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Results from the Eastern Spring Barley Nursery

Rich Horsley, Paul Schwarz and
the ESBN Cooperators

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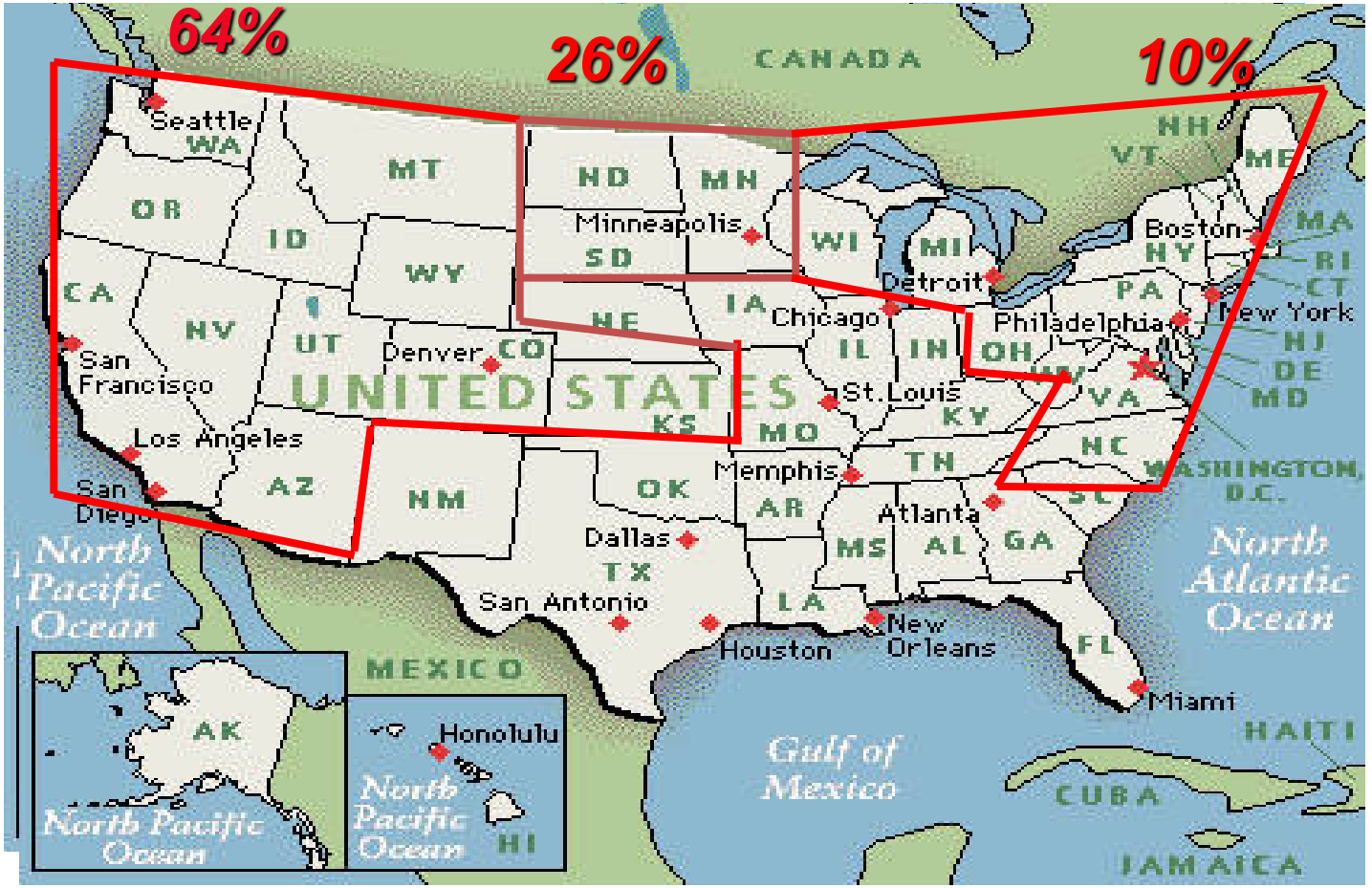
Estimated Percentage of US Barley Production by Region in 2018



Source: USDA/NASS/ Agriculture Statistics Board

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Needs for Eastern Barley Growing Region

- Cultivars suitable for the craft industry
- Winter barley for areas south of Vermont and Maine.
- Cultivars able to handle warm nighttime temperatures.
- Cultivars with resistance to:
  - Fusarium head blight and DON accumulation
  - Net and spot blotch
  - Powdery mildew and leaf rust (southern area of region)
  - Pre-harvest sprouting

Is there a Single Breeding Program Addressing All of These Needs for the East?

- For the northern spring barley region, not exactly.
- For the southern winter barley region, programs in New York, Ohio, and Virginia.

Location of Barley Breeding Programs for All Brewers

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Analytical Guidelines for Barley Breeders Specified by AMBA (abbreviated list)

Barley factors	Six-rowed	Adjunct Two-rowed	All Malt Two-rowed
On 6/64	> 80%	> 90%	> 90%
Thru 5/64	< 3%	< 3%	< 3%
Protein	≤13.5%	≤13.0%	≤12.0
Germination (4 mL 72hr GE)	> 98%		
Skinned and broken	< 5%		
Hull characteristics	The hull should be thin, bright, and adhere to the kernel during harvesting, cleaning, and malting.		

General comments: the variety should mature rapidly, break dormancy quickly, and germinate uniformly.
Malted barley should exhibit a well-balanced modification in a conventional malting schedule with four-day germination.

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Analytical Guidelines for Barley Breeders Specified by AMBA (abbreviated list)

Malt factors	Six-rowed	Adjunct Two-rowed	All Malt Two-Rowed
Total protein (d.b.)	≤12.8%	≤12.8%	≤11.8%
Soluble protein (d.b.)	5.2-5.7%	4.8-5.6%	<5.3%
Kolbach Index (d.b.)	42-47%	40-47%	38-45%
Extract (fine grind d.b.)	>79.0%	>81.0%	>81.0%
Wort color (ºASBC)	1.8-2.5	1.6-2.5	1.6-2.8
Fine-coarse difference	< 1.2%		
Wort ß-glucan (ppm)	<120	<100	<100
Diastatic power (ºASBC)	>150	>120	110-150
Alpha amylase (DU)	>50	>50	40-70

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2019 AMBA Recommended Varieties

Recommended Six-rowed Malting Barley Varieties

Variety	Year	Variety	Year
Celebration	2011	Quest	2011
Innovation	2014	Stellar-ND	2006
Lacey	2000	Thoroughbred	2015
Legacy	2001	Tradition	2004

Recommended Two-rowed Malting Barley Varieties

Variety	Year	Variety	Year
AAC Synergy	2015	LCS Genie	2018
ABI Growler	2019	Merit 57	2010
ABI Voyager	2014	Moravian 37	2010
AC Metcalfe	2005	Moravian 60	2010
Bill Coors 100	2019	Moravian 165	2019
CDC Copeland	2015	ND Genesis	2016
Charles	*2012*	Newdale	2018
Conlon	2000	Pinnacle	2011
Conrad	2007	*Puffin*	*2018*
Endeavor	*2014*	Scarlett	2008
Expedition	2018	*Thunder*	*2019*
Explorer	2018	*Wintmalt*	*2018*
Hockett	2010		

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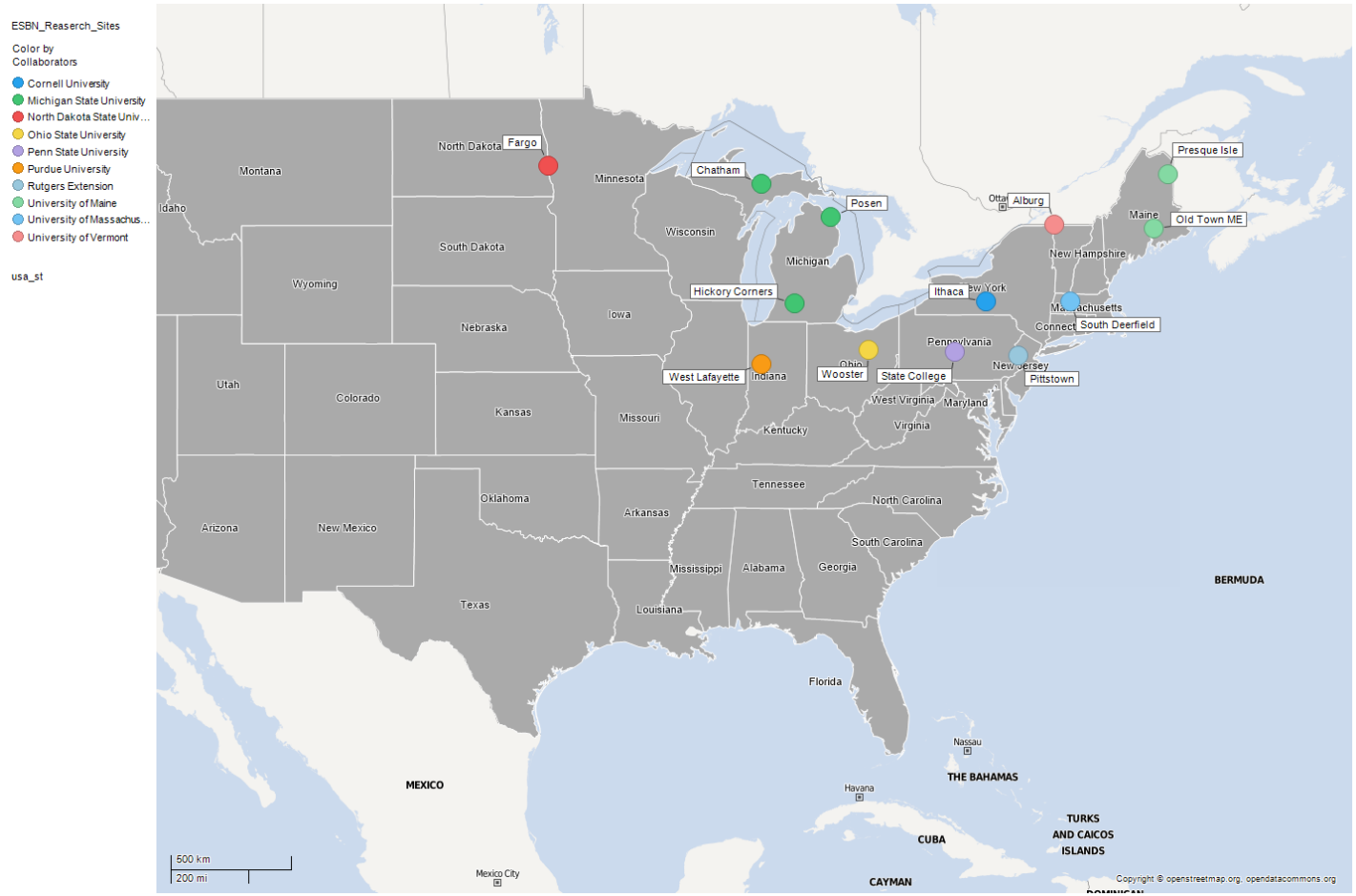
Identifying Varieties for the Eastern Growing Region

- Established the Eastern Spring Barley Nursery (ESBN) in 2015.
- Common list of 20-25 varieties grown in the north eastern region of the US.
- Varieties selected based on input from craft industry personnel and university researchers in the region.
- Varieties included two- and six-rowed entries from the US, Canada, and Europe.

ESBN Research Sites



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Data Collected

Field Data

- Days to heading, plant height, lodging, foliar diseases, stem breakage, and yield

Barley Quality Data

- Grain moisture, test weight, protein, barley color, kernel plumpness,1000-kernel weight, DON, DON (NDSU FHB nurseries), and stirring number (RVA).

Malt Data (3 locations + NDSU)

- Extract, wort protein, wort color, S/T, DP, α-amylase, wort ß-, wort viscosity, and FAN

2015 ESBN Entry List (Two-rowed Entries)

Variety	Developer
AAC Synergy	Agriculture and Agri-Food Canada
AC Metcalfe	Agriculture and Agri-Food Canada
Newdale	Agriculture and Agri-Food Canada
Cerveza	Agriculture and Agri-Food Canada
CDC Copeland	Crop Development Centre
CDC Meredith	Crop Development Centre
Bentley	Field Crop Development Centre
Harrington	Crop Development Centre
Klages	USDA-ARS Aberdeen, ID
Conlon	North Dakota State University
ND Genesis	North Dakota State University
Pinnacle	North Dakota State University
Full Pint	Oregon State University
Scarlett	Saatzucht Josef Breun GmbH & Co (Germany)

2016 ESBN Entry List (Two-rowed North American Entries)

Variety	Developer
AAC Synergy	Agriculture and Agri-Food Canada
AC Metcalfe	Agriculture and Agri-Food Canada
Newdale	Agriculture and Agri-Food Canada
Cerveza	Agriculture and Agri-Food Canada
CDC Copeland	Crop Development Centre
CDC Meredith	Crop Development Centre
Bentley	Field Crop Development Centre
Conlon	North Dakota State University
ND Genesis	North Dakota State University
Pinnacle	North Dakota State University
2ND28065	North Dakota State University

2016 ESBN Entry List (Two-rowed European Entries)

Variety	Developer
LCS Genie	Limagrain Cereal Seeds (France)
LCS Odyssey	Limagrain Cereal Seeds (France)
SY Sirish	Syngenta
Explorer	Secobra (France)
Pioneer	Secobra (France)
Steffi	Ackermann (Germany)
Acorn	Ackermann (Germany)
KWS Fantex	KWS (Germany)
KWS Beckie	KWS (Germany)

Mean Yield and Barley Quality Across Entries for Selected ESBN Locations (2015-2018)

Location	Yield	Test weight	Protein	DON	RVA†
	(bu/ac)	(lb/bu)	(%)	(ppm)	(SN)
Fargo, North Dakota	91.0	50.5	11.2	0.06	102
Chatham, MI	70.4	48.5	11.4	0.06	114
Northeast Michigan	69.8	49.0	11.9	0.02	118
Hickory Corners, Michigan	52.2	46.8	12.6	0.08	101
Alburgh, Vermont	51.5	47.2	10.8	0.77	134
Orono, Maine	88.1	50.4	9.4	0.01	152
Presque Isle, Maine	93.0	48.2	10.2	1.43	76
Ithaca, New York	51.5	45.5	10.5	0.08	45

†A stirring number less than 120 is indicative of grain with sprout damage. The lower the number the higher the level of damage from pre-harvest sprouting. RVA data provided by Dr. Paul Schwarz, NDSU Plant Sciences.

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Stirring Number of Varieties Tested in Environments Showing Damage from PHS in 2016†

Variety	Chatham, MI	Presque Isle, ME	Fargo, ND
AAC Synergy	5	20	28
Bentley	5	43	29
Cerveza	5	4	20
Newdale	6	47	22
Pinnacle	78	43	128
ND Genesis	16	35	103
2ND28065	45	106	89
LCS Genie	179	105	126
Pioneer	67	110	151
KWS Fantex	131	89	154
Tradition	80	117	143

†RVA data provided by Dr. Paul Schwarz, NDSU Plant Sciences.

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Mean Malt Quality Across Entries for ESBN Locations, 2015-2017

Location	Plump	Protein	Extract	Wort protein	S/T	DP	Alpha-amylase	ß-glucan
	(%)	(%)	(%)	(%)	(%)	(°ASBC)	(20° DU)	(ppm)
Fargo, ND	88.2	11.4	81.4	6.30	55.7	122	76.2	149
Chatham, MI	94.2	10.9	81.5	4.65	43.0	87	60.4	358
Northeast MI	84.1	12.4	79.5	4.92	39.5	139	66.7	364
Hickory Corners, MI	91.0	11.8	80.8	5.05	42.2	115	69.6	143
Alburgh, VT	92.2	10.1	81.5	5.70	56.4	91	74.3	192
Orono, ME	94.1	9.3	82.4	5.03	54.9	95	77.3	365
Ithaca, NY	82.8	8.4	81.7	4.71	55.9	73	69.2	212
University Park, PA	87.4	11.1	81.4	5.62	50.9	108	67.1	233

†Malt quality data provided by Dr. Paul Schwarz, NDSU Plant Sciences.

Top Performing Two-rowed Varieties for Yield in Selected Locations (2015-2018)

Rank	Fargo, ND	Chatham, MI	Northeast MI	Hickory Corners, MI
1	Cerveza	AAC Synergy	AAC Synergy	AAC Synergy
2	Bentley	Explorer	Explorer	KWS Tinka
3	Conlon	Cerveza	Cerveza	2ND28065
4	AAC Synergy	Sirish	Bentley	Esma
5	Explorer	Conlon	ND Genesis	2ND33760

Top Performing Two-rowed Varieties for Resistance to Pre-harvest Sprouting in Selected Locations (2015-2018)

Rank	Fargo, ND	Chatham, MI	Northeast MI	Hickory Corners, MI
1	LCS Genie	Pinnacle	Pinnacle	2ND28065
2	Acorn	Explorer	Sirish	KWS Beckie
3	LCS Odyssey	LCS Genie	LCS Genie	Sirish
4	Sirish	2ND33760	ND Genesis	Acorn
5	KWS Fantex	2ND33757	Pinnacle	LCS Genie

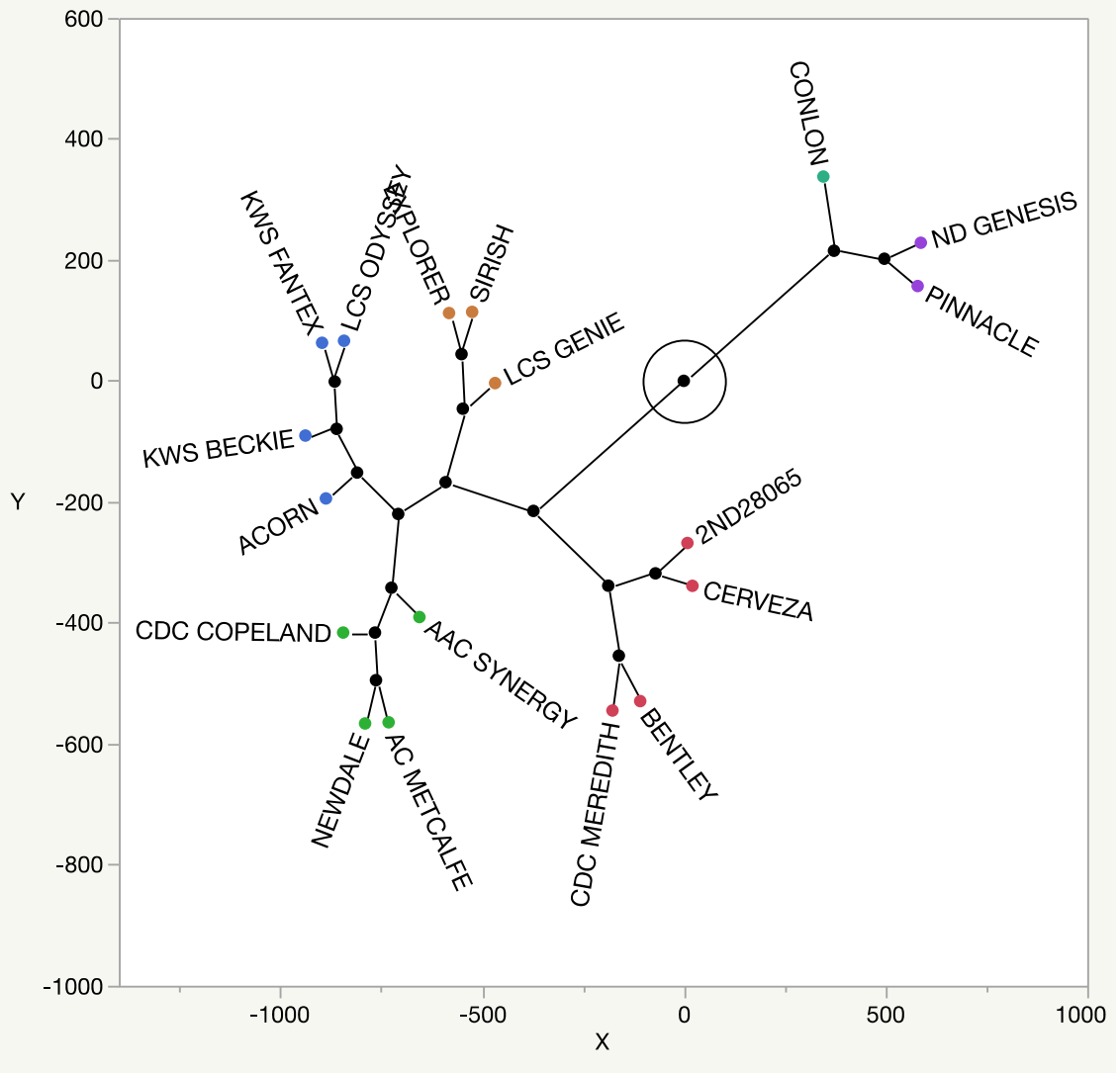
Top Performing Two-rowed Varieties for Malt Extract in Selected Locations (2015-2017)

Rank	Fargo, ND	Chatham, MI	Northeast MI	Hickory Corners, MI
1	Acorn	Acorn	Acorn	Acorn
2	KWS Fantex	Cerveza	LCS Odyssey	KWS Fantex
3	LCS Odyssey	KWS Fantex	KWS Fantex	LCS Genie
4	LCS Genie	KWS Beckie	LCS Genie	KWS Odyssey
5	Cerveza	LCS Odyssey	KWS Beckie	KWS Beckie

Top Performing Two-rowed Varieties for Wort ß-glucan in Selected Locations (2015-2017)

Rank	Fargo, ND	Chatham, MI	Northeast MI	Hickory Corners, MI
1	Explorer	Explorer	Explorer	Explorer
2	Sirish	Sirish	Sirish	Sirish
3	CDC Copeland	LCS Genie	CDC Copeland	AAC Synergy
4	AAC Synergy	CDC Copeland	KWS Beckie	LCS Genie
5	KWS Beckie	AAC Synergy	LCS Genie	KWS Beckie

Cluster Analysis Results for Chatham, MI Based on Agronomic and Malt Quality Traits



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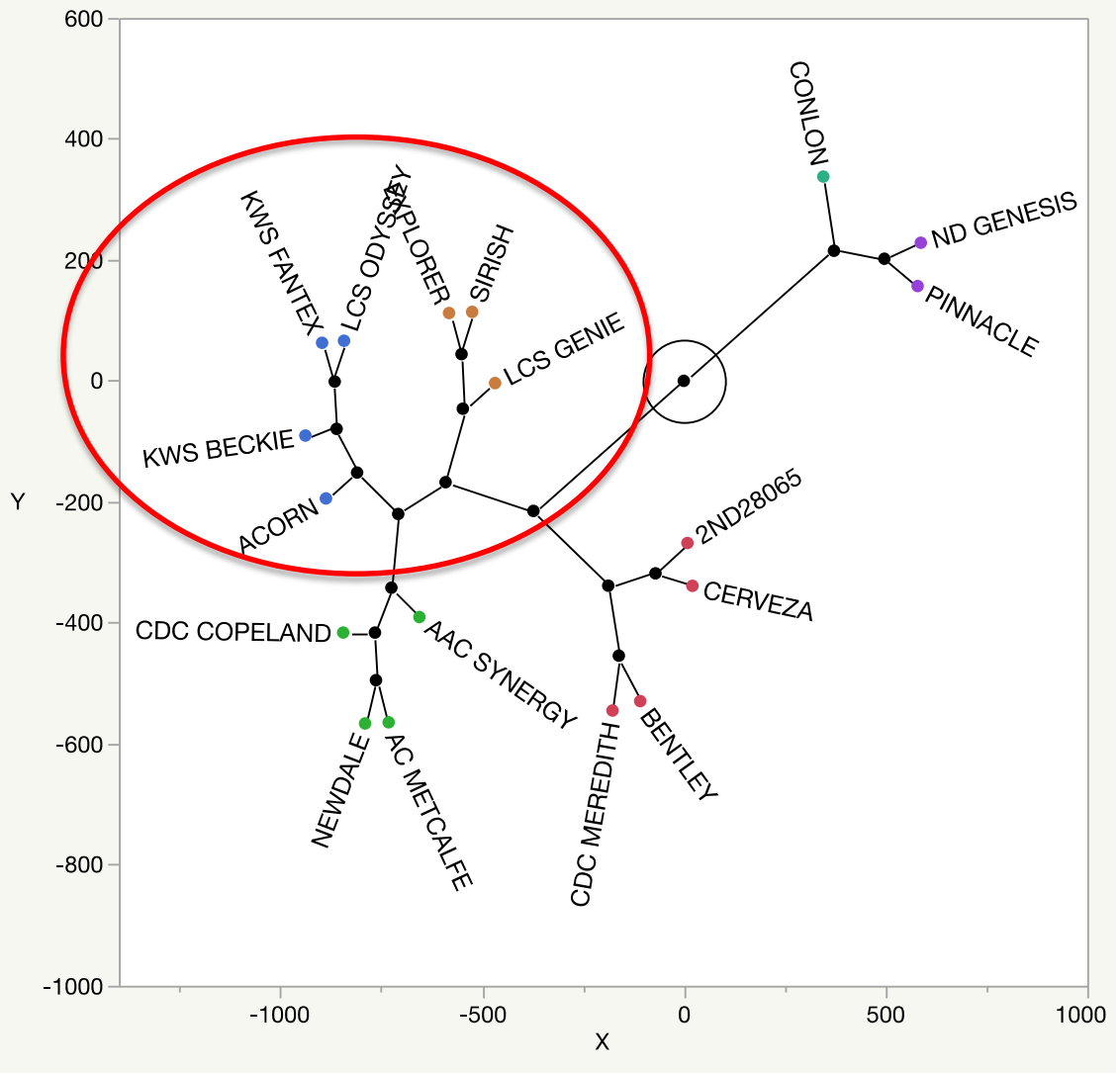
Cluster Analysis Results for Chatham, MI Based on Agronomic and Malt Quality Traits

Cluster	Yield	Test weight	Stirring number	Protein	Extract	Wort ß-glucan
1	69.9	47.2	97	10.8	81.7	352
2	74.3	48.9	93	10.9	81.3	260
3	68.3	48.5	123	10.2	82.4	277
4	71.0	48.9	136	10.7	81.7	232
5	77.5	49.1	62	11.6	81.2	525
6	65.5	51.9	134	10.3	81.5	513

Cluster Analysis Results for Chatham, MI Based on Agronomic and Malt Quality Traits



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Preferred Varieties Based on Cluster Analysis of Agronomic and Malt Quality Traits

Fargo, ND	Chatham, MI	Northeast MI	Hickory Corners, MI
Acorn	Explorer	Explorer	AAC Synergy
Explorer	LCS Genie	LCS Genie	Explorer
KWS Beckie	Sirish	Sirish	KWS Beckie
KWS Fantex	Acorn		LCS Genie
LCS Genie	KWS Beckie		LCS Odyssey
LCS Odyssey	KWS Fantex		Sirish
Sirish			

Conclusions

- No one barley variety has all of the qualities for low-risk production in the eastern half of the US.
- Pre-harvest sprouting resistance and low DON accumulation will be the major challenges to producing malting barley in the east.
- I believe with time we can find varieties that will work for local production.

Acknowledgements

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Any Questions?

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Yield Trials at Osnabrock, ND