Great Lakes Hop & Barley Conference 2018

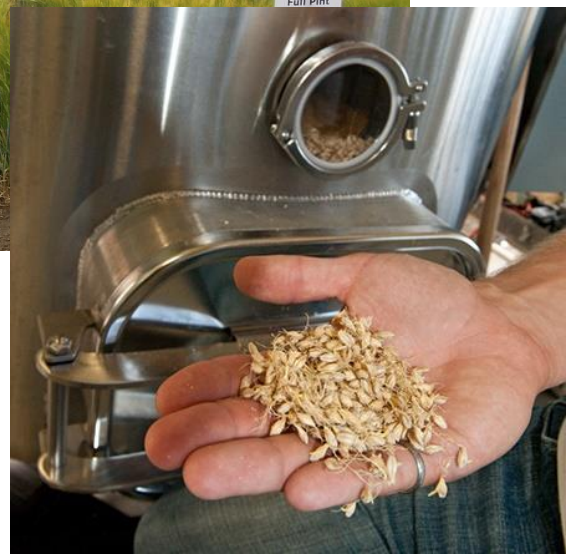
Barley Contributions to Beer Flavor: Flavor Fields and The Oregon Promise

OSU Barley Project

Breeding/Genetics

Management

Malting



The Life Cycle of Barley World

Crossing

Doubled haploids

Genetics and Breeding

Publication, Variety/Germplasm release

Herb, D.W., et al. 2017. Malt modification and its effects on the contributions of barley genotype to beer. flavor. J. Amer. Soc. Brew. Chem. 75:345-353

Breeding Objectives

Winter/Facultative Malting

- 2-row
- Agronomics
  - Yield, Lodging, Height…
- Quality
  - Adjunct & All Malt
- Disease Resistance
  - BSR, Scald, Leaf Rust…
- Winter Hardiness

Spring Malting

- 2-row
- Agronomics
  - Yield, lodging, height…
- Quality
  - Adjunct & All Malt
- Flavor
- Disease resistance
  - BSR, Leaf Rust….

Winter/Facultative Naked

- 2-row, 6-row
- Agronomics
  - Yield, lodging, height…
- Disease Resistance
  - BSR, Scald, Leaf Rust…
- Winter Hardiness
- Color
- Flavor
- Malt Quality

Malting barley variety development

Grain to Glass 11 – 13 years

Time frame (yrs)	*Activity*	*Amount of seed required for one malting quality assessment*	*Amounts of seed available and scale*
2-3	Breeding and selection; initial agronomic assessment •Segregating generations •Doubled haploid populations	***0***	**0g – 1 kg** for breeding program
3-4	Preliminary to advanced agronomic testing and micro-malting of samples from multiple environments	***200 grams***	**1 kg – 20 kg** for breeding and extension programs
3	AMBA Pilot Scale Test must be rated satisfactory in 2/3 years of testing	***7 kilograms/ location*** ***2 locations***	**20 kg –100 kg** for breeding and extension programs. Initiate large-scale increase of pure seed for commercial scale quality assessment and variety release
3	AMBA Plant Scale malting and brewing trials must be rated satisfactory in 3/3 brewing trials	***800 metric tons***	**Large volumes** for on-farm testing and commercial scale malting and brewing

Malting

Controlled germination and kilning

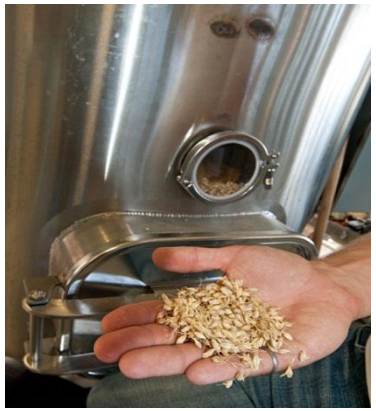
1. Steeping
2. Germination
3. Kilning

- Time (~1 week)
- Temperature (~50^{o} – 350^{o})
- Moisture (~4% – 50%)

The OSU Malt House

Premise

- Malt Bottleneck
- Pilot malting for pilot brewing
  - OSU & Other Breweries
- Sensory Assessment
  - New Varieties
  - Locations
  - Recipes



Mini-Malter

Development

- OSU Barley Project, Fermentation Sciences, School of Mechanical, Industrial, and Manufacturing Engineering in 2011

Malt Production

- Unimalter
- ~7 day process
- 100-300 lbs

CLP Steep/Germinator & Kiln

Malt Production

- 8 samples @ 500 grams each
- 2 samples @ 8 kilograms each

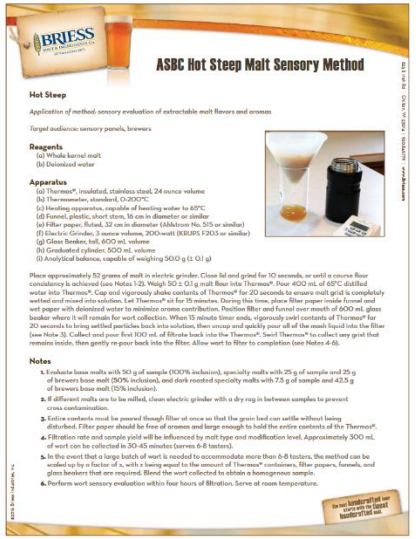
More samples, less grain

Homebrew

Picobrew

Nanobrew

Hot Steep



BRIESS

ASBC Hot Steep Malt Sensory Method

Hot Steep

Application of method: sensory evaluation of extractable malt flavors and aromas

Target audience: sensory panels, brewers

Reagents

(a) Whole kernel malt
(b) Deionized water

Apparatus

(a) Thermos®, insulated, stainless steel, 24 ounce volume
(b) Thermometer, standard, 0-200°C
(c) Heating apparatus, capable of heating water to 65°C
(d) Funnel, plastic, short stem, 16 cm in diameter or similar
(e) Filter paper, fluted, 32 cm in diameter (Ahlstrom No. 515 or similar)
(f) Electric Grinder, 3 ounce volume, 200-watt (KRUPS F203 or similar)
(g) Glass Beaker, tall, 600 mL volume
(h) Graduated cylinder, 500 mL volume
(i) Analytical balance, capable of weighing 50.0 g (± 0.1 g)

Place approximately 52 grams of malt in electric grinder. Close lid and grind for 10 seconds, or until a course flour consistency is achieved (see Notes 1-2). Weigh 50 ± 0.1 g malt flour into Thermos®. Pour 400 mL of 65°C distilled water into Thermos®. Cap and vigorously shake contents of Thermos® for 20 seconds to ensure malt grist is completely wetted and mixed into solution. Let Thermos® sit for 15 minutes. During this time, place filter paper inside funnel and wet paper with deionized water to minimize aroma contribution. Position filter and funnel over mouth of 600 mL glass beaker where it will remain for wort collection. When 15 minute timer ends, vigorously swirl contents of Thermos® for 20 seconds to bring settled particles back into solution, then uncap and quickly pour all of the mash liquid into the filter (see Note 3). Collect and pour first 100 mL of filtrate back into the Thermos®. Swirl Thermos® to collect any grist that remains inside, then gently re-pour back into the filter. Allow wort to filter to completion (see Notes 4-6).

Notes

1. Evaluate base malts with 50 g of sample (100% inclusion), specialty malts with 25 g of sample and 25 g of brewers base malt (50% inclusion), and dark roasted specialty malts with 7.5 g of sample and 42.5 g of brewers base malt (15% inclusion).
2. If different malts are to be milled, clean electric grinder with a dry rag in between samples to prevent cross-contamination.
3. Entire contents must be poured though filter at once so that the grain bed can settle without being disturbed. Filter paper should be free of aromas and large enough to hold the entire contents of the Thermos®.
4. Filtration rate and sample yield will be influenced by malt type and modification level. Approximately 300 mL of wort can be collected in 30-45 minutes (serves 6-8 tasters).
5. In the event that a large batch of wort is needed to accommodate more than 6-8 tasters, the method can be scaled up by a factor of x, with x being equal to the amount of Thermos® containers, filter papers, funnels, and glass beakers that are required. Blend the wort collected to obtain a homogenous sample.
6. Perform wort sensory evaluation within four hours of filtration. Serve at room temperature.

Testing the hypothesis that barley variety contributes to beer flavor

Golden Promise x Full Pint

The Flavor Pack

Brewers Association, Deschutes, Firestone-Walker, New Glarus, Summit, Russian River, Sierra Nevada, Bell's, Westland

Mecca Grade Estate Malting, Rahr Malting

Beer Flavor

Hops ✓
Water ✓
Yeast ✓
Malt ✓

Barley ?

Barley & Beer Flavor

Contributors

- Malting Process
- Malt House
- Location Grown
- Variety

The Oregon Promise

Golden Promise x Full Pint

↓

200 doubled haploids

↓

Select 34 based on agronomic performance

↓

Grow 34 + parents + check at 3 locations in Oregon

↓

Micro-malt → **Nano-brew** → **Beer Sensory**

111 micro-malts, 150 nano-brews = 10 sensory sessions

17 descriptors, 0 – 8 scale

Name: _____ Oregon Promise Date:

Sample #:

Instructions: Look at, smell and then taste each beer sample.

Evaluate each beer sample in the order provided, and indicate the magnitude of flavor difference of samples from reference beer for the following descriptors. No significant difference can be indicated with a mark in the reference box.

COLOR	☐ LIGHTER	☐	☐	☐	☐ REFERENCE	☐	☐	☐	☐ DARKER
GRAINY	☐ WEAKER	☐	☐	☐	☐ REFERENCE	☐	☐	☐	☐ STRONGER
CEREAL	☐ WEAKER	☐	☐	☐	☐ REFERENCE	☐	☐	☐	☐ STRONGER
MALTY	☐ WEAKER	☐	☐	☐	☐ REFERENCE	☐	☐	☐	☐ STRONGER
TOASTED/BREAD	☐ WEAKER	☐	☐	☐	☐ REFERENCE	☐	☐	☐	☐ STRONGER
TOFFEE/CARAMEL	☐ WEAKER	☐	☐	☐	☐ REFERENCE	☐	☐	☐	☐ STRONGER
HONEY	☐ WEAKER	☐	☐	☐	☐ REFERENCE	☐	☐	☐	☐ STRONGER
COCOA/COFFEE	☐ WEAKER	☐	☐	☐	☐ REFERENCE	☐	☐	☐	☐ STRONGER
ROASTED	☐ WEAKER	☐	☐	☐	☐ REFERENCE	☐	☐	☐	☐ STRONGER
FRUIT	☐ WEAKER	☐	☐	☐	☐ REFERENCE	☐	☐	☐	☐ STRONGER
FLORAL	☐ WEAKER	☐	☐	☐	☐ REFERENCE	☐	☐	☐	☐ STRONGER
GRASS/GREEN	☐ WEAKER	☐	☐	☐	☐ REFERENCE	☐	☐	☐	☐ STRONGER
VEGETABLE	☐ WEAKER	☐	☐	☐	☐ REFERENCE	☐	☐	☐	☐ STRONGER

Barley Contributes to Beer Flavor!

- Significant differences between parents and progeny
- New combinations of flavors in progeny
- Mapped flavor QTLs
- Environmental effects
- Not just malt quality/modification

Effects of Barley (*Hordeum vulgare* L.) Variety and Growing Environment on 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.;* **Brigid Meints,** *Dept. of Crop & Soil Science, Washington State University, Mt. Vernon, WA U.S.A.;* **Rebecca Jennings, Robert Monsour, Sean Tynan, and Kristi Vinkemeier,** *Rahr Malting Co., Shakopee, MN U.S.A.;* **Ignacio Romagosa,** *University of Lleida, Lleida, Spain;* **Matthew Moscou,** *The Sainsbury Laboratory, Norwich Research Park, Norwich, NR4 7UH U.K.;* **Daniel Carey and Randy Thiel,** *New Glarus Brewing Co., New Glarus, WI U.S.A.;* **Luis Cistue,** *Estación Experimental Aula Dei, CSIC, Zaragoza, Spain;* **Christopher Martens,** *Cereal Crop Research Unit, USDA-ARS, Madison, WI U.S.A.;* **and William Thomas,** *The James Hutton Institute, Invergowrie, Dundee DD2 5DA, Scotland, U.K.*

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 Carey and Randy Thiel,** *New Glarus Brewing Co., New Glarus, WI U.S.A.;* **Luis Cistue,** *Estación Experimental Aula Dei, CSIC, Zaragoza, Spain;* **Rebecca Jennings, Robert Monsour, Sean Tynan, and Kristi Vinkemeier,** *Rahr Malting Co., Shakopee, MN U.S.A.;* **Yueshu Li, Andrew Nguygen, and Aaron Onio,** *Canadian Malting Barley Technical Centre, Winnipeg, MB Canada;* **Brigid Meints,** *Dept. of Crop & Soil Sciences, Washington State University, Mt. Vernon, WA U.S.A.;* **Matthew Moscou,** *The Sainsbury Laboratory, Norwich Research Park, Norwich NR4 7UH U.K.;* **Ignacio Romagosa,** *University of Lleida, Lleida, Spain;* **and William Thomas,** *The James Hutton Institute, Invergowrie, Dundee DD2 5DA, Scotland, U.K.*

Flavor descriptors

Top three Oregon Promise selections, parents, and check (Copeland)

Nano-beers

Selection	New Glarus descriptors	Rahr descriptors			
		Fruity, floral	*Cereal, malt, sweet, toast, toffee*	*Honey*	*Grassy*
120058	Nice foam, clean, smooth - best "American" type	4.3	3.8	3.9	4.4
120285	Sweet, full, very clean, bread, and malt	4.5	3.9	3.4	4.5
120341	Sweet, full, bitter after taste, malty, and clean	4.0	4.4	3.5	4.5
Full Pint	Full, malty, European	3.3	4.6	4.1	4.6
Golden Promise	Harsh bitterness	4.8	3.7	3.8	4.6
Copeland	Not included in New Glarus sensory	4.5	3.6	4.1	4.6

Next Steps

Higher Resolution Genetic Mapping of Flavor

- 164 Oregon Promise Malt Samples
- Grown in Corvallis 2014
- Nano-brew and sensory at Rahr Malting
- QTL mapping

Scale It Up!

Oregon Promise Pilot Scale Flavor Assessment

Lines

- DH120058
  - Nice Foam, Clean, Smooth - Best "American" Type
- DH120285
  - Sweet, Full, Very Clean, Bread, Malt
- 120341
  - Sweet, Full, Malty, Clean
- Full Pint
  - Full, Malty, European
- Copeland

Locations

- Lebanon, Madras, Summerville (OR) 2017 (except Copeland)

Grain Quality Data

Selection	**Location**					
	LEB		*MAD*		*SUM*	
	Plump (%)	*Protein (%)*	*Plump (%)*	*Protein (%)*	*Plump (%)*	*Protein (%)*
DH120058	95	11.4	82	11.1	100	14.2
DH120285	98	9.9	94	11.9	99	14.2
120341	97	10.9	78	11.9	99	13.2
Full Pint	96	11.5	94	11.8	99	13.6

Oregon Promise Pilot Scale Flavor Assessment

Malting – December/January

- OSU Malt House

Brewing - February

- Deschutes Brewery
  - Replicated 1 Barrel Brews (~11 plato beer)
  - “No major issues in brewing or fermentations thus far. (Squeals of excitement)”

Beer Sensory – This Month!

- Flavor Pack Members
  - Deschutes, Firestone-Walker, New Glarus, Bell’s, Rahr Malting

Andy Tullis/Bend Bulletin photo

Quality of Pilot Scale Malts

HARTWICK COLLEGE est. 1797 | Center for Craft Food & Beverage

Selection	Moisture	Friability	Extract	Color	β-glucan	Soluble	Protein	S/T	FAN	DP	Alpha
	%	%	%	°SRM	mg/L	%	%	%	mg/L	°L	Amylase
DH120058	5.3	82.3	80.1	1.46	173	4.47	10.6	42.2	167	150	56.5
DH120285	4.7	85	80.4	1.84	58	4.99	10.5	47.5	205	168	64.2
120341	5.7	68.7	81.4	1.55	727	4.11	10.6	38.8	154	124	46.5
Full Pint	5.4	78.6	80.5	1.80	164	4.82	10.8	44.6	196	178	90.0
Copeland	4.5	90.3	82.1	1.54	74	4.84	10.8	44.8	195	146	58.6

Flavor Fields Experiment - 2017

What is the role of the environment in barley contributions to flavor?
Is there genotype x environment interaction?
Validate previous findings.

Genotypes (20)

- 8 Oregon Promise Selections
- 9 OSU 2-row Facultative Malt Selections
- Golden Promise, Full Pint, Copeland

Environments (10)

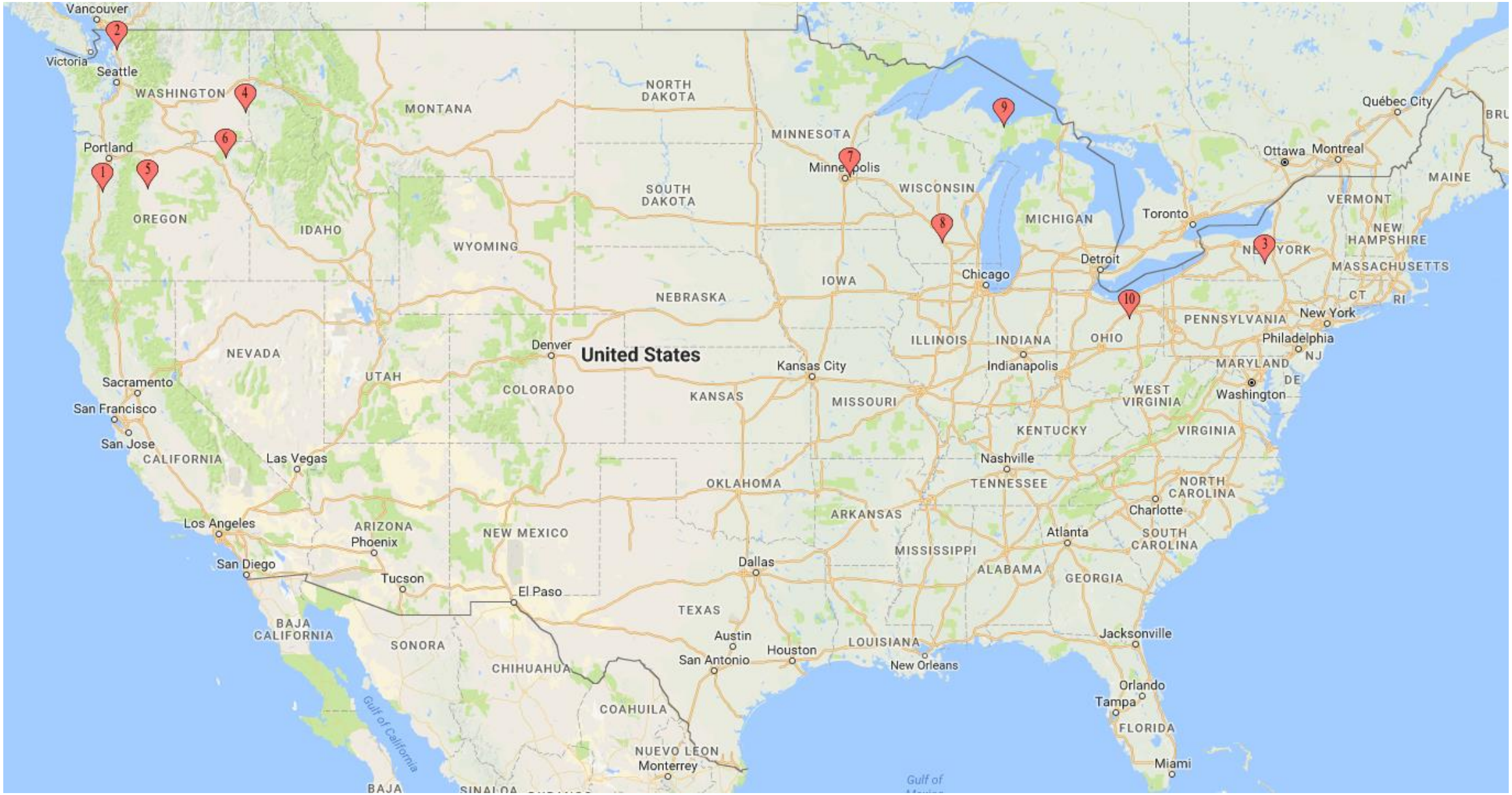
- OR (3), WA (2), MN, WI, MI, OH, NY

Grain Traits

- Plump, Protein, Test Weight, RVA (MI)

Micro-Malt, Nano-brew, Sensory (beer and/or hot steep)

- Rahr Malting
- 44 Selected Samples from Possible 200


Vancouver
Victoria
Seattle
Portland
WASHINGTON
OREGON
MONTANA
NORTH DAKOTA
SOUTH DAKOTA
MINNESOTA
Minneapolis
WISCONSIN
MICHIGAN
IDAHO
WYOMING
NEBRASKA
IOWA
Chicago
Detroit
Toronto
Québec City
Ottawa
Montreal
MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
CT
RI
NEW YORK
New York
PENNSYLVANIA
Philadelphia
NJ
MARYLAND
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Washington
WEST VIRGINIA
VIRGINIA
OHIO
INDIANA
Indianapolis
ILLINOIS
Kansas City
MISSOURI
KANSAS
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Denver
United States
NEVADA
UTAH
Sacramento
San Francisco
San Jose
CALIFORNIA
Las Vegas
KENTUCKY
Nashville
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OKLAHOMA
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El Paso
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BAJA CALIFORNIA
SONORA
CHIHUAHUA
COAHUILA
NUEVO LEON
Monterrey
Austin
San Antonio
Houston
LOUISIANA
New Orleans
Jacksonville
Orlando
Tampa
FLORIDA
Miami
Gulf of California
Gulf of
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Micro-Malt, Nano-brew, Sensory Sample Selection

Genotypes (11)

- Oregon Promise Lines (8) & Parents/Checks (3)
  - Drop Facultative Lines

Grain Traits

- <12.5% protein

Location	Protein Avg. (%)	Plump Avg. (%)
Chatham, MI	12.0	83.6
St. Paul, MN	13.7	55.8
Ithaca, NY	11.3	70.1
Wooster, OH	12.6	83.0
Summerville, OR	14.1	96.2
Lebanon, OR	10.8	94.4
Madras, OR	12.8	74.9
Mt. Vernon, WA	10.1	91.3
Pullman, WA	11.7	94.3
Madison, WI	13.8	83.5

Grain Traits – Chatham, MI

Line	Protein	Plump	RVA
120373	11.9	82.2	81
120341	11.7	74.9	99
120657	12.5	69.1	102
120285	12.4	83.3	90
120691	13.0	85.2	15
120058	12.2	94.6	111
120520	12.2	93.3	5
120145	10.8	74.5	161
Golden Promise	11.8	87.1	124
Full Pint	11.7	87.3	24
Copeland	11.7	87.6	146

Many Lines Susceptible to Pre-Harvest Sprouting

Rapid Visco Analysis

Risk of Germ Loss
≥120 - Low Risk
≥50 & <120 - Intermediate Risk
<50 - High Risk

Agronomic Data – Chatham, MI

Line	Yield (lbs/acre)	Blotch (%)
120373	2219	20
120341	2182	35
120657	753	55
120285	1133	20
120691	1074	60
120058	2054	20
120520	1824	25
120145	1456	25
Golden Promise	2054	20
Full Pint	1845	20
Copeland	1724	55
GRAND MEAN	1557.9	38.6
LSD	394.6	26.7
CV	14.6	40.1

Final Selection

Genotypes (11)

- 8 Oregon Promise Selections, Golden Promise, Full Pint, Copeland

Environments (4)

- Lebanon, OR; Mount Vernon, WA; Pullman, WA; Ithaca, NY

Next Steps:

Currently in queue at Rahr for malting, nano-brewing (and/or hot steep), Sensory

Flavor is Great! Adaptation is Necessary!

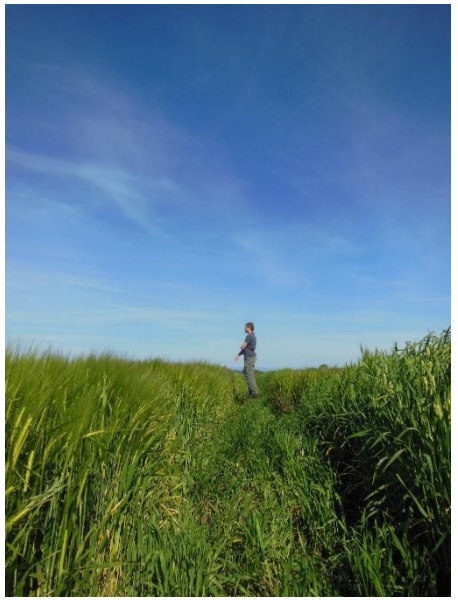
The Search for Barley Flavor

Romp of Otters

- Maris Otter Crosses
  - 10 selections based on agronomics & MQ

World Core Collection

- 2062 original lines
  - 26 lines + checks from 3 locations – previously malted at Rahr and in queue for hot steep sensory
  - 20 selected lines 2017 harvest
    - 4 planted in larger strips 2018



Naked Malting

OREI Multi-Use Naked Barley Project

- Malting, Food, Feed

Benefits of Naked Barley for Malting/Brewing

- New flavor frontiers?
- Higher malt extract
- Color

Considerations

- Mash Filter
- Rice Hulls
- % of Total Grain Bill

Quality of Buck Naked Malt

HARTWICK COLLEGE est. 1797 | Center for Craft Food & Beverage

Selection	Moisture	Friability	Extract	Color	β-glucan	Soluble	Protein	S/T	FAN	DP	Alpha
	%	%	%	°SRM	mg/L	%	%	%	mg/L	°L	Amylase
Buck	4.6	n/a	87.8	1.45	208	4.12	9.9	41.6	161	75	37.9

Barley – the next wave in craft beer flavor?

Thanks!

www.barleyworld.org

@barleyworld

@multibarley

BARLEY DAY

June 1, 2018

Corvallis, OR