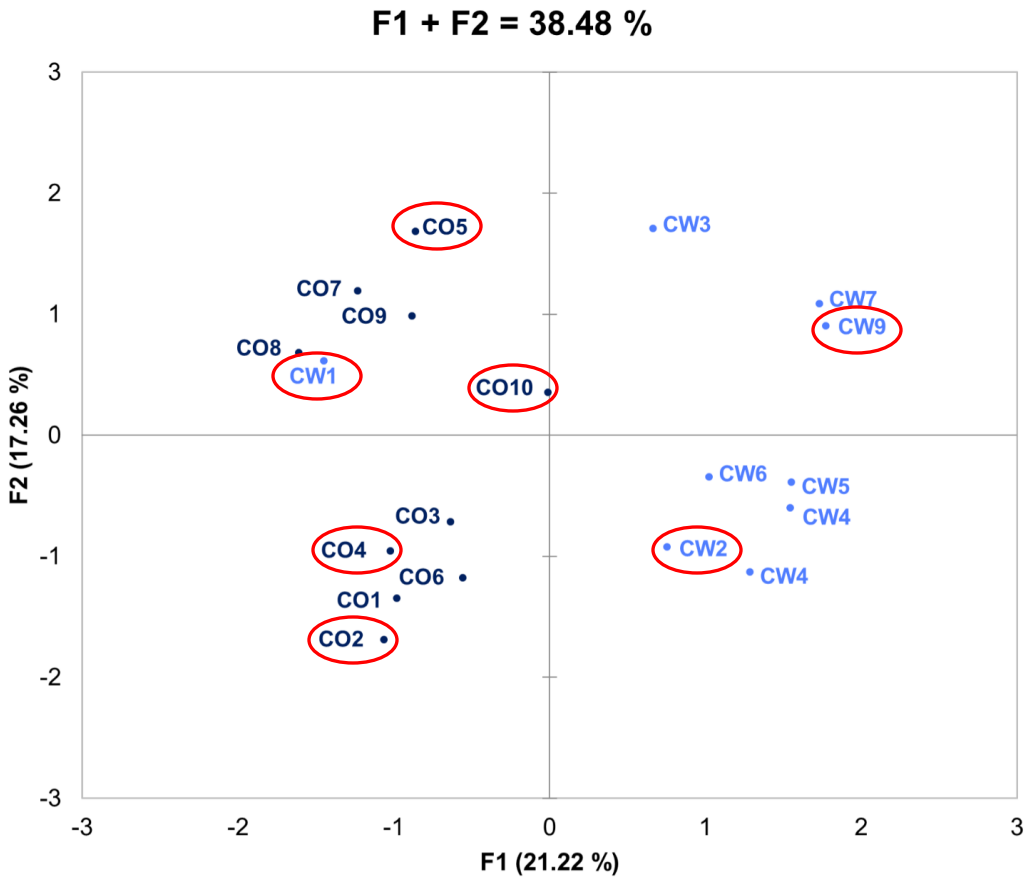


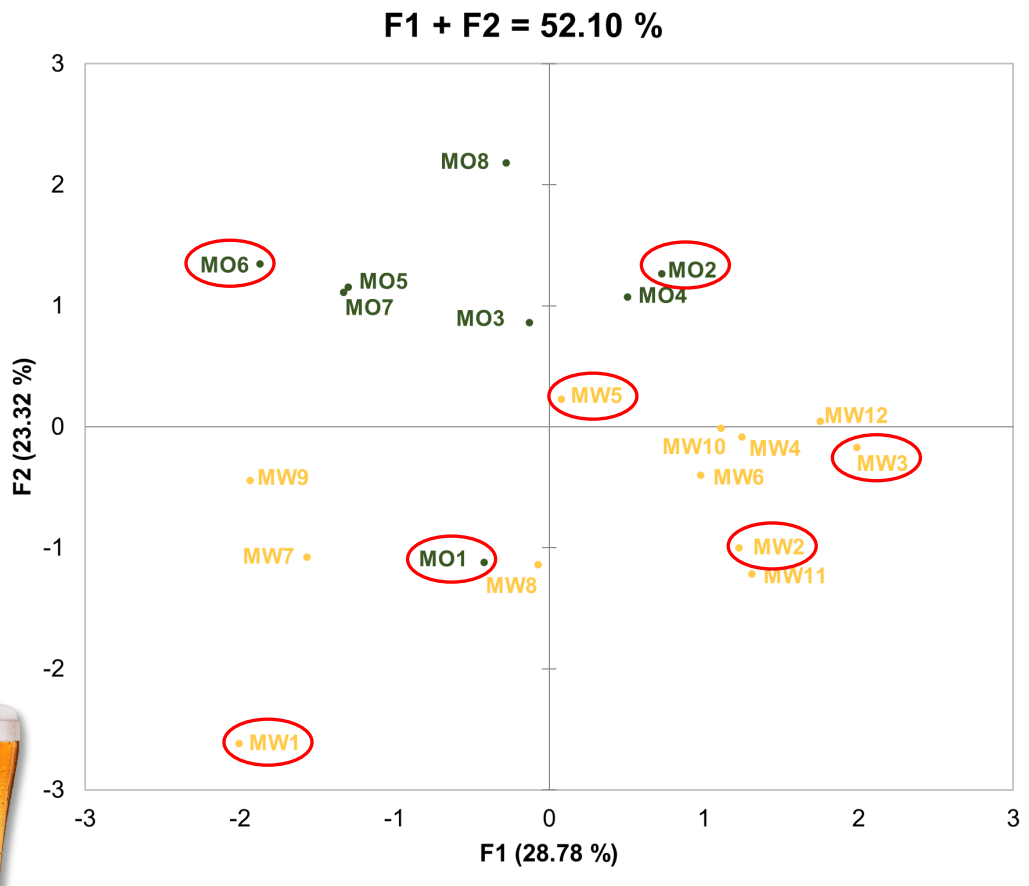
Hop regional identity – Mosaic chemistry & sensory





Brewing Trials – hop selection





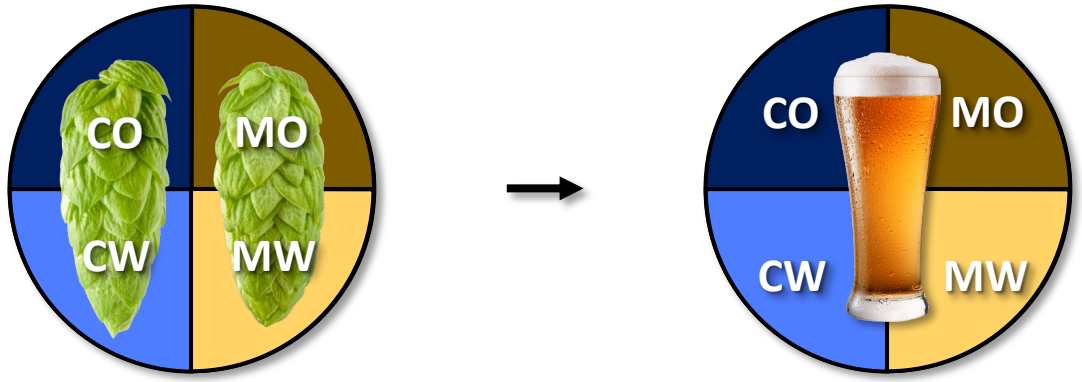
CO × 4 + **CW × 3** **MO × 3** + **MW × 4**

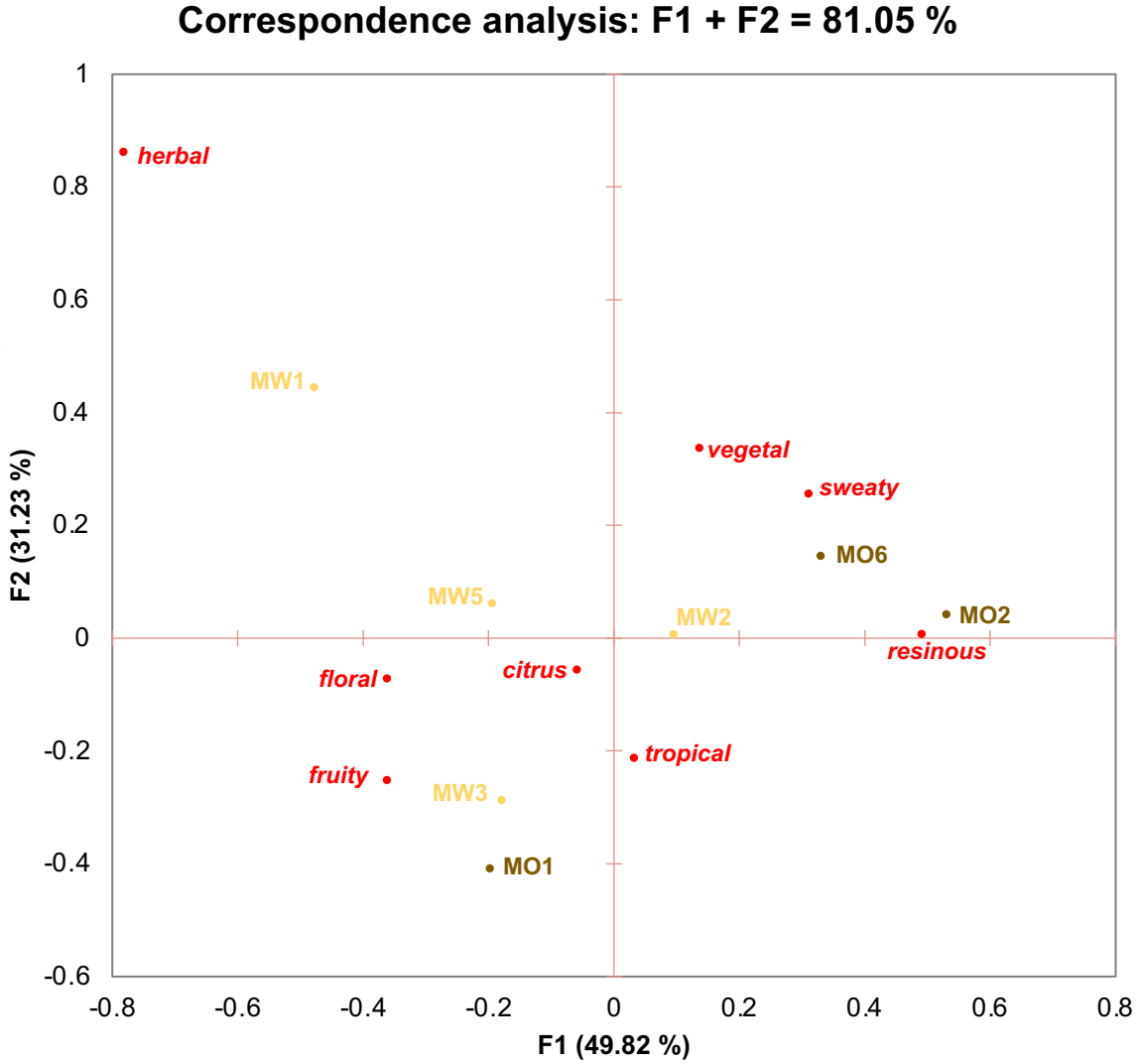
14 beers total

Beer aroma evaluation – CATA results - Mosaic

beer sample	frequency of aroma attributes selected by the panelists (N=12) during sensory evaluation by CATA													
	citrus	tropical	* fruity	* resinous	sweaty	floral	vegetal	* herbal	melon	grassy	sweet aromatic	woody	DMS	burnt
CO2	7	8	7	3	2	2	1	1	3	1	3	0	3	0
CO4	6	4	6	3	2	4	1	2	4	1	2	1	1	0
CO5	6	3	7	7	2	2	1	4	1	2	1	1	0	0
CO10	8	4	3	5	3	3	4	2	2	2	2	0	2	0
CW1	4	3	3	3	4	2	1	4	2	3	5	3	1	3
CW2	4	6	8	3	2	5	2	3	2	2	1	1	3	0
CW9	7	3	3	5	4	2	2	4	1	2	1	1	1	1
MO1	6	9	9	3	3	4	1	0	1	1	1	1	0	0
MO2	9	7	1	9	6	0	3	0	0	2	0	1	0	0
MO6	3	7	4	9	8	3	4	1	0	0	2	0	1	0
MW1	7	4	5	1	4	3	3	5	3	4	1	1	0	0
MW2	7	6	4	6	4	3	3	1	1	1	0	3	0	0
MW3	9	8	6	4	1	3	1	1	1	1	0	2	0	0
MW5	6	5	5	4	3	5	3	2	3	0	1	1	0	0
sum	89	77	71	65	48	41	30	30	24	22	20	16	12	4
% of max	100	87	80	73	54	46	34	34	27	25	22	18	13	4

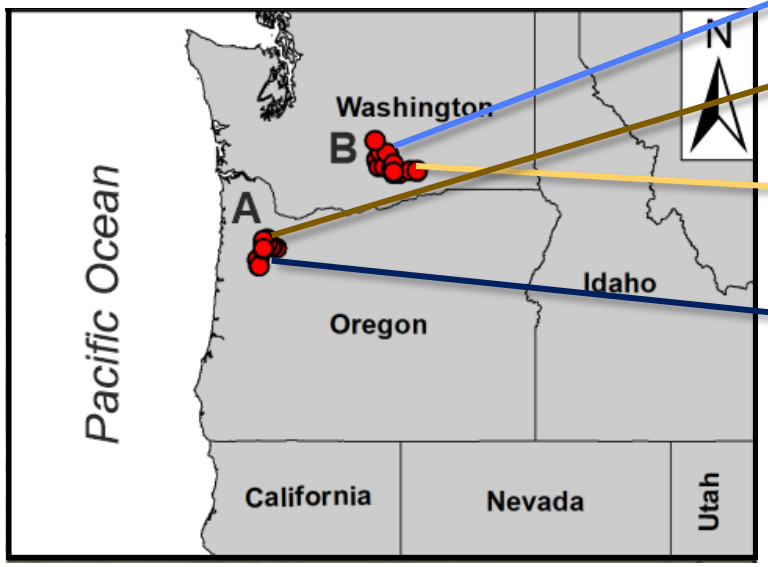
*Significant differences acc. to Cochran-Q-Test (CI 95 %)

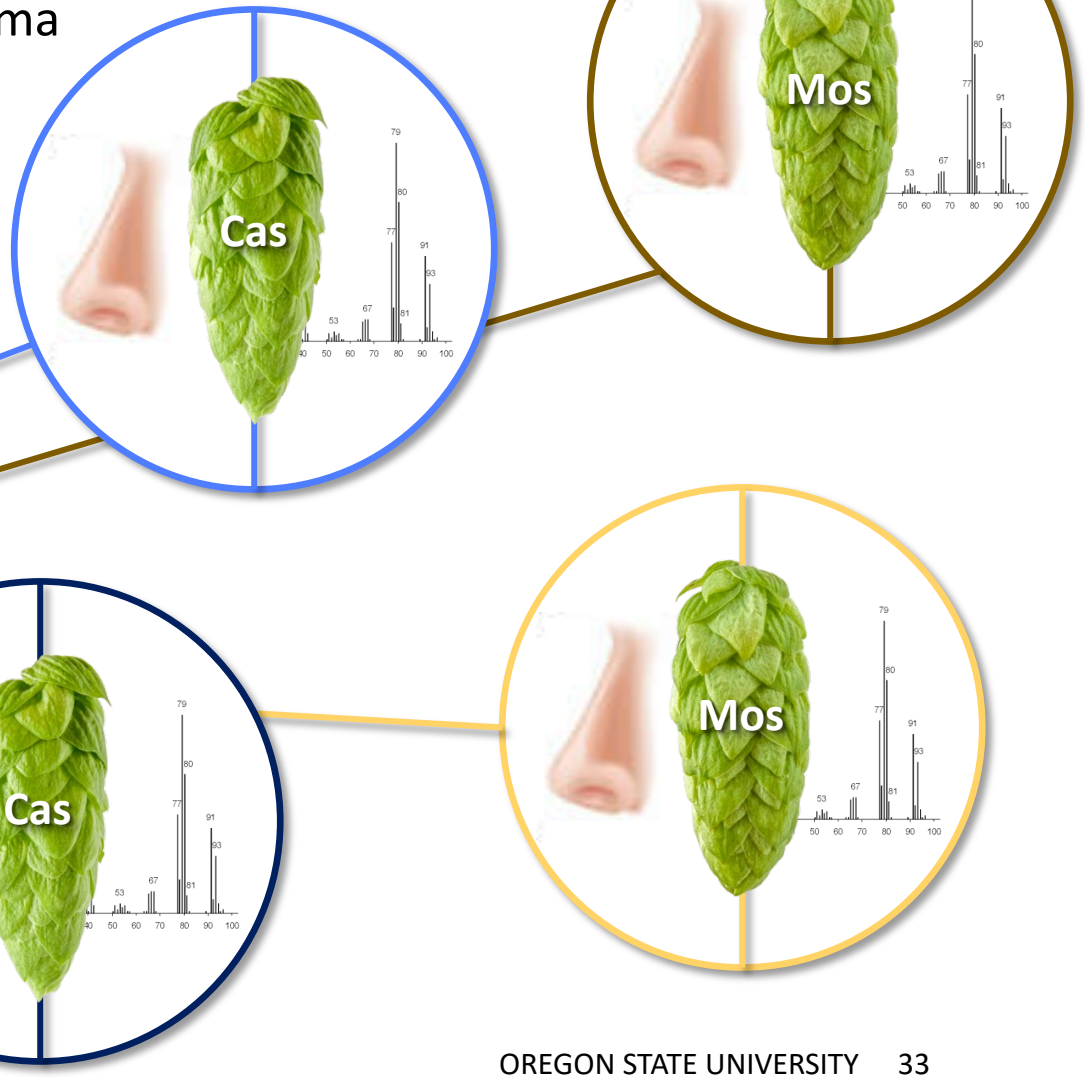




Regional identity and hop quality

- Terroir effect leads to distinct differences in hop aroma and hop chemistry for Cascade, Simcoe, and Mosaic
- At a state level as well as a local level
- Differences between regions comparable in scale to differences between varieties
- Differences between hops are also significant in the respective beers (IPA)





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OREGON HOP GROWERS ASSOCIATION

USA HOPS
HOP GROWERS OF AMERICA

WASHINGTON HOP COMMISSION

OREGON HOPS

Thank you for your attention!

Oregon State University

The impact of regionality on malt flavor and quality

How does the interaction between barley variety and growing environment - via malt - influence beer flavor?

=

?

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Outline

1. What do we already know about barley variety and beer flavor?
2. What is the impact of terroir (GxE) on malt quality?
3. What is the impact of terroir (GxE) on beer flavor?
4. Conclusions and opportunities for future work.

This work has been adapted from two manuscripts currently in press:

- ***Barley grain protein is influenced by genotype, environment, and N management and is a major driver of malting quality***. *Halstead, M et al.* Crop Science
  - **5 genotypes** (Thunder, Lightning, DH140963, DH142010, DH141132) x

    3 locations (Corvallis, OR; Pendleton, OR; Tulelake, CA)
  - Micro-malts (0.5kg) – research protocol, same for all entries
- ***Barley Variety and Growing Location Provide Nuanced Contributions to Beer Flavor Using Elite Germplasm in Commercial-type Malts and Beers.*** *Morrissy, C et al.* JASBC
  - **3 genotypes** (Thunder, Lightning, DH140963) x **3 locations** (same)
  - Mini-malts (100kg) – bespoke malting protocols per entry, pilsner-style malt, commercial-like golden ale

Does barley variety impact beer flavor?

Journal of the American Society of Brewing Chemists
The Science of Beer

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Effects of Barley (*Hordeum Vulgare* L.) Variety and Growing Environment on Beer Flavor

Dustin Herb, Tanya Filichkin, Scott Fisk, Laura Helgerson, Patrick Hayes

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Comprehensive Analysis of Different Contemporary Barley Genotypes Enhances and Expands the Scope of Barley Contributions to Beer Flavor

S. Windes [a], H. M. Bettenhausen [b], K. R. Van Simaeys[c], J. Clawson[c], S. Fisk [a], A. L. Heuberger [b], J. Lim [c], S. H. Queisser [c], T. H. Shellhammer [c], and P. M. Hayes[a]

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*e-Xtra**

Malt Modification and Its Effects on the Contributions of Barley Genotype to Beer Flavor

Dustin Herb,[1] Tanya Filichkin, Scott Fisk, Laura Helgerson, and Patrick Hayes, *Crop & Soil Science Dept., Oregon State University, Corvallis, OR U.S.A.*; Amanda Benson and Veronica Vega, *Deschutes Brewery, Bend, OR U.S.A.*; Daniel Care... *Aula Dei, CS... Malting Co., Technical Ce... Mt. Vernon,... Ignacio Ron... Dundee DD...*

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Continued Exploration of Barley Genotype Contribution to Base Malt and Beer Flavor Through the Evaluation of Lines Sharing Maris Otter® Parentage

Campbell P. Morrissy [a], Michael Féchir[b], Harmonie M. Bettenhausen [c], Karli R. Van Sim... Tho...

Contents lists available at ScienceDirect
Journal of Cereal Science
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Variation in Sensory Attributes and Volatile Compounds in Beers Brewed from Genetically Distinct Malts: An Integrated Sensory and Non-Targeted Metabolomics Approach

Harmonie M. Bettenhausen [a], Amanda Benson [b], Scott Fisk [c], Dustin Herb[c], Javier Hernandez [c], Juyun Lim [d], Sue H. Queisser [d], Thomas H. Shellhammer [d], Veronica Vega [b], Linxing Yao [e], Adam L. Heuberger [a], and Patrick M. Hayes[c]

[a] Department of Horticulture and Landscape Architecture, Colorado State University, CO, U.S.A.; [b] Deschutes Brewery, Bend, OR, U.S.A.; [c] Department of Crop and Soil Science, Oregon State University, Corvallis, OR, U.S.A.; [d] Department of Food Science and Technology, Oregon State University, Corvallis, OR, U.S.A.; [e] Proteomics and Metabolomics Facility, Colorado State University, Fort Collins, CO, U.S.A.

Genetic basis of barley contributions to beer flavor☆

Brooke Sayre-Chavez [a], Harmonie Bettenhausen [b,c], Sarah Windes [d], Patricia Aron [e], Luis Cistué [f], Scott Fisk [d], Laura Helgerson [d], Adam L. Heuberger [a,b], Sean Tynan [e], Patrick Hayes [d,*], María Muñoz-Amatriaín [a,g,**]

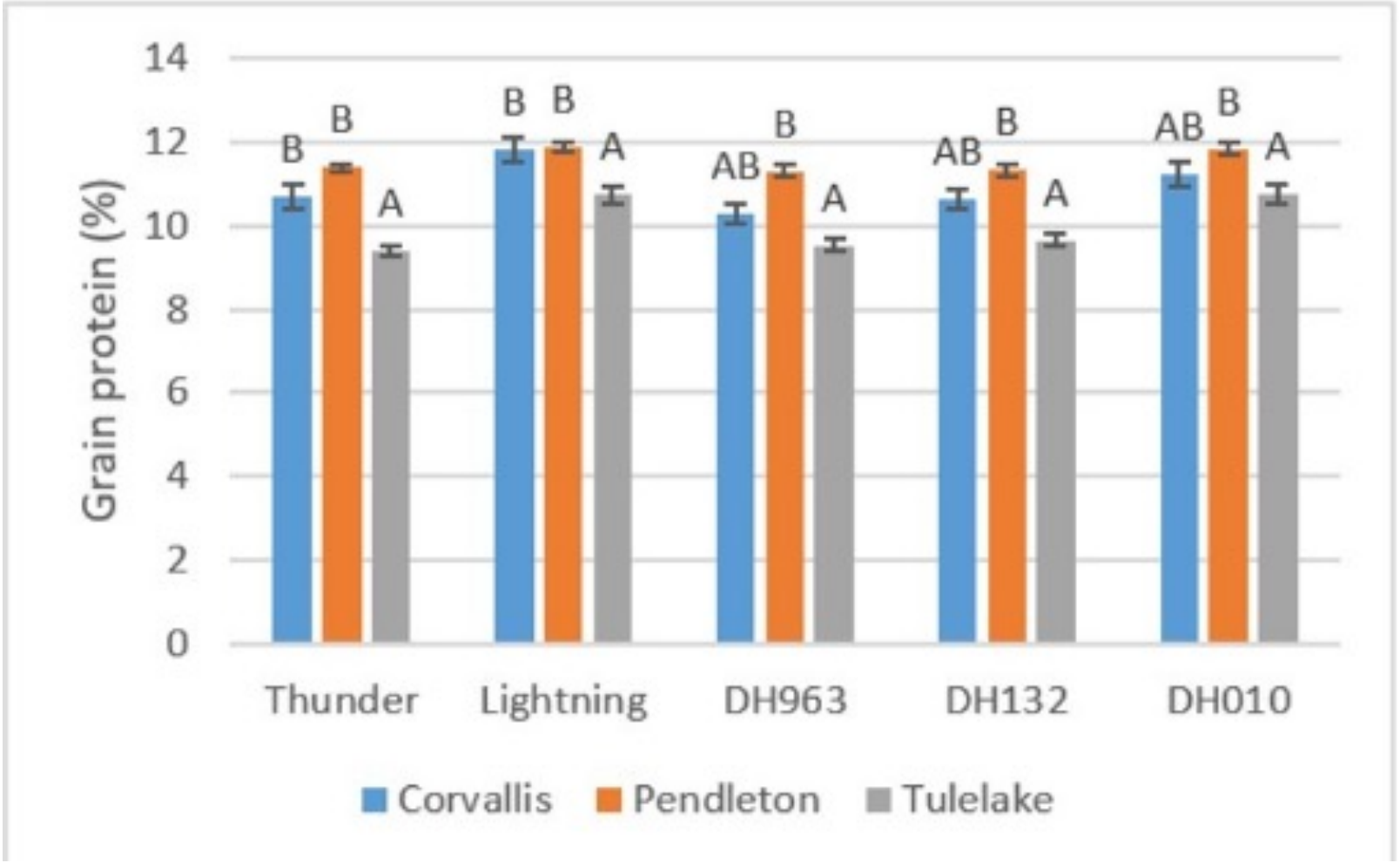
Variety → flavor?

- *Few malts are purchased based on barley variety and the respective contributions to beer flavor (exceptions... ex. Maris Otter®).*
- *Barley variety (via malt) contributes to malt and beer flavor and affects the metabolomic profile of beer, but the overall flavor outcomes are nuanced.*
- *The differences diminish as the malting and brewing process becomes more complex.*
  - *Beer = base malt + specialty malt + hops + yeast + …*
- *Genetic basis of varietal impact on beer flavor only beginning to be unwrapped.*
  - *QTLs for flavor associated with dormancy and dwarfing genes.*

So where does terroir come into play?

Terroir (GxE) effect on Malt Quality

- Yield and malt quality are the drivers for variety release.
- Maltsters contract grain to meet specific protein specifications.
- Significant Line x Location effect on grain protein ($p<0.001$).
- Ex. Thunder-Tulelake: 9.4% protein in a line that is primarily grown for adjunct brewing.
  (COR – 10.7%; PEN– 11.4%)

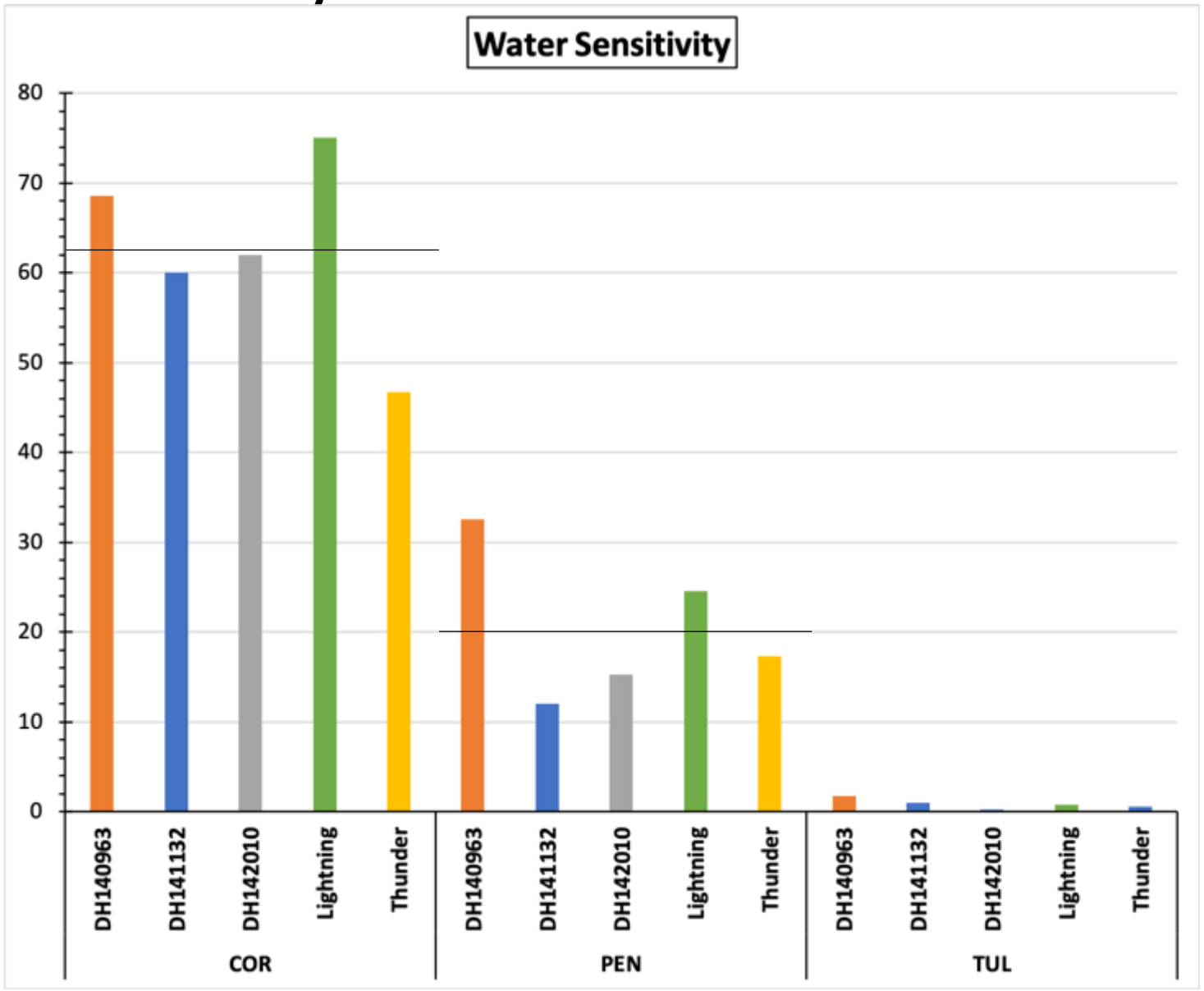


Dormancy & Water Sensitivity

Dormancy: No issues with any line or location. All entries >97% (4mL).

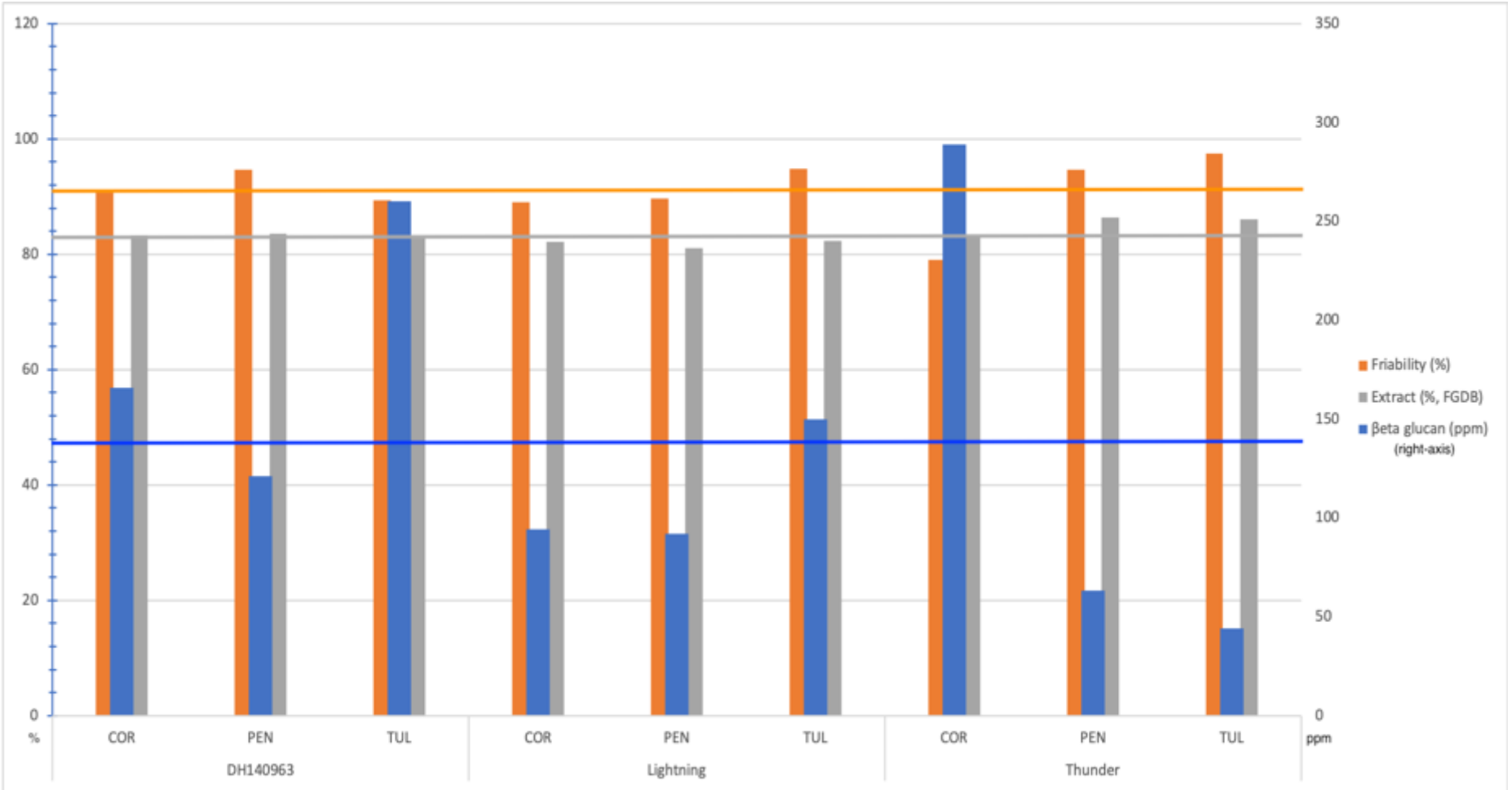
Water Sensitivity: Significant differences across lines and locations.

- Significant Line x Location effect: **p < 0.001.**
- Overall most problematic at Corvallis and least at Tulelake.
- WS impacts hydration rate during steeping → modification → flavor?



Water sensitivity by line at each location.
Location mean is shown by horizontal line.
*Tulelake mean (0.85%) is not shown

Cytolytic Modification



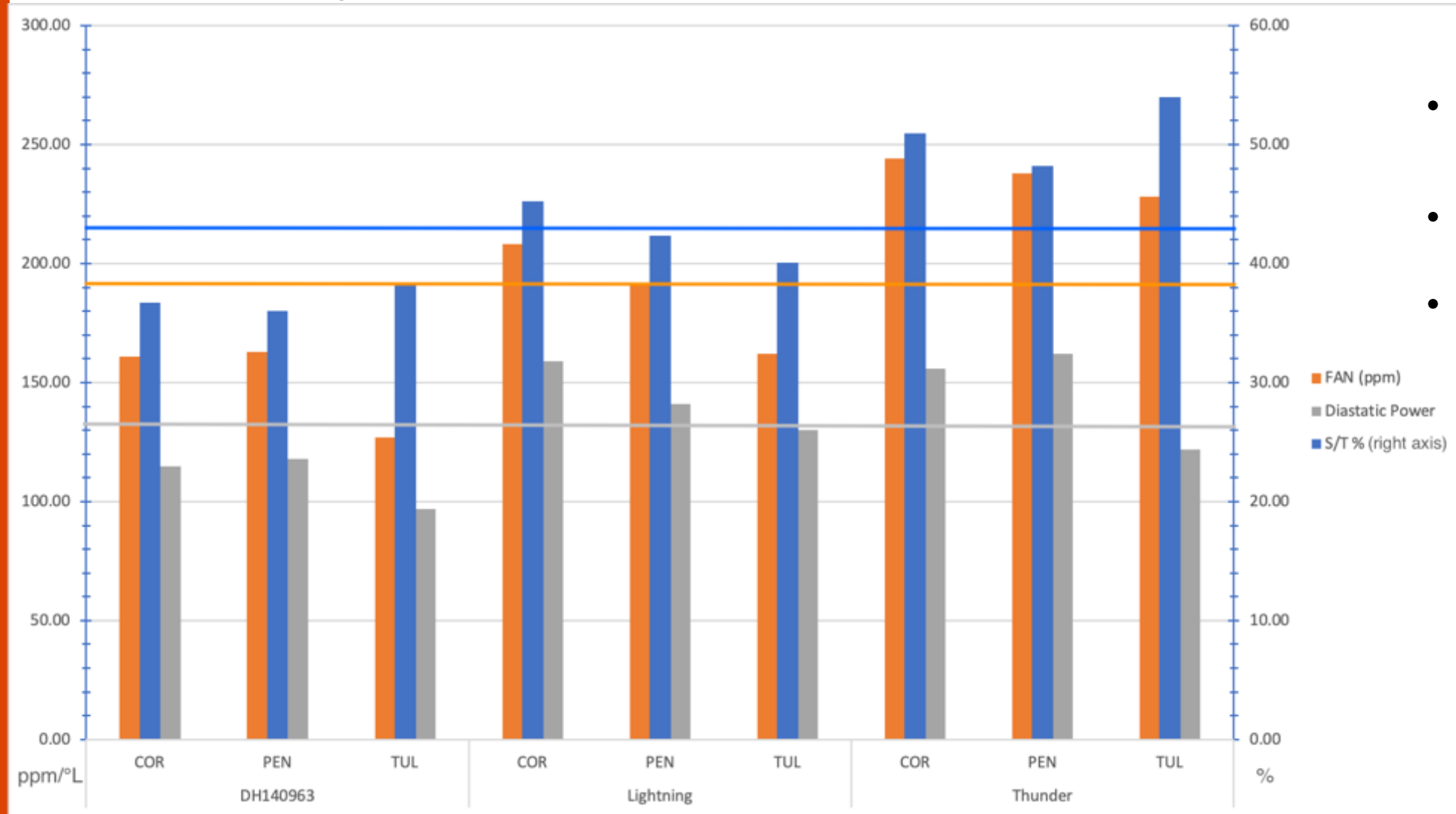
Experimental mean for each parameter shown as horizontal lines.

BG a bit all over the place – Lightning was most even across locations. Perhaps explains solid performance in brewhouse.

All lines met AMBA extract spec. (>81.0%).

Water sensitivity is potential driver of spread of modification.

Proteolytic Modification



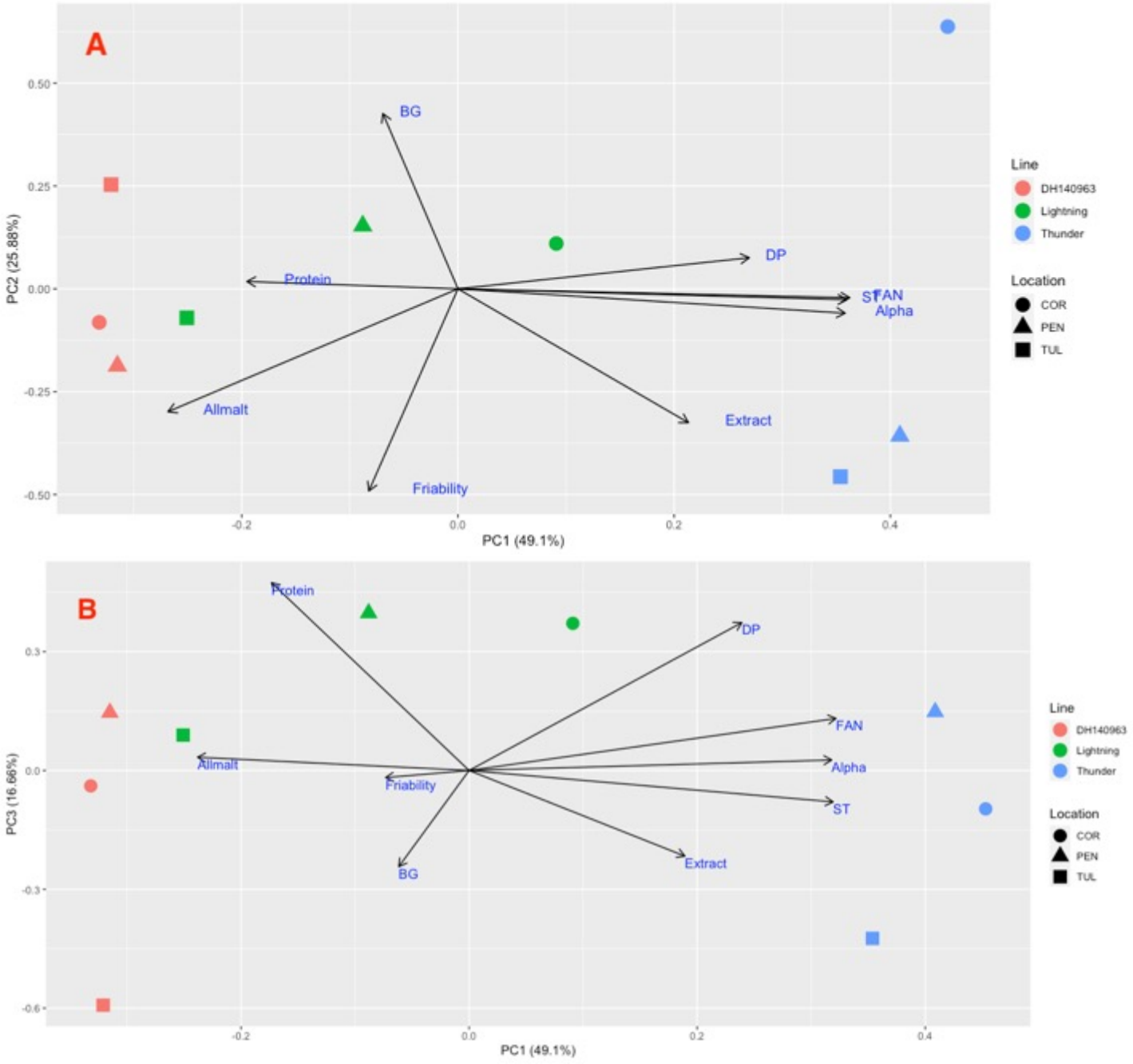
- Under – DH140963
  - All <40% S/T
- Even – Lightning
- Over – Thunder
  - All >200 FAN
  - 2/3 >50% S/T

Experimental mean for each parameter shown as horizontal lines.

Mini Malting

DH140963 least susceptible to location effect.
Lightning most susceptible to location.

Thunder may also be highly susceptible to modifications issues driven by water sensitivity and water uptake. Unsure if Thunder-COR is outlier or possible trend.

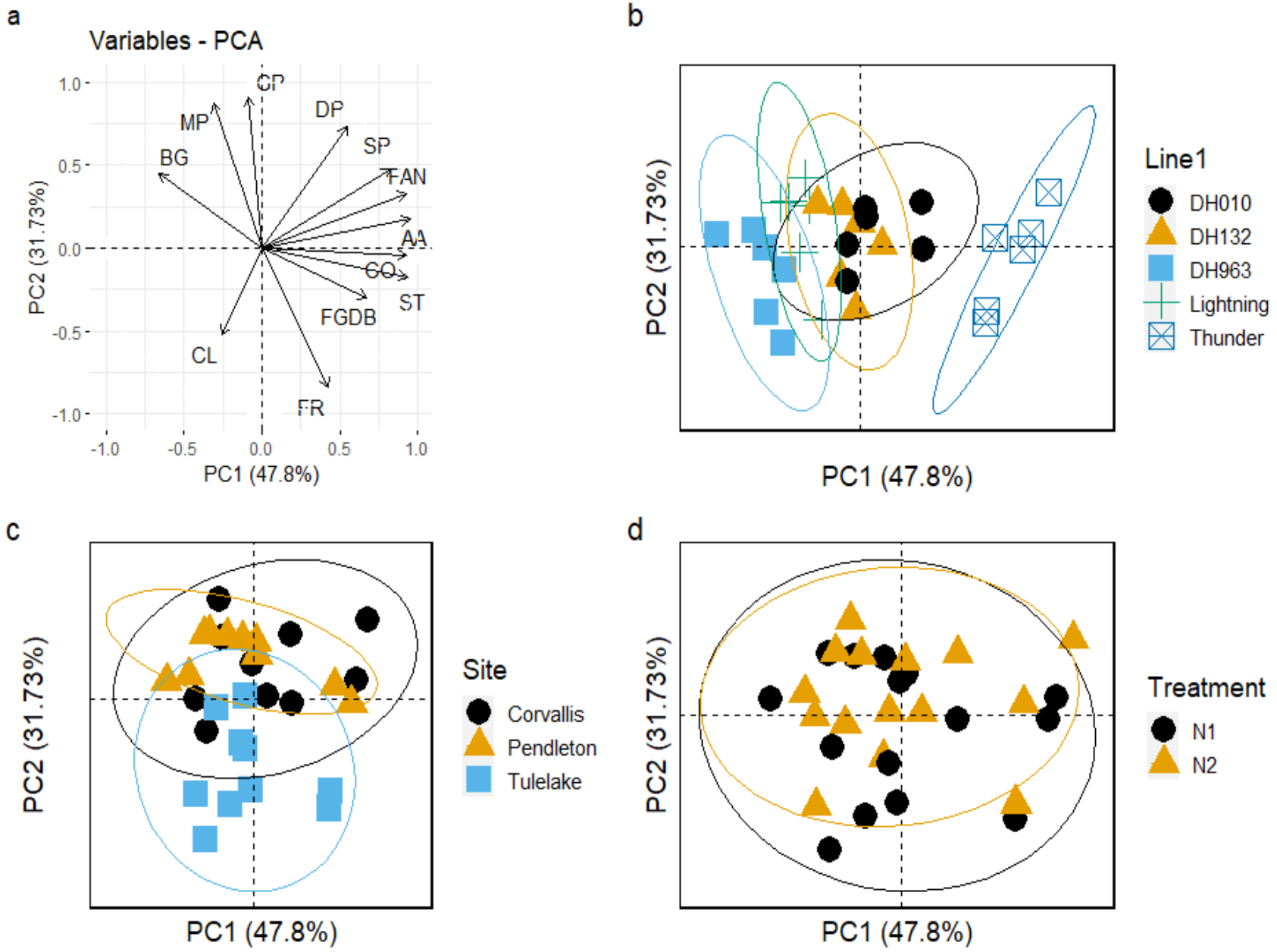


Micro Malting

Grain protein was primary driver of “all-malt” score with a strong negative correlation.

As grain protein was influenced heavily by GxE interaction, a conclusion can be made on GxE and malt quality.

N treatment increased grain protein but was not as significant as line, location, or interaction.



So what does the beer taste like?

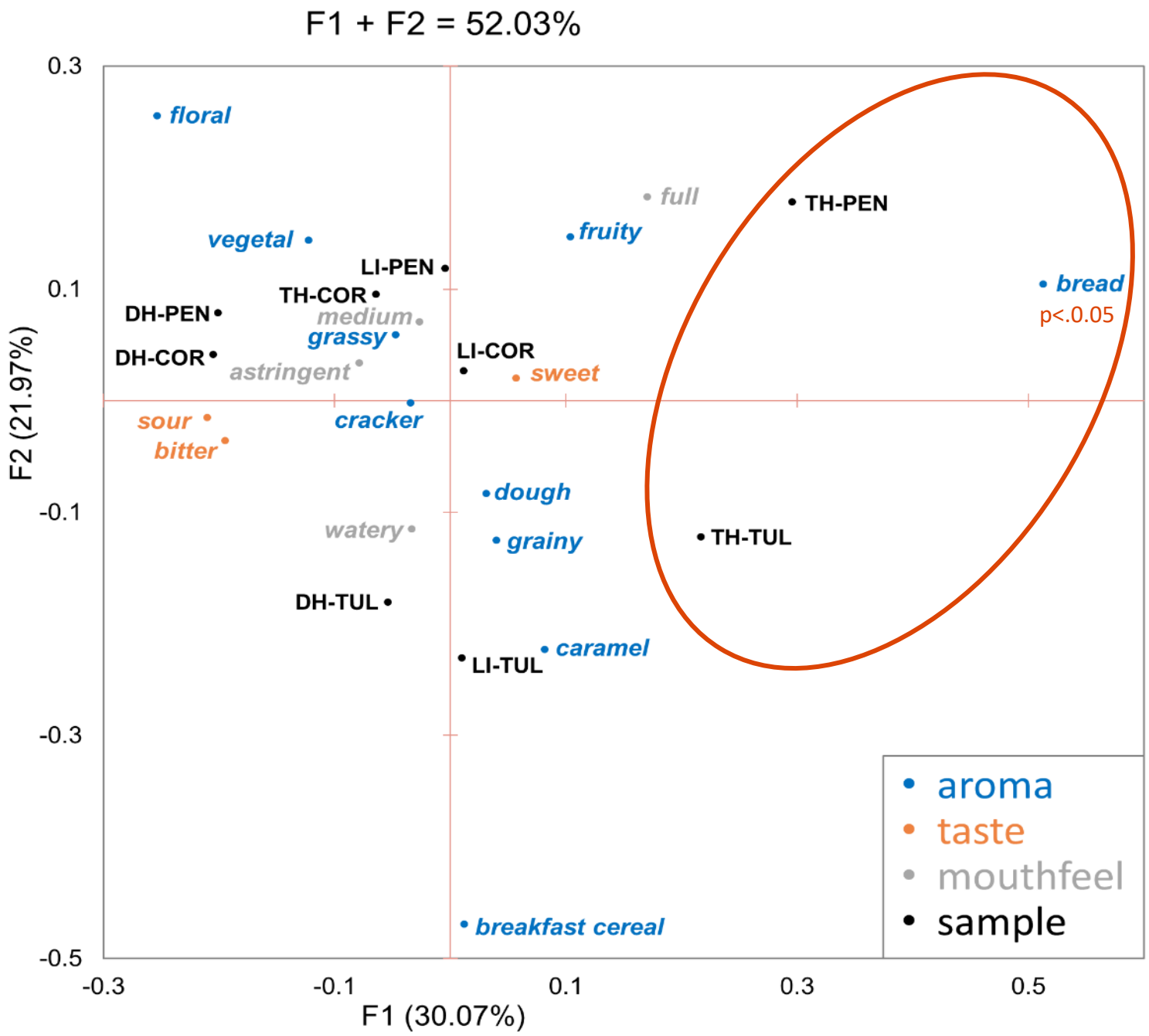
Well… kind of the same with nuanced differences. Similar conclusions to other work just on variety.

Two sensory evaluations:

- Descriptive analysis – check-all-that-apply (CATA).
- Projective mapping (Napping).

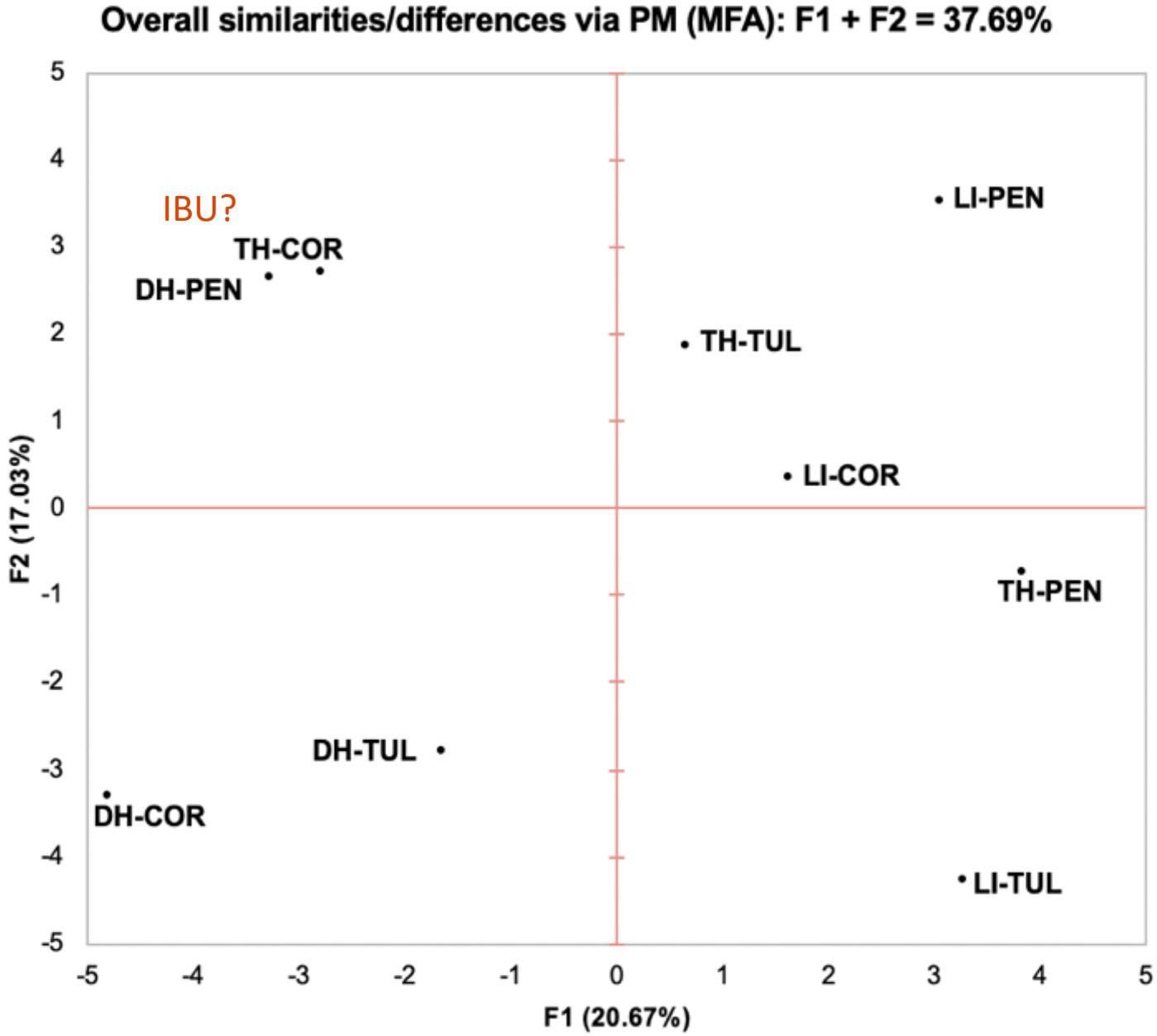
CATA Analysis

- Only significant attribute was *bread. Positively correlated with FAN, S/T, alpha, and extract*
- Low RDF plots with dough, grainy, caramel and watery. DH-TUL was below spec for FAN and DP. ***But not significant descriptors.***
- Low RE plots with vegetal, grassy, medium body, astringent. ***But not significant descriptors.***
- *Terroir effect an extension of modification?*



Projective Mapping

- Small groupings that don't line up with CATA results. Mix of lines and locations.
- Perceived sensory differences that may be associated with attributes not captured in descriptive analysis
  - TH-COR + DH-PEN – highest IBU and negative correlation to low IBU (LI-TUL).
  - No other clear groupings based on brewing analysis.
- Variation from other variables such as yeast and fermentation?
  Hops from same lot and storage conditions.



Conclusions and opportunities

Conclusions

- Grain and malt quality are influenced by GxE interactions. Protein is a major driver of malt quality and protein is influenced by GxE.
- In mini-malting trials each entry performed quite differently even with bespoke malting protocols to promote even modification. Water sensitivity possible driver of malting outcomes.
- Brewing performance was also varied with spreads in brewhouse yield, color, and ABV.
- Sensory differences were present but nuanced. Related to modification.
- Terroir influences modification and by extension sensory.

Opportunities

- A future for lines that don't meet the established malt quality standards?
  - Re-thinking "many barleys are called, but few are chosen."
- True understanding of terroir requires multi-location and multi-year trials. Limitations and costs with malting, brewing, and sensory make this challenging. Need a higher throughput method.
  - Hot steep and metabolomics?
- Understanding the genetic basis of barley contribution to beer flavor.

Thank you to all of our collaborators:

- My co-authors on the manuscript, in particular Margaret Halstead, my primary collaborator on this work.
- Darrin Culp and Rob Wilson at the UC-Davis IREC and Ryan Graebner at the OSU CBARC for managing field experiments in Tulelake and Pendleton respectively
- Deschutes Brewery for in-kind support of the brewing portion of this work.
- The Brewers Association for financial support of the research.

Please reach out with any questions.

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Local supply chains, hop marketing, and terroir

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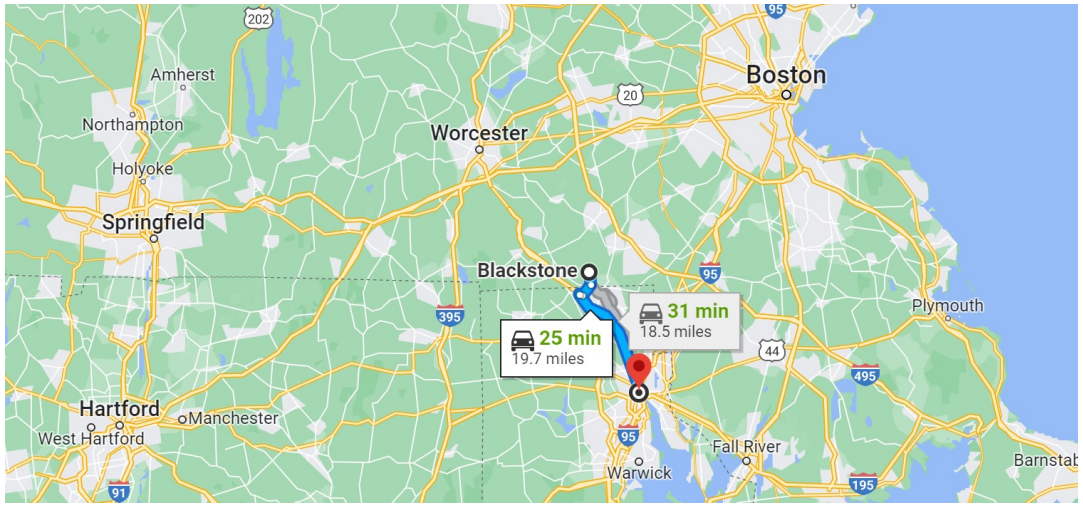
About me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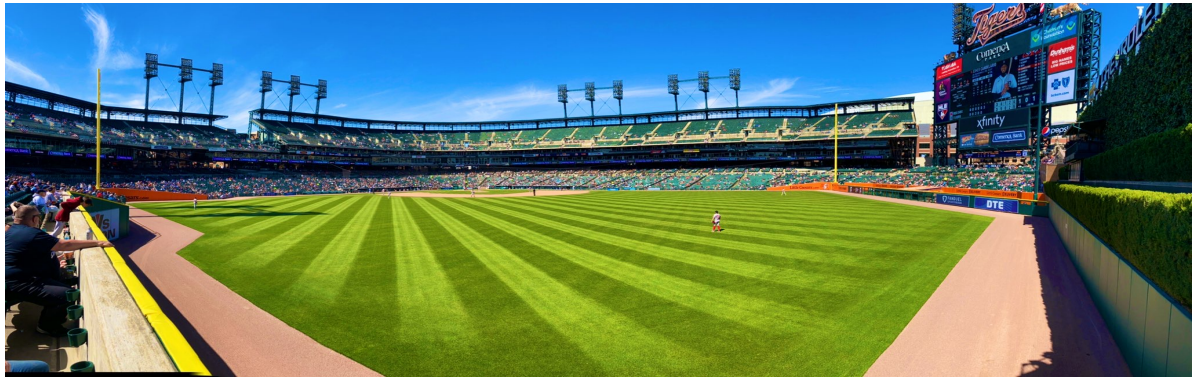
West Hartford
Manchester
Warwick
Fall River
Barnstable



Roadmap

01

Introduction

- The craft beer revolution
- America's hop industry
- Diversification of hop type and hop origin
- Local hopyards and their many challenges

02

Hopping Local

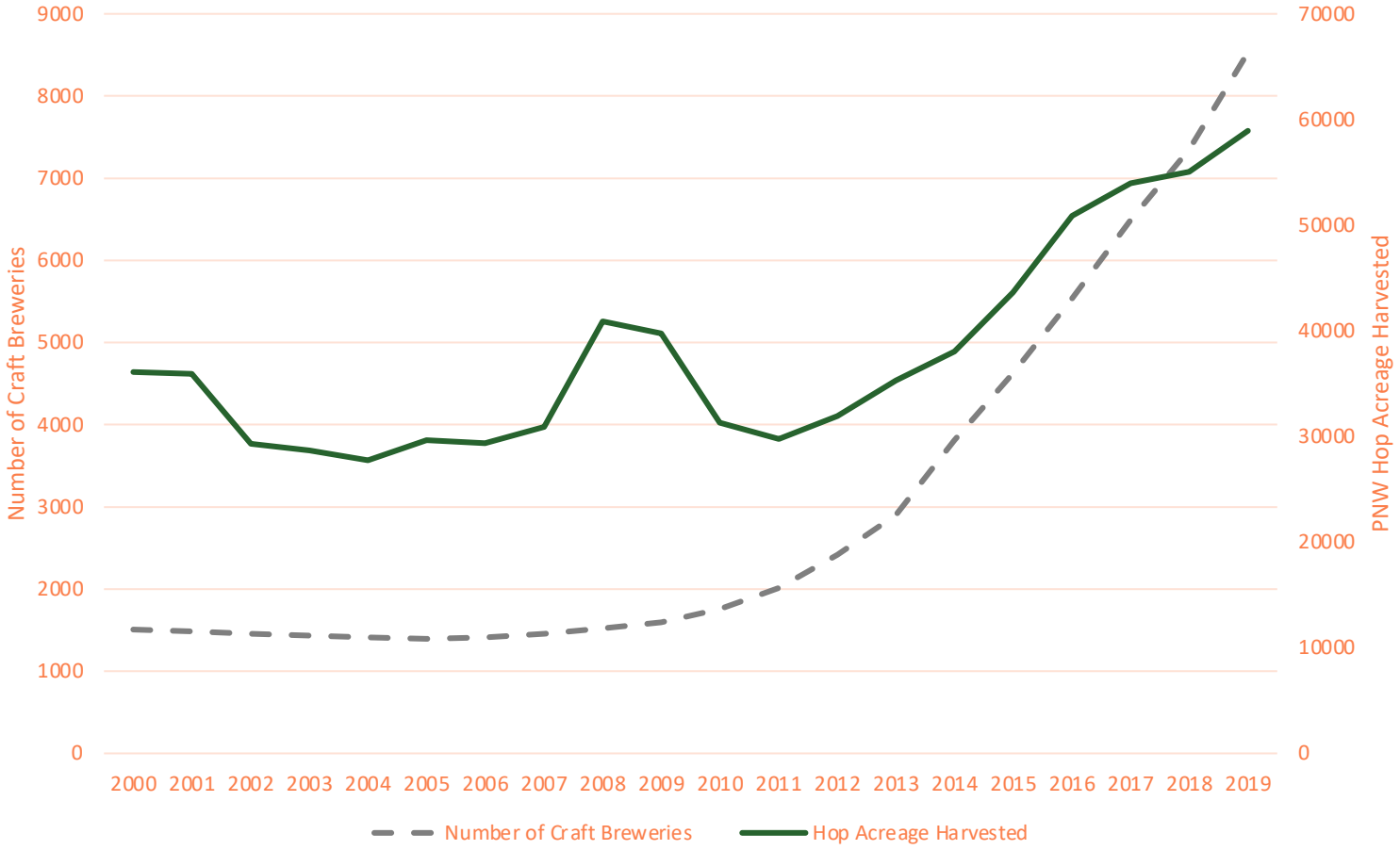
- What drives a brewer's decision to purchase local hops?
- Perceived consistency is key
- What opportunities exist for local hops?

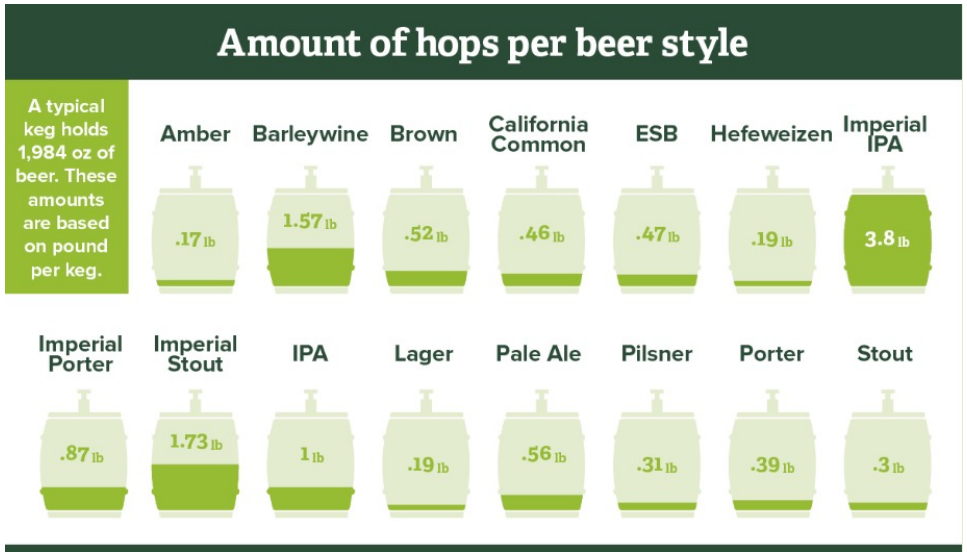
03

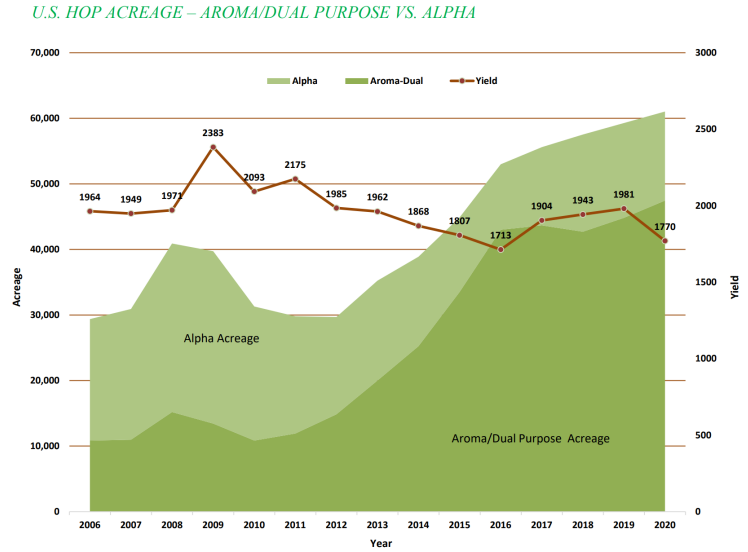
Untapping Terroir

- Biophysical side of terroir: chemical analyses and blind taste tests
- Marketing side of terroir: brewer valuation, consumer preference, nested names

Craft beer revolution → Hop Demand







Sources: Brewers Association (2022); Hop Growers of America (2000-2022)

Preference for local: 80% of adults live within 10 miles of a brewery

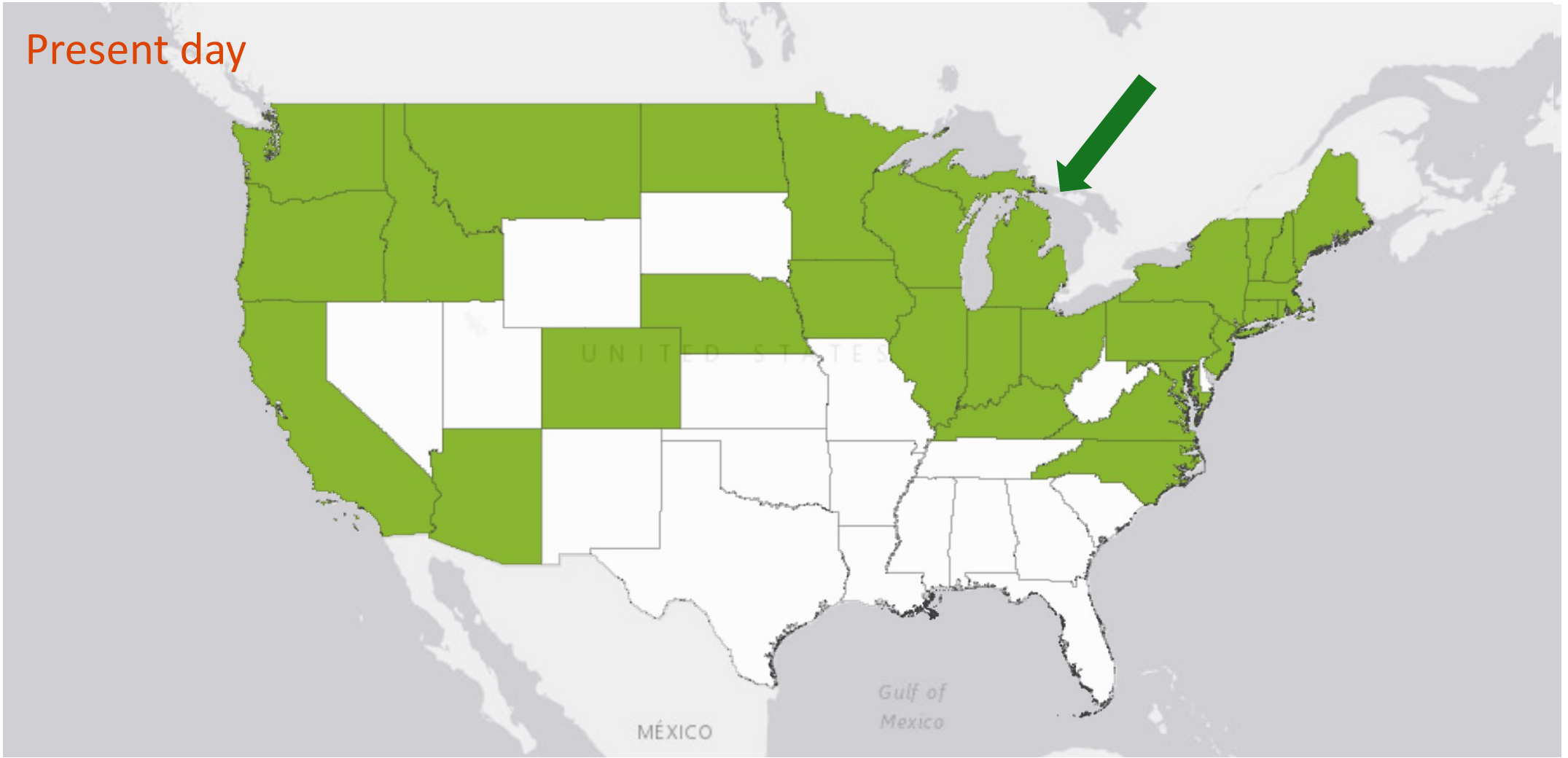
Local value chains can:

1. Increase consumer satisfaction
2. Promote environmental awareness
3. Diversify a farmer's revenue stream
4. Boost local economies

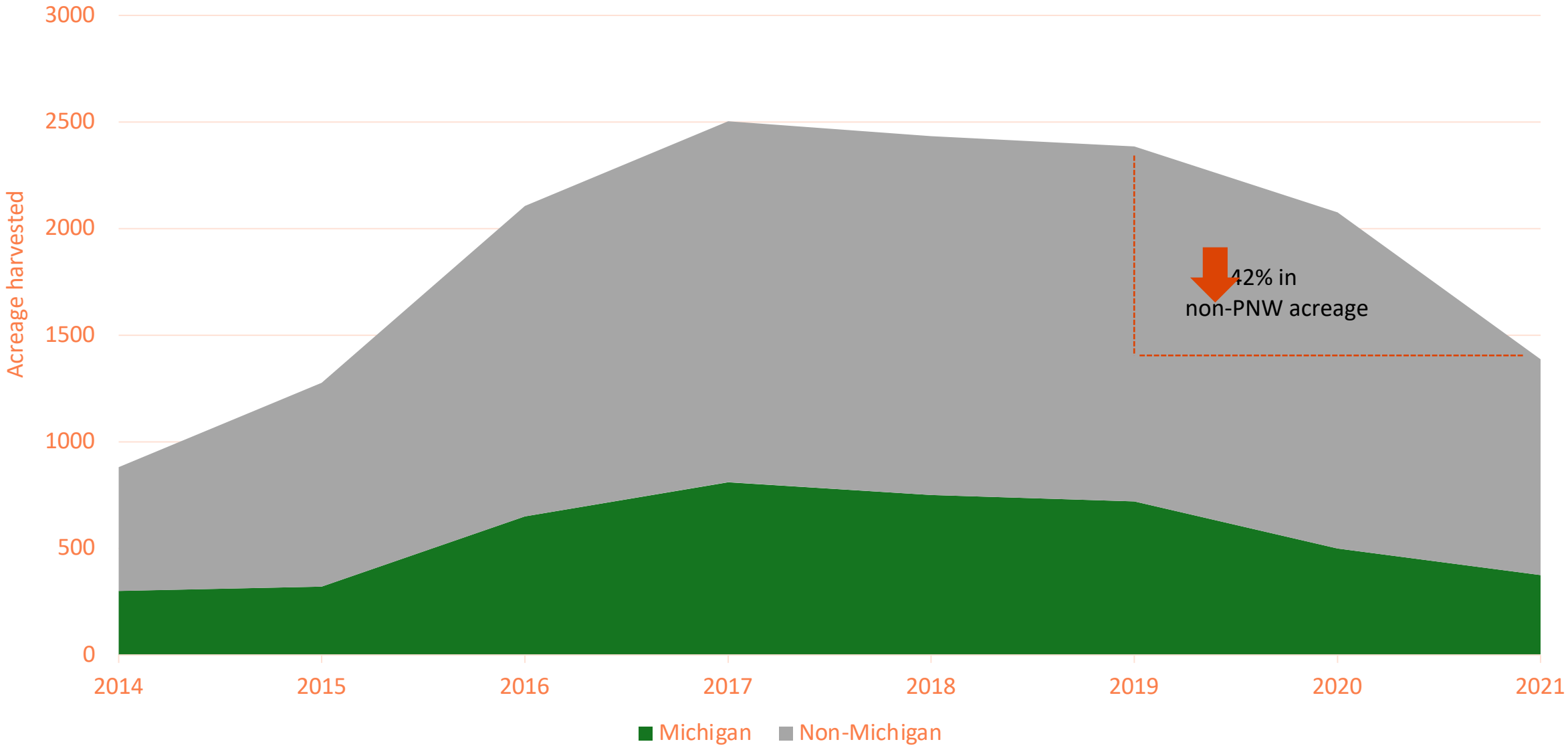
"The Michigan craft beer industry alone generated nearly $500 million in gross state product in 2016, contributing nearly $1 billion and 9,738 jobs to the state's economy."

– Miller et al. (2019)

Hop production is becoming more regionally diverse

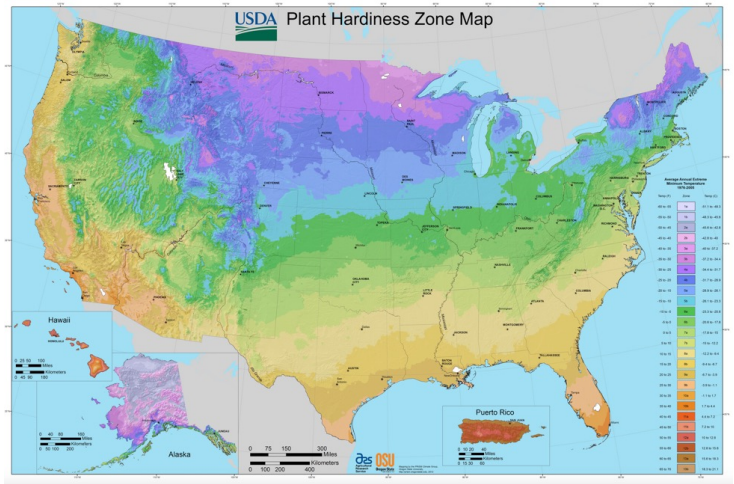


Non-PNW Acreage Harvested



Growing pains for hop growers outside PNW

- Higher production costs
- Crop insurance policies
- Lack of access to proprietary hops
- Pests and disease
- Sub-optimal growing conditions
- Forward contracts
- Economic conditions



Survey to Michigan craft breweries in 2019

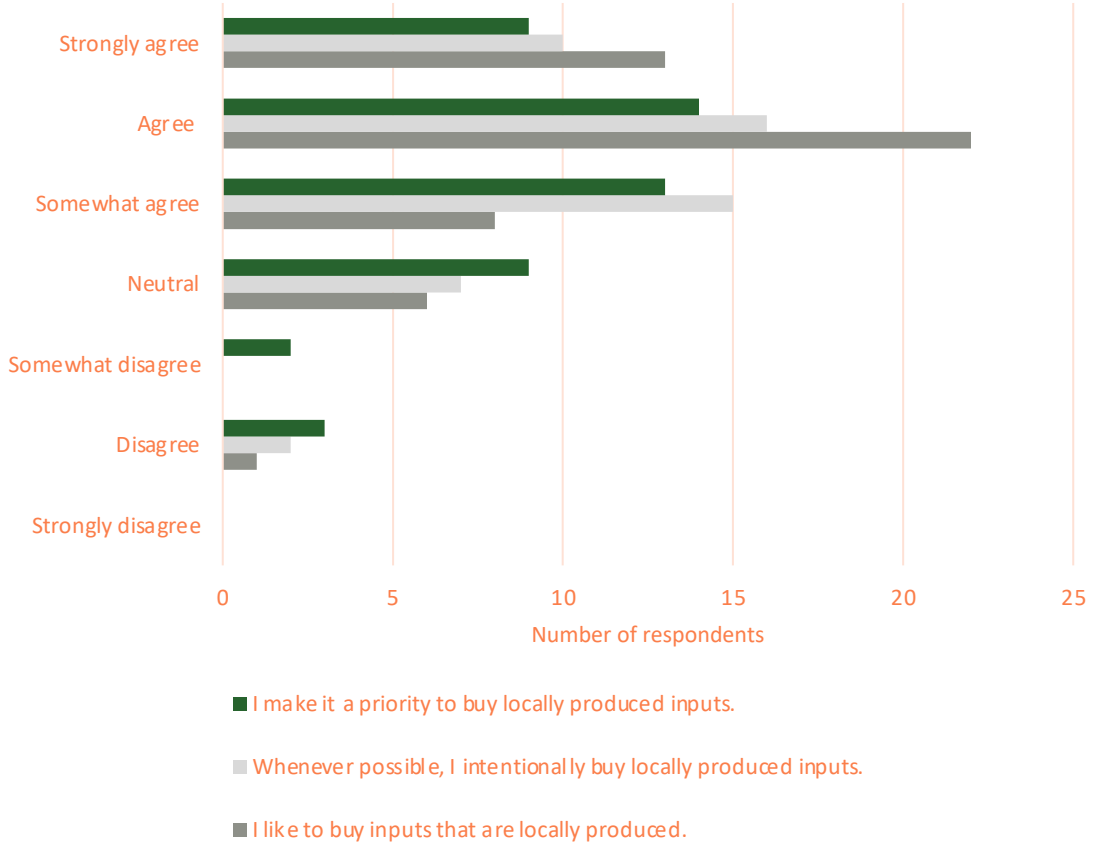
Ask about the brewery's:

- Hop purchasing decisions
- Brewery characteristics
- Preferences for localness

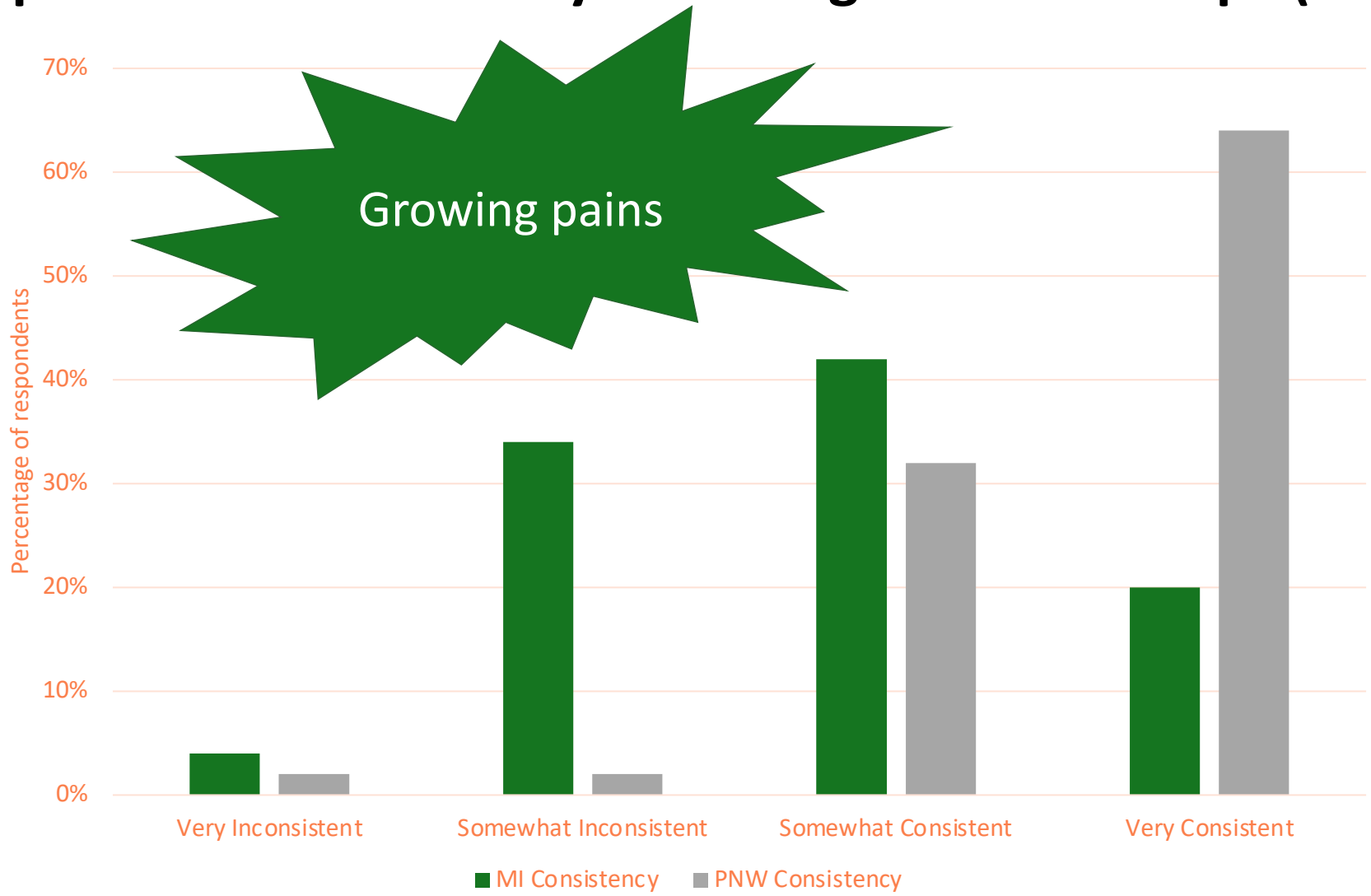
Analyze what drives a brewery's decision to purchase state-grown hops.

MSU Extension

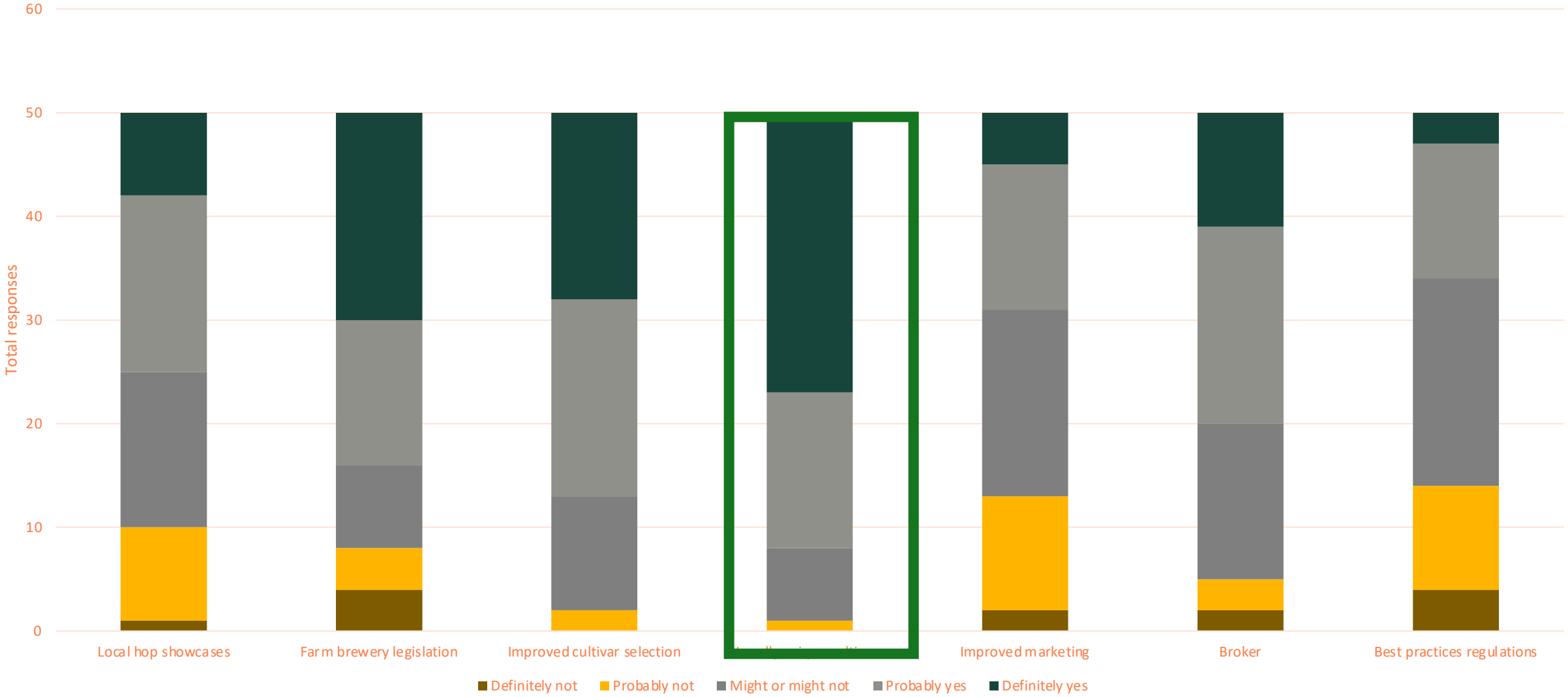
Brewers enjoy purchasing local (n=50)



But perceived consistency of Michigan v. PNW hops (n=50)



Would the following initiatives incentive you to use more local hops?

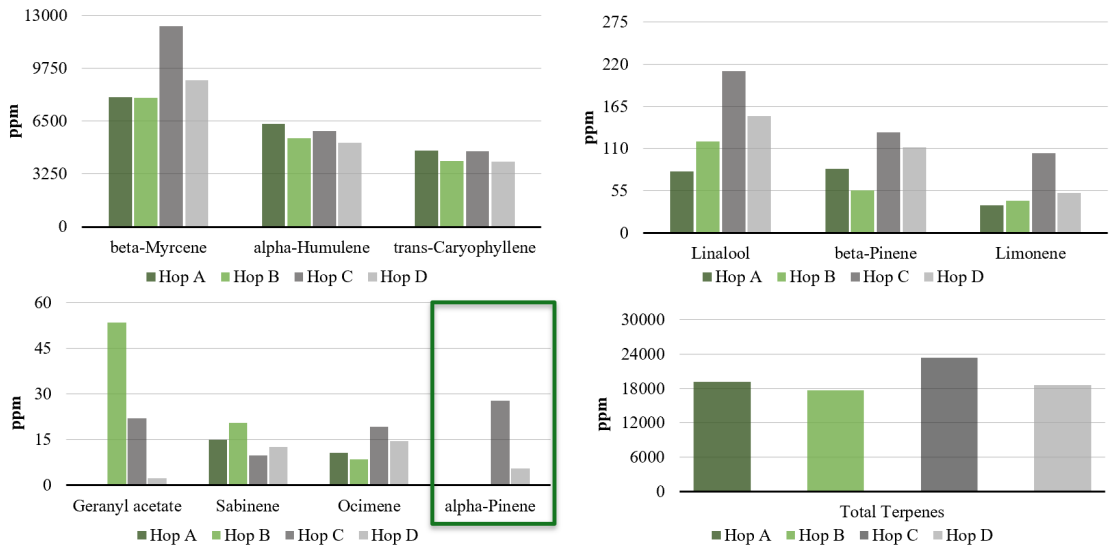


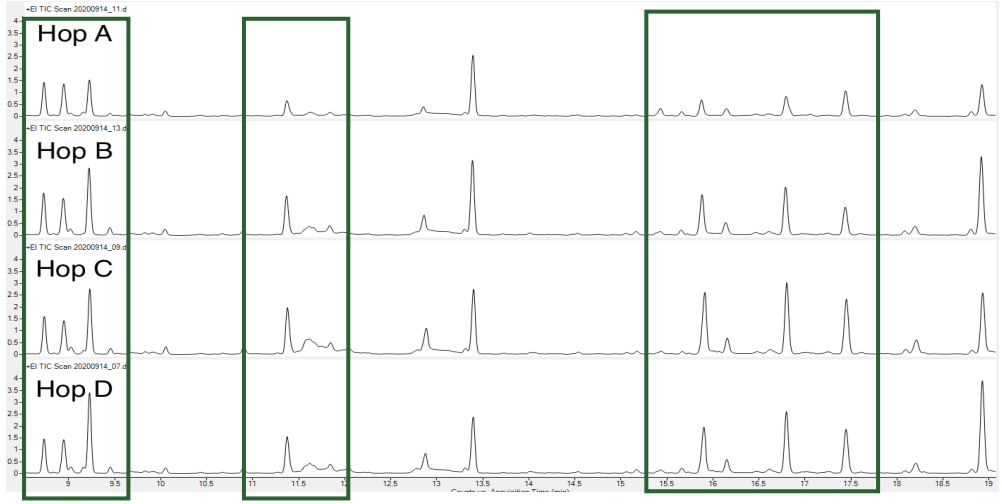
The Two Sides of Terroir

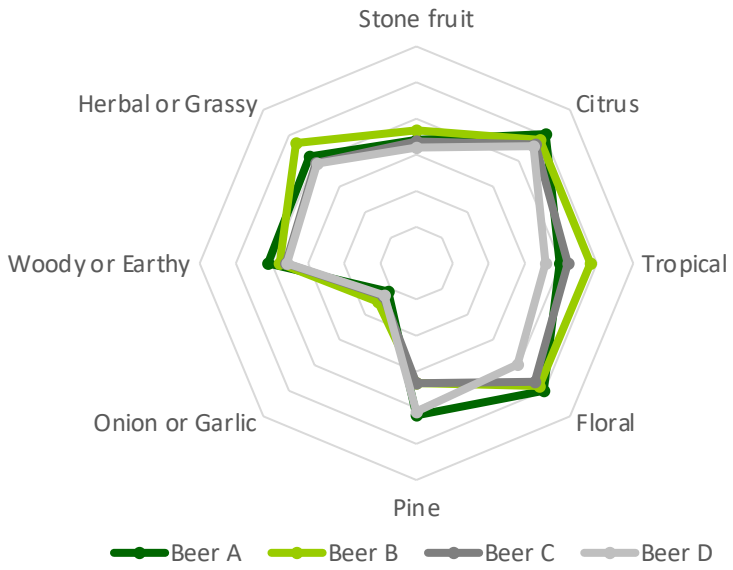
Biophysical

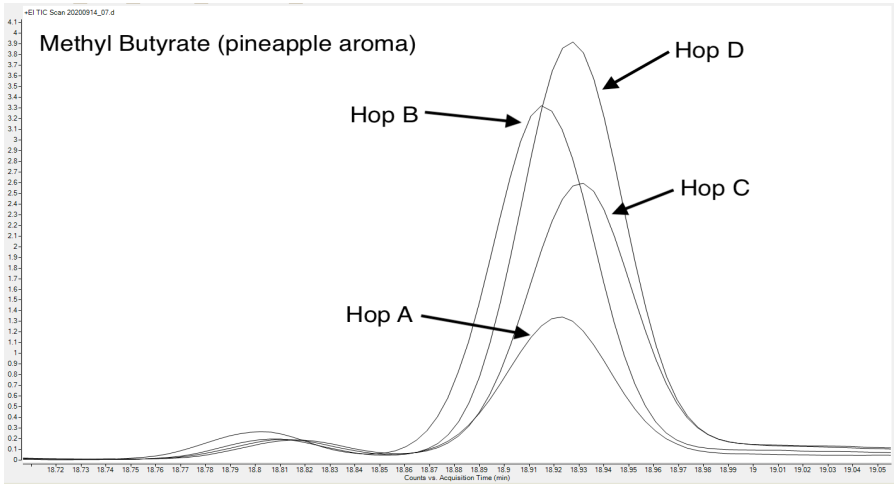
Marketing

Biophysical



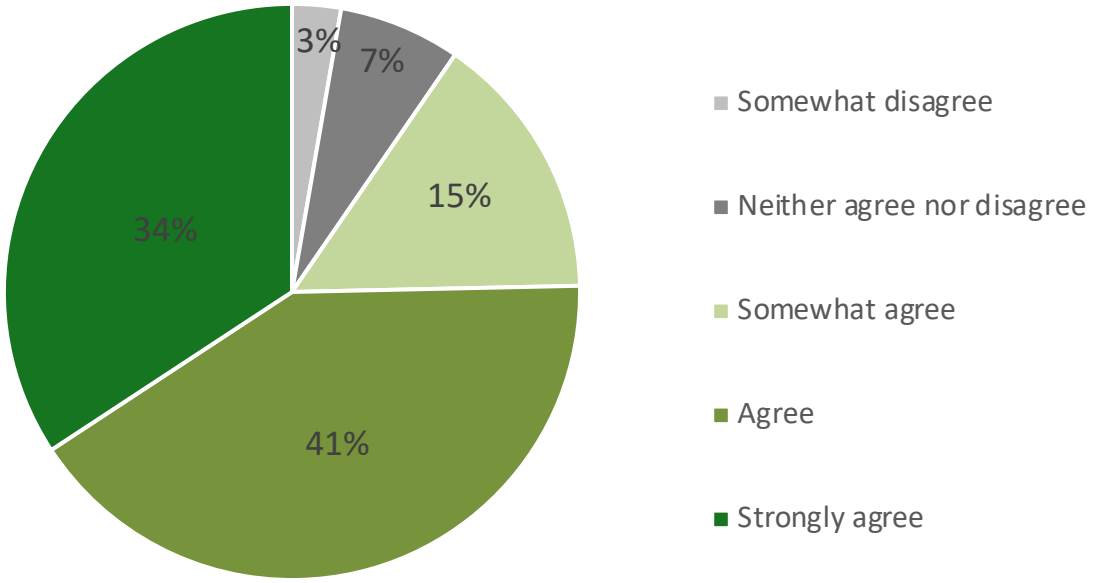




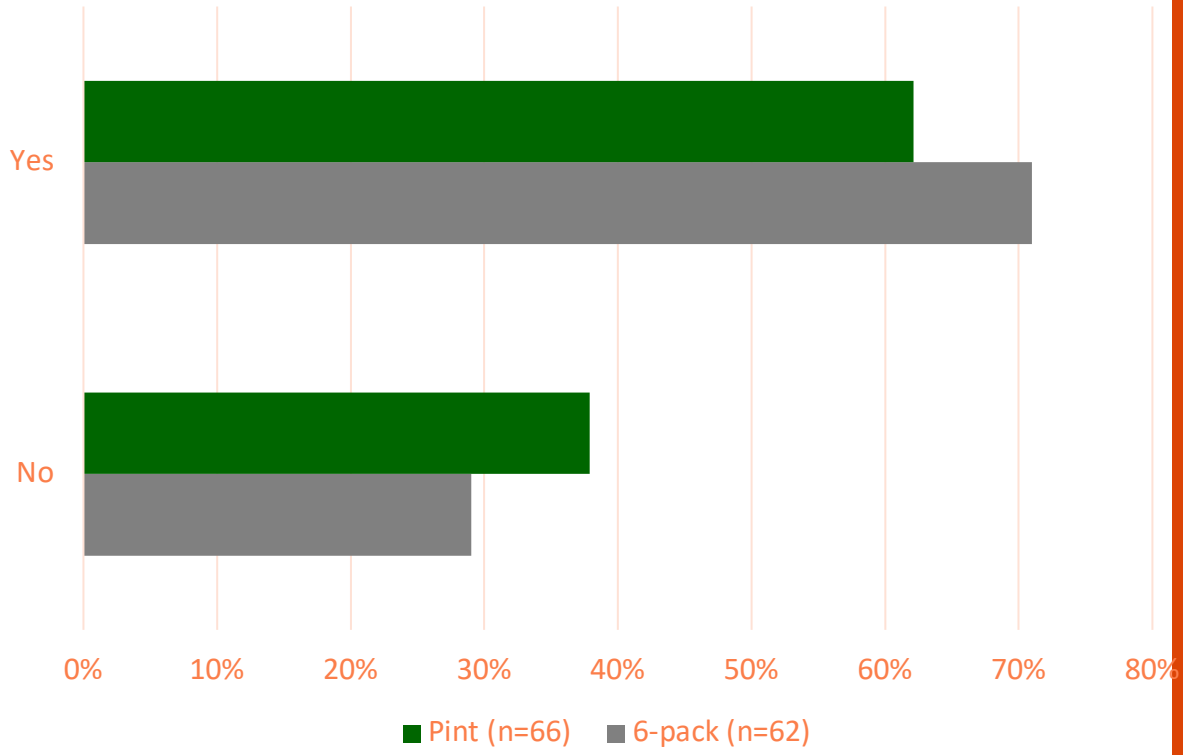


Marketing

To what extent do you agree or disagree: Local hops taste different than non-local hops. (n=74 craft brewers)



Do you believe your consumers are willing to pay a premium for a beer brewed with local hops in the following locations?



Marketing

Nested Names in Wine

Chardonnay

White wine, dry, medium/full body… but what about flavors?

California Chardonnay

“Lemon zest and chalky minerality to baked apple and tropical fruits like pineapple” (Wine Mag)

Burgundy Chardonnay

“Meyer lemon, golden apple, golden pear, quince, and yellow plum. There's also usually a fresh, earthy aroma of white button mushroom or truffle” (Wine Folly)

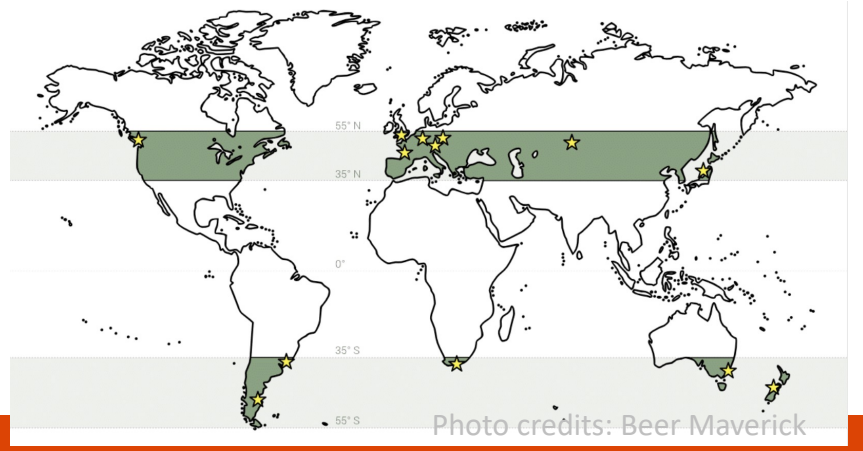


Photo credits: Beer Maverick

Marketing

Mitten Brewing Company

Product Differentiation & Value-Added

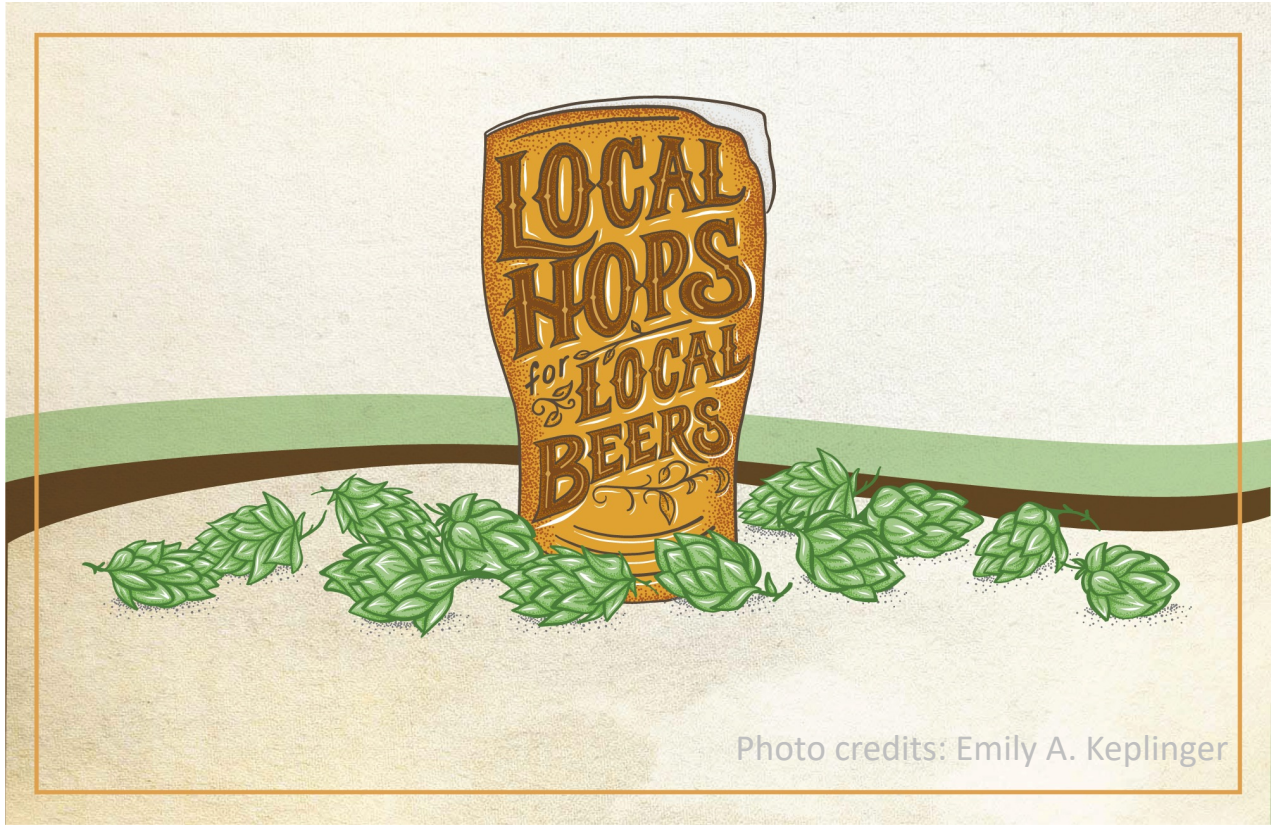


Photo credits: Emily A. Keplinger

Marketing

- Craft brewers are searching for ways to differentiate their product
- Hop growers are searching for ways to overcome production and marketing challenges
- BUT!!! You cannot sacrifice quality or consistency for localness

Localness
X Terroir
A Story

Main Takeaways

1. **A changing hop landscape**: America's hop industry has diversified in the past decade, including an expansion in acreage, a switch from alpha to aroma varieties, and a boom-bust cycle of variation in geographical production.

2. **Hop consistency is key:** One of the leading factors of brewery purchasing decisions is the perceived consistency of state-grown hops

3. **Marketing terroir:** Terroir could play a larger role in hop marketing, particularly as more research on the topic becomes available

Interested in learning more?

Hopping on the Localness Craze

Untapping Beer & Hop Terroir

Cheers!

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