Developing Michigan's Brewing Supply Chain

INDEPENDENT

★ BARLEY & MALT ★

Bringing Barley Back

- We have been growing barley in MI since 2018
- We are pilot malting our own barley
- We have Tepee in the ground in MI and OH
- We will be collaborating with regional brewers for brewing with our malts starting this summer
- We are planting European spring barley varieties in MI and Ontario this spring

Bringing Back Commercial-Scale Malting

What Makes Us Independent

- Raw material from our strategic partner, The Andersons
- Great Lakes marine transport
- Site in Litchfield, MI - small town MI
- Low-cost, low-carbon energy
- Water from the headwaters of five major Great Lakes rivers
- Strategic partnerships for technology and construction

- We are completing permitting and finance over the next couple months on our 64,600 tons per year facility

- Join us at upcoming Malt Mashups, field days, and groundbreaking in 2020

Vince Coonce
IB&M Director of Malting

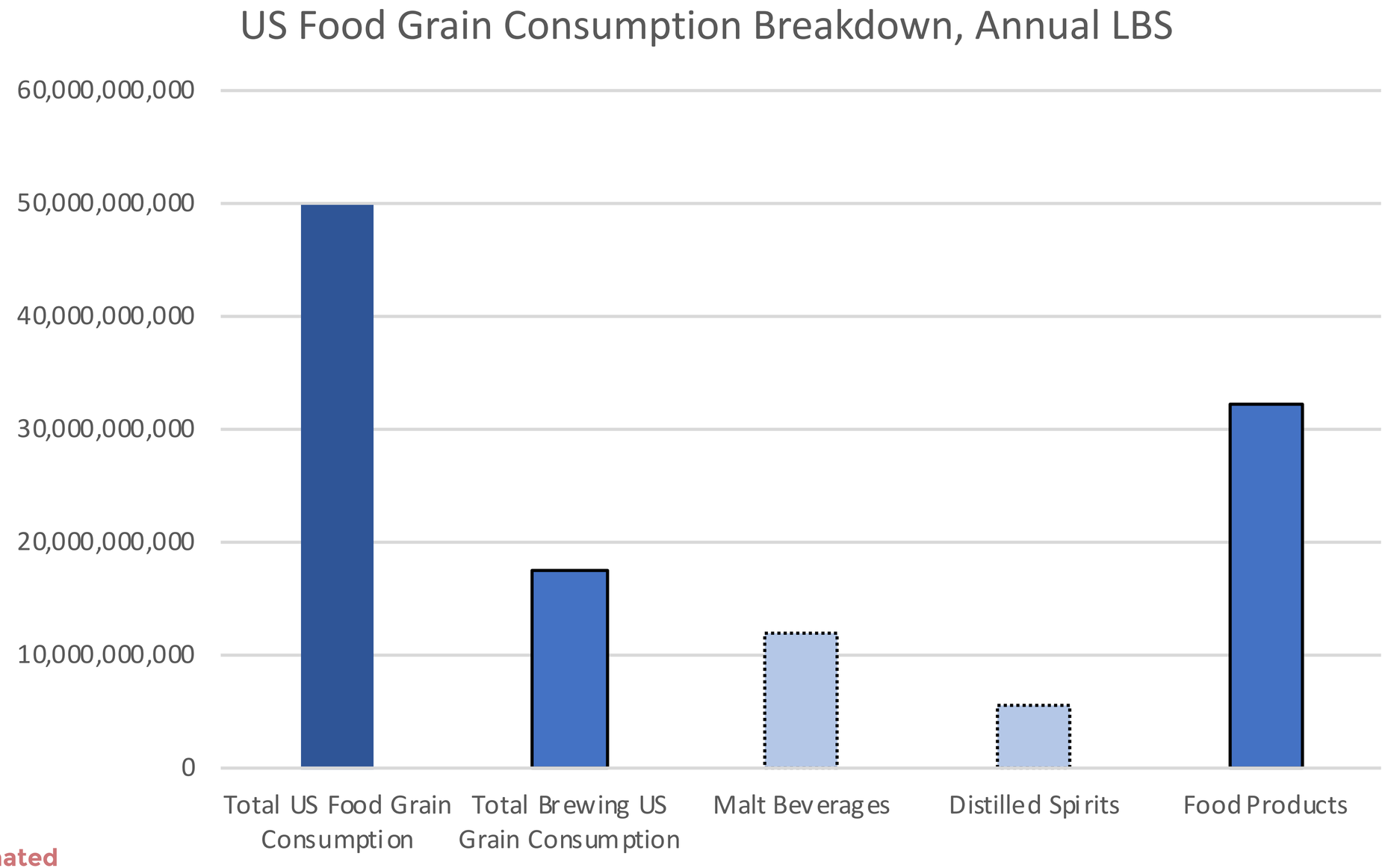
Previously Director of R&D and Chilton Plant Manager at Briess
Cargill, Great Western, Ladish Malt, and MillerCoors

Over 30 years of technical and management experience in malting and brewing, engineering, production management, research and development

IB&M Responsibilities

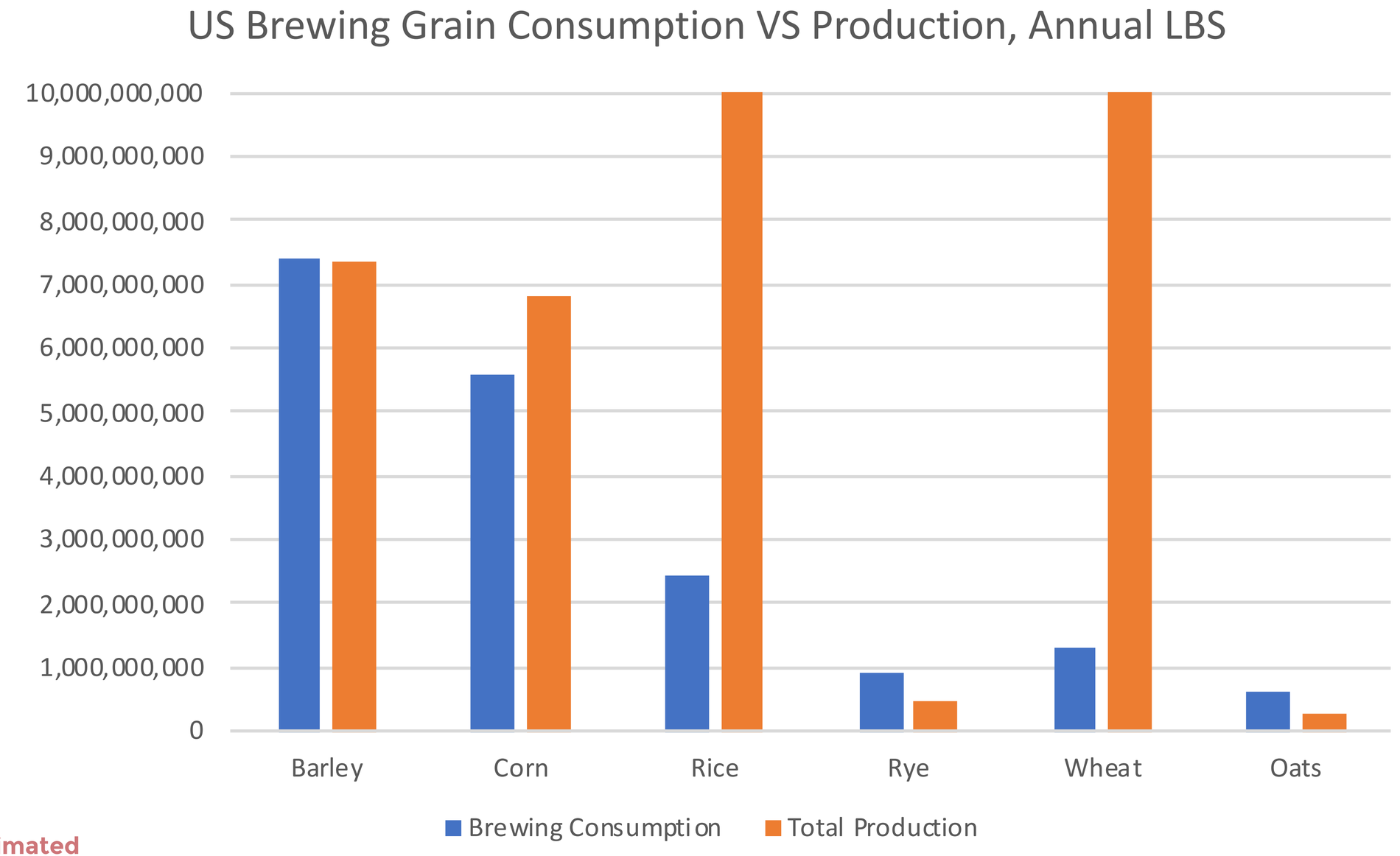
- Plant design including malting, roasting, flaking, and packaging
- Product R&D and quality
- Plant operations
- Varietal selection and breeding
- Custom crafted products
- Analytics

Brewing Grains Significant in Food Demand



Estimated

Brewing Usage by Grain Breakdown



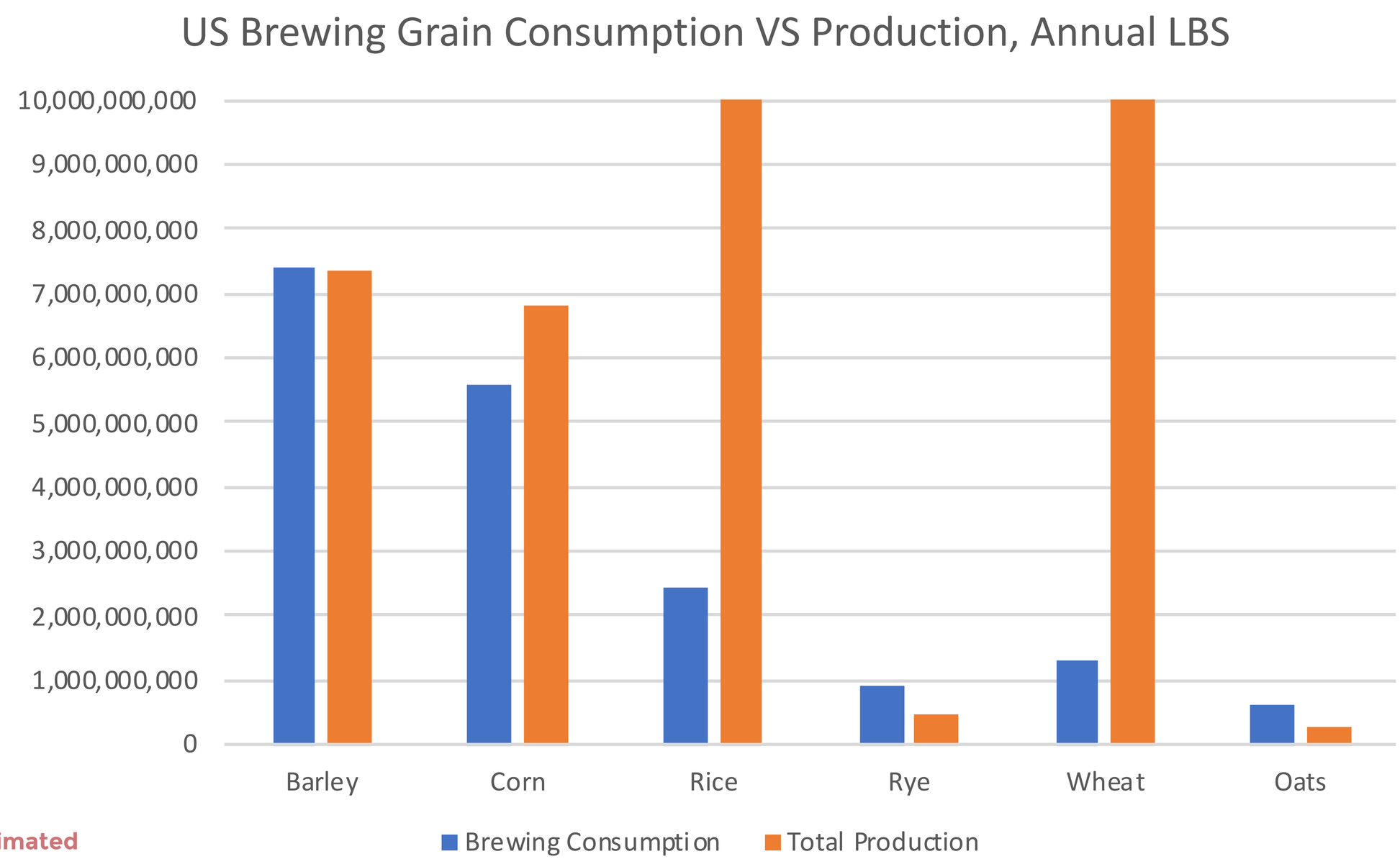
Estimated

Corn and Rice in Beer?

An example of how low Extract indirectly effects beer quality

Brewed with
no Corn Syrup.

Brewing Usage by Grain Breakdown



Estimated

Potential Brewing Grain Market

	US Nation	IB&M Demand	MI Acres	2018 MI Planted Acres
		Michigan Potential		
Barley	7,412,720,000	109,000,000	28,385	5,000
Corn	5,570,030,345	4,000,000	461	1,940,000
Rice	2,430,400,000			
Rye	917,238,621	8,000,000	5,714	Not Published
Wheat	1,287,637,241	16,000,000	3,509	510,000
Oats	607,600,000	4,000,000	1,984	75,000
		Total Potential Acres	**40,053**	**2,525,000**

Estimated

Premiums are Paid for Brewing Quality Grains

Brewing Market Considerations

- Quality/Price are primary
- “Locally Produced” must also meet quality
- Opportunity to exceed current quality standards
- Highest quality product = super premium
- Unique, local, branding (terroir)

MI Brewing Grain Agronomics

- MI climate is NOT ideal - relative short growing season
- Wet weather near flowering and harvest - mycotoxins, staining, pre-harvest sprout
- Harsh and erratic winters - winter kill in winter crops

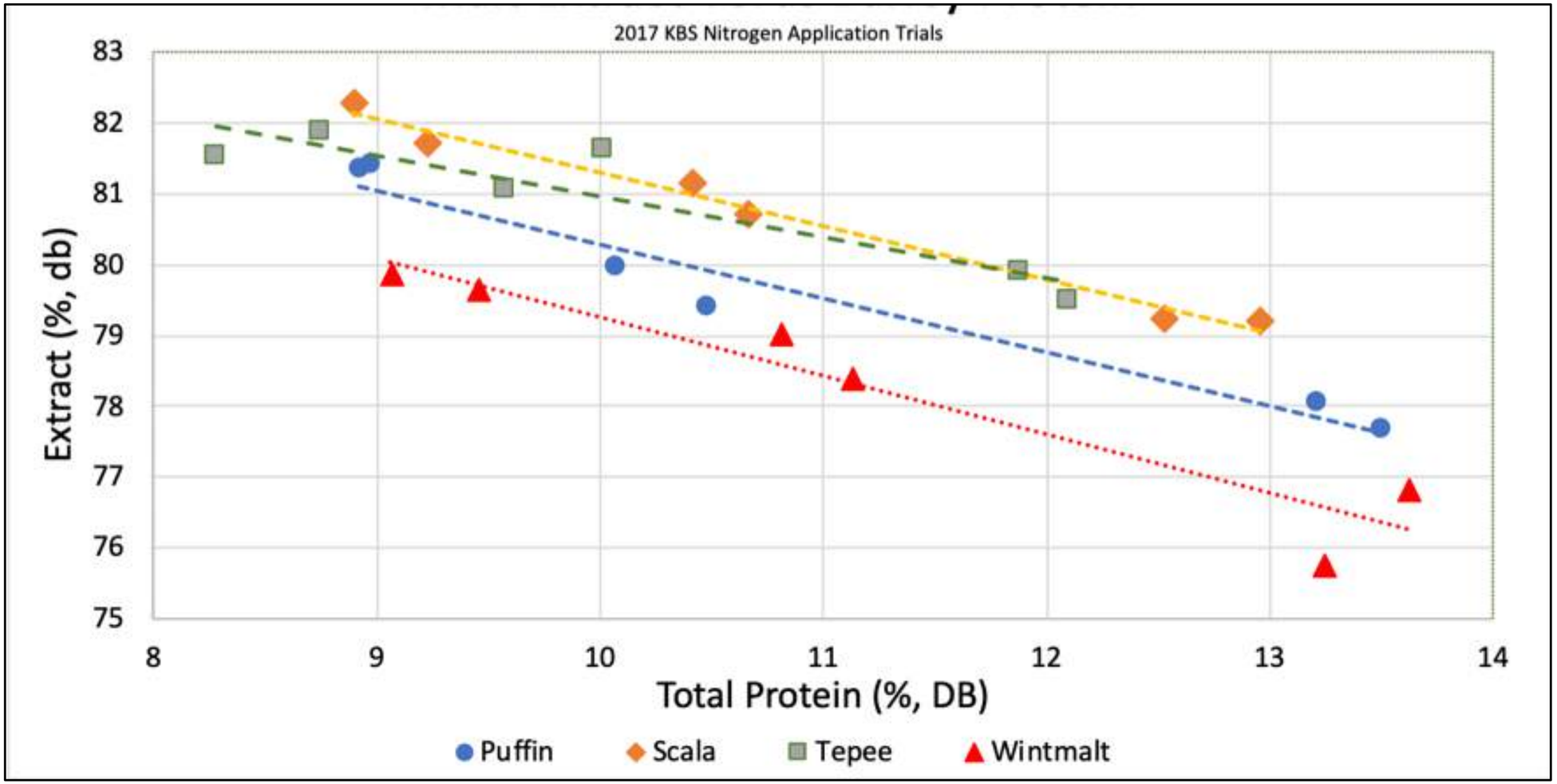
Select only from grain varieties proven successful in MI

Important Brewing Grain Quality Targets

- Protein
  - Lower Protein is higher quality
  - Easily measured on raw grain
  - First step in brewing varietal acceptance
- Plump
  - Higher plump is higher quality
  - Easily measured on raw grain
  - First step in brewing varietal acceptance

Use Protein and Plump for Initial Screening

Important Brewing Metric: Protein



Grain variety selection AND optimized ag practices critical

Lower Protein = Higher Quality

Variety is Super Important

The Farmer has Control of Quality

Reporting Protein Measurements

Brewing Industry: total Protein dry-basis

- Food grain Industry: total Protein as-is
  Includes standard moisture correction

- NIR

10% Protein db = 8.8% Protein as-is corrected to 12% moisture

- It is critical to define protein % basis in publications

- Include measurement basis in reporting Protein

Quality Targets

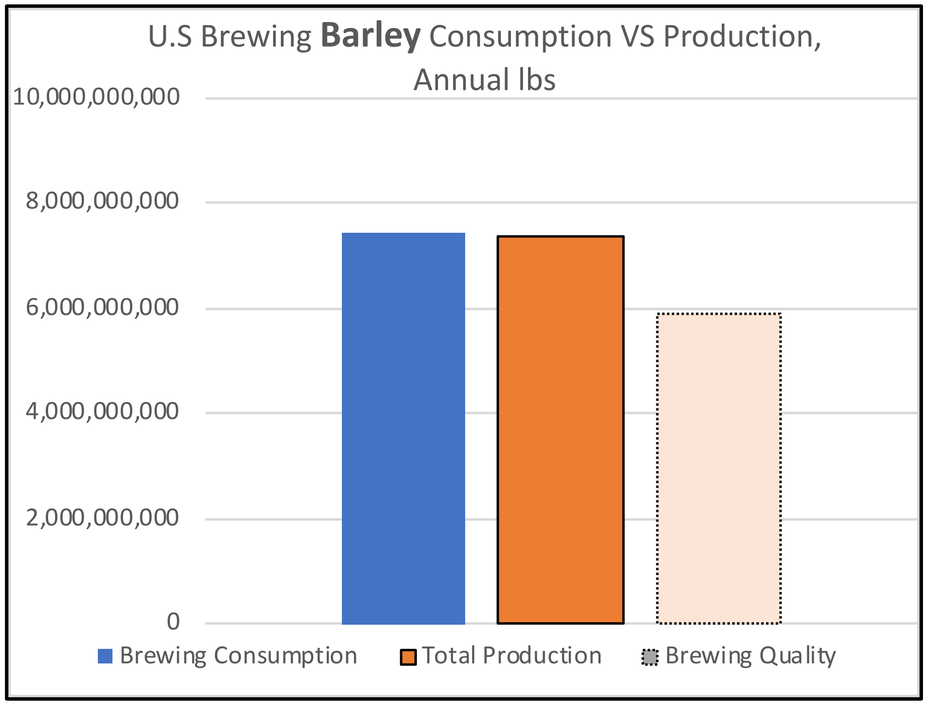
MALT Quality Targets

- Plump
- Extract
- Friability
- Diastatic Power
- Free Amino Nitrogen
- ß-Glucan
- Turbidity
- Viscosity
- Product Sensory Characteristics

ADJUNCT Quality Targets

- Cereal Extract
- Spirit Yield Potential
- Millability
- Product Sensory Characteristics

Barley



- The US supplies ~75% of demand
- ~100% grown for brew use (almost entirely malt)
- Significant US production > 7B lbs
  - Brewing quality targets well established
  - Significant R&D
- Major imports from CAN
- CAN is global barley exporter
  - With $ exchange CAN barley sets US market price
- CAN barley possesses very good brew quality

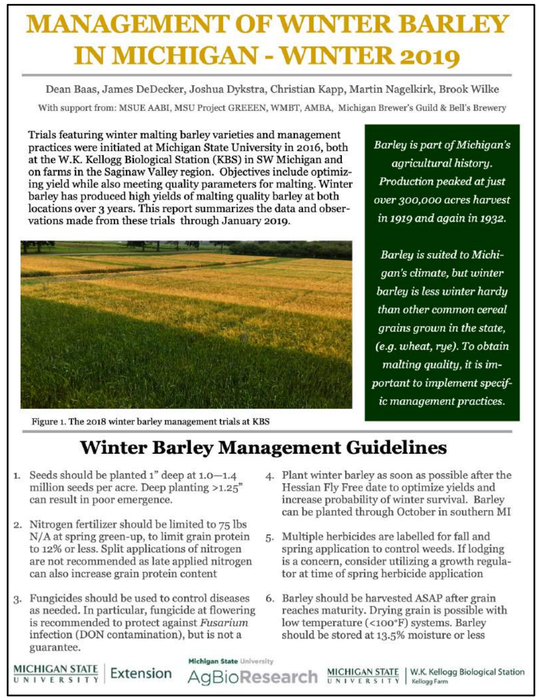
Brewing quality acceptability is < 80%

- Acceptability improvement choosing best agronomic and quality performance and optimal farming practices

What to do with unacceptable quality barley?

- Develop alternative outlet for unacceptable quality barley

MI Barley Agronomics and Barley Quality



MANAGEMENT OF WINTER BARLEY IN MICHIGAN - WINTER 2019

Dean Baas, James DeDecker, Joshua Dykstra, Christian Kapp, Martin Nagelkirk, Brook Wilke

With support from: MSUE AABI, MSU Project GREEEN, WMBT, AMBA, Michigan Brewer's Guild & Bell's Brewery

Trials featuring winter malting barley varieties and management practices were initiated at Michigan State University in 2016, both at the W.K. Kellogg Biological Station (KBS) in SW Michigan and on farms in the Saginaw Valley region. Objectives include optimizing yield while also meeting quality parameters for malting. Winter barley has produced high yields of malting quality barley at both locations over 3 years. This report summarizes the data and observations made from these trials through January 2019.

Barley is part of Michigan's agricultural history. Production peaked at just over 300,000 acres harvest in 1919 and again in 1932.

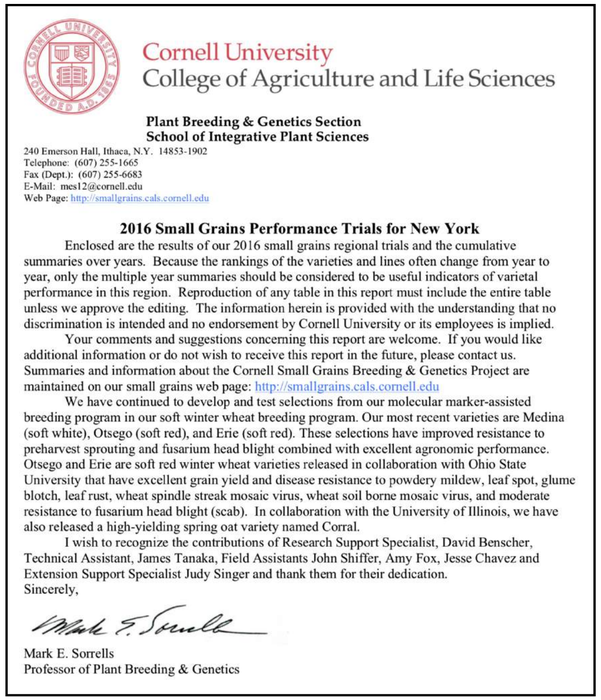
Barley is suited to Michigan's climate, but winter barley is less winter hardy than other common cereal grains grown in the state, (e.g. wheat, rye). To obtain malting quality, it is important to implement specific management practices.

Figure 1. The 2018 winter barley management trials at KBS

Winter Barley Management Guidelines

1. Seeds should be planted 1" deep at 1.0—1.4 million seeds per acre. Deep planting >1.25" can result in poor emergence.
2. Nitrogen fertilizer should be limited to 75 lbs N/A at spring green-up, to limit grain protein to 12% or less. Split applications of nitrogen are not recommended as late applied nitrogen can also increase grain protein content
3. Fungicides should be used to control diseases as needed. In particular, fungicide at flowering is recommended to protect against *Fusarium* infection (DON contamination), but is not a guarantee.
4. Plant winter barley as soon as possible after the Hessian Fly Free date to optimize yields and increase probability of winter survival. Barley can be planted through October in southern MI
5. Multiple herbicides are labelled for fall and spring application to control weeds. If lodging is a concern, consider utilizing a growth regulator at time of spring herbicide application
6. Barley should be harvested ASAP after grain reaches maturity. Drying grain is possible with low temperature (<100°F) systems. Barley should be stored at 13.5% moisture or less

MICHIGAN STATE UNIVERSITY | Extension | Michigan State University AgBioResearch | MICHIGAN STATE UNIVERSITY | W.K. Kellogg Biological Station Kellogg Farm



Cornell University
College of Agriculture and Life Sciences

Plant Breeding & Genetics Section
School of Integrative Plant Sciences

240 Emerson Hall, Ithaca, N.Y. 14853-1902
Telephone: (607) 255-1665
Fax (Dept.): (607) 255-6683
E-Mail: mes12@cornell.edu
Web Page: http://smallgrains.cals.cornell.edu

2016 Small Grains Performance Trials for New York

Enclosed are the results of our 2016 small grains regional trials and the cumulative summaries over years. Because the rankings of the varieties and lines often change from year to year, only the multiple year summaries should be considered to be useful indicators of varietal performance in this region. Reproduction of any table in this report must include the entire table unless we approve the editing. The information herein is provided with the understanding that no discrimination is intended and no endorsement by Cornell University or its employees is implied.

Your comments and suggestions concerning this report are welcome. If you would like additional information or do not wish to receive this report in the future, please contact us. Summaries and information about the Cornell Small Grains Breeding & Genetics Project are maintained on our small grains web page: http://smallgrains.cals.cornell.edu

We have continued to develop and test selections from our molecular marker-assisted breeding program in our soft winter wheat breeding program. Our most recent varieties are Medina (soft white), Otsego (soft red), and Erie (soft red). These selections have improved resistance to preharvest sprouting and fusarium head blight combined with excellent agronomic performance. Otsego and Erie are soft red winter wheat varieties released in collaboration with Ohio State University that have excellent grain yield and disease resistance to powdery mildew, leaf spot, glume blotch, leaf rust, wheat spindle streak mosaic virus, wheat soil borne mosaic virus, and moderate resistance to fusarium head blight (scab). In collaboration with the University of Illinois, we have also released a high-yielding spring oat variety named Corral.

I wish to recognize the contributions of Research Support Specialist, David Benscher, Technical Assistant, James Tanaka, Field Assistants John Shiffer, Amy Fox, Jesse Chavez and Extension Support Specialist Judy Singer and thank them for their dedication.

Sincerely,

Mark E. Sorrells
Professor of Plant Breeding & Genetics

- Cornell published
- Multiple years
- 2-row spring/winter varieties
- Yield
- Winter survival %
- Pre-Harvest Sprout Score
- Fusarium Resistance Index
- Malting quality data

- MSU published
- Multiple years
- 2-row spring/winter varieties
- 4 different MI nurseries
- Yield
- Pre-harvest sprout
- Malting quality data

Ag data vast but # varieties studied limited

Ag Brewing Quality Top Performers

Spring Barley Top Performers

	Malt Quality	Ag Performance
Josie	3	7
Fantex	4	5
Tinka	4	1
Odyssey	8	17
Beckie	10	6
Genie	15	2

MSU Top Winter Performers

	Malt Quality	Ag Performance
Lyberac	1	8
Flavia	2	6
Puffin	4	10
Wintmalt	6	9
Thoroughbred	7	2
Hirondella	8	3

Cornell Data

	Malt Quality	Ag Performance
DH131738	2	6
Doneau	3	9
Calypso	3	1
Flavia	5	10
KWS Scala	6	10
SY Tepee	7	8

Winter vs Spring 2-Row Comparison

	BU WT	Yield	RVA	Plump	Extract	Protein	S/T	DP	æ-Amyl	ß-Glucan	FAN
Lyberac	50	135	147	88.1	78.6	11.53005	36.6	181	45.9	49	141
Flavia	49	151	142	95.2	78.3	11.53846	35.1	145	37.8	114	116
Tinka	47.1	51.7	163	98.4	82	10.8	37.9	108	50.6	77	181

Malt Quality Fingerprint

Variety	Plump	Friability	Ext	DP	ß-Glucan	FAN
2ND28065	93.1	84.4	81.2	122	115	251
2ND33710	83.7	78.8	79.5	146	86	252
2ND33757	95.3	72	80.1	110	321	187
2ND33760	95.5	84.2	81.7	91	205	196
2ND33821	93.2	78.9	81	86	255	191
Synergy	71.6	76.4	79.8	137	196	209
Acorn	76.8	76.3	80.2	135	219	239
Bettina	96.8	79.9	81	147	76	232
Conlon	96.9	86.7	81.7	100	121	202
Esma	77.3	82.6	81.1	88	143	189
Explorer	98.7	91.6	81.4	114	40	227
Beckie	95.2	91.7	80.7	105	19	222
Fantex	98.9	85.3	82.4	101	135	196
Josie	96.9	85.6	81.3	115	153	213
Tinka	98.4	91.4	82	108	77	181
Genie	95.9	80.1	81.5	107	95	219
Odyssey	96.4	88	81	126	26	247

Low
Medium
High

Source: 2017 MSU Spring Barley Trials

Beer Style	Plump	Friability	Ext	DP	ß-Glucan	FAN
Pilsner						
Domestic Lager						

Continuing MI Barley Research

Role of Planting Date and Seeding Rate in Optimizing Winter Survival, Yield, and Quality of Malting Barley: *Maninder Singh*

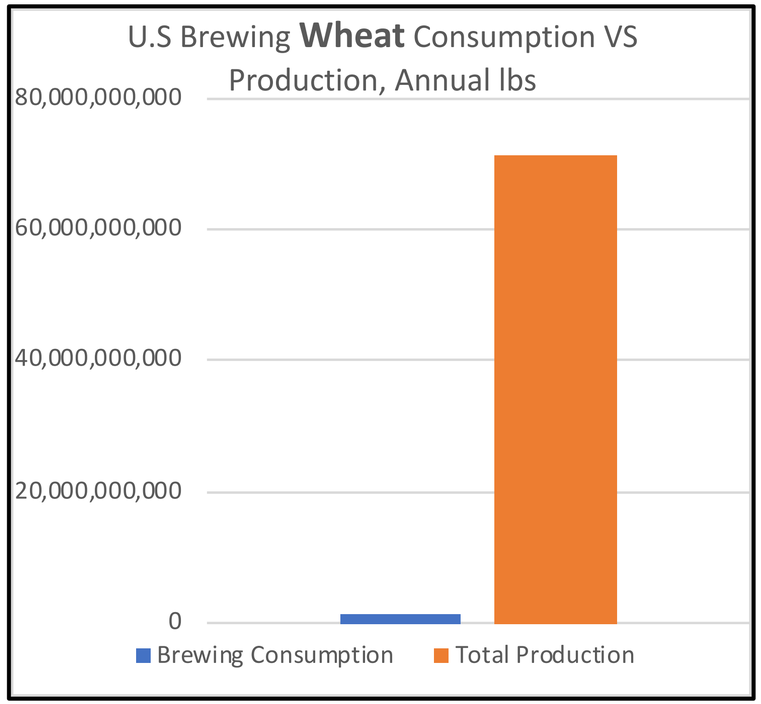
Optimizing Fungicide Inputs for Disease Management in Barley and Hop: *Dr. Martin Chilvers, Tim Miles*

Investigating Winter Hardiness to Advance Winter Malting Barley as Climate Adaptation Strategy in MI: *Dr. James Dedecker*

Recommended Further Work

Improve Extract in Winter varieties
and Yield in Spring varieties

Wheat



- Brewer's wheat used in beer production and distilled products
- Most US what used in baking (targeting high Protein)
- Use in brewing is minute vs use in food
  - Brewing quality targets well established globally
  - Little US R&D for brewing qualities

- Brewing not mentioned under uses
- NA most red wheat malt from CAN Hard Red Spring Wheat
- Germany malts produced from Soft Winter Wheats
- Soft Winter Wheats (red and white) produce best malt qualities

Class	2018 Prod (Bushels)	Location Produced	Uses
Hard Red Winter	661 million	Great Plains (TX to MT)	Bread Flour
Hard Red Spring	583 million	Northern Plains (ND, MT, MN, SD)	High Protein Blending
Soft Red Winter	292 million	Eastern States	Cakes Cookies Crackers
White	267 million	WA, OR, ID, MI, NY	Flour for noodles Crackers Cereals
Durum	73 million	ND, MT	Pasta

Source: Agricultural Marketing Resource Center 2/18/20

MI Wheat Variety Ag Performance Available

- Over 100 different varieties
- 6 different nurseries
- 2-year, 3-year, 4-year avg Yield performance
- Test Weight
- Fusarium Resistance (index)
- Baking quality data

- Top 20 Yield performance
- Median to superior Test Weight
- Median to superior Fusarium Resistance

Entry	Variety Name	Color	Company
6	AgriMAXX 485	Red	AgriMAXX Wheat Company
31	Dyna-Gro 9362W	White	Dyna-Gro Seed
37	Dyna-Gro WX17775	Red	Dyna-Gro Seed
43	HS EX 18R	Red	Harrington Seeds Inc.
45	HS EX 20W	White	Harrington Seeds Inc.
47	ISF 718	Red	Irrer Seed Farm
49	L11639	Red	Irrer Seed Farm
59	Kokosing	Red	MI Corp Improve-ment Assoc
81	MI14R0011	Red	MSU
85	MI14W0190	White	MSU
102	SY 912	White	Syngenta - AgriPro
107	W 304	Red	Wellman Seeds Inc.

Will Any Top Ag Performers Produce High Quality Wheat Malt?

Pilot Malting

Malthouse Yield (%)

Sample	Sample ID	Yield
1	HS EX 18R	84
2	MI14W0190	84
3	AgriMAXX 485	79
4	SY 912	82
5	ISF 718	81
6	MI14R0011	84
7	L11639	84
8	Kokosing	86
9	HS EX 20W	81
10	Dyna-Gro WX17775	83
11	W 304	83
12	Dyna-Gro 9362W	84

Blotter Germination

Sample	Sample ID	48-HR	72-HR
1	HS EX 18R	94	97
2	MI14W0190	98	99
3	AgriMAXX 485	98	99
4	SY 912	97	100
5	ISF 718	98	100
6	MI14R0011	98	100
7	L11639		98
8	Kokosing	94	100
9	HS EX 20W	99	99
10	Dyna-Gro WX17775	94	94
11	W 304	98	100
12	Dyna-Gro 9362W	98	99

Pilot Malting

HARTWICK COLLEGE | Center for Craft Food & Beverage

Company: Michigan State University
Date: July 5, 2019

LAB ID	Description	Moisture	Friability	PUG	WUG	FEDB	CEDB	F-C Diff	Color	β-glucan	Viscosity	Soluble Protein	Total Protein	S/T	FAN	DP	α-amylase	Filtration	Visual Clarity	A(700)	pH	Plump	>7/64	>6/64	>5/64	<5/64	Test Weight
		%	%	%	%	%	%	%	°SRM	mg/L	cps	%	%	%	mg/L	°L	D.U.	Time					%	%	%	%	lb/bu
ML-19-1539	# 71369	5.9	96.7	0.0	0.0	81.0	79.1	1.9	2.62	74	1.60	5.37	14.5	37	127	147	46.7	normal	clear	0.009	6.16	90.9	46.6	44.3	8.6	0.5	42.3
ML-19-1540	# 8SING	5.7	86.5	0.0	0.0	81.3	79.3	2.0	2.86	75	1.62	5.56	14.6	38.1	126	210	49.2	normal	clear	0.013	6.18	98.4	79.5	18.9	1.4	0.2	43.6
ML-19-1543	# 11304	5.6	96.3	0.0	0.0	81.8	80.7	1.1	3.25	73	1.47	5.77	12.8	45.1	158	153	63.4	normal	clear	0.018	6.18	88.4	45.0	43.4	10.5	1.1	40.2
ML-19-1544	# 12362W	6.0	90.6	0.2	0.1	83.4	81.8	1.6	2.76	73	1.62	5.19	13.2	39.3	130	142	48.9	normal	clear	0.016	6.29	88.6	44.9	43.7	10.7	0.7	43.0
ML-19-1545	# 118R	6.9	64.3	2.3	1.1	80.9	79.8	1.1	3.58	72	1.51	6.11	13.0	47	143	178	54.6	normal	clear	0.017	6.19	86.7	37.6	49.1	11.9	1.4	43.2
ML-19-1546	# 20190	6.8	64.8	1.4	0.7	80.3	78.1	2.2	3.42	74	1.51	6.29	14.5	43.4	148	239	62.1	normal	clear	0.015	6.24	91	59.5	31.5	7.9	1.1	42.1
ML-19-1547	# 3485	5.8	58.1	1.8	0.9	79.3	77.2	2.1	3.64	70	1.46	6.03	14.1	42.8	151	176	59.1	normal	clear	0.018	6.14	83.7	33.9	49.8	14.8	1.5	37.5
ML-19-1548	# 4912	5.8	66.1	2.8	0.7	80.4	79.2	1.2	2.96	74	1.55	5.77	14.3	40.3	143	176	53.9	normal	clear	0.019	6.17	90	42.9	47.1	9.2	0.8	38.7
ML-19-1549	# 5718	5.3	85.3	0.1	0.1	79.0	74.4	4.6	3.47	73	1.58	5.4	14.5	37.2	120	161	50.1	normal	clear	0.016	6.26	90.5	45.7	44.8	9.0	0.5	41.0
ML-19-1550	# 60011	5.8	53.4	8.4	2.8	80.0	75.9	4.1	3.15	77	1.80	5.24	13.6	38.5	111	226	45.3	normal	clear	0.014	6.29	92.7	50.1	42.6	7.0	0.4	42.6
ML-19-1541	# 920W	5.6	83.3	0.0	0.0	80.0	78.6	1.4	3.11	75	1.55	6.17	13.8	44.7	151	171	63.7	normal	clear	0.013	6.16	86.7	43.2	43.5	12.1	1.2	39.6
ML-19-1542	# 10775	6.1	88.3	0.0	0.0	80.1	77.5	2.6	3.75	72	1.53	6.32	14.3	44.2	164	167	60.1	normal	clear	0.017	6.19	90.6	50.8	39.8	8.8	0.7	39.1

Wheat Malt Analysis Results

Fria %	PUG %	WUG %	FEDB %	CEBD %	DIFF %	COLOR SRM	VISC cps	SOL PROT %	Total PROT %	S/T %	FAN mg/L	DP L	Plump	>7/64 %	Test Wt LB/BU	Sample ID
96.7	0.0	0.0	81.0	79.1	1.9	2.62	1.60	5.37	14.5	37	127	147	90.9	46.6	42.3	L11639
86.5	0.0	0.0	81.3	79.3	2.0	2.86	1.62	5.56	14.6	38.1	126	210	98.4	79.5	43.6	Kokosing
96.3	0.0	0.0	81.8	80.7	1.1	3.25	1.47	5.77	12.8	45.1	158	153	88.4	45.0	40.2	W 304
90.6	0.2	0.1	83.4	81.8	1.6	2.76	1.62	5.19	13.2	39.3	130	142	88.6	44.9	43.0	Dyna-Gro 9362W
64.3	2.3	1.1	80.9	79.8	1.1	3.58	1.51	6.11	13.0	47	143	178	86.7	37.6	43.2	HS EX 18R
64.8	1.4	0.7	80.3	78.1	2.2	3.42	1.51	6.29	14.5	43.4	148	239	91	59.5	42.1	MI14W0190
58.1	1.8	0.9	79.3	77.2	2.1	3.64	1.46	6.03	14.1	42.8	151	176	83.7	33.9	37.5	AgriMAXX 485
66.1	2.8	0.7	80.4	79.2	1.2	2.96	1.55	5.77	14.3	40.3	143	176	90	42.9	38.7	SY 912
85.3	0.1	0.1	79.0	74.4	4.6	3.47	1.58	5.4	14.5	37.2	120	161	90.5	45.7	41.0	ISF 718
53.4	8.4	2.8	80.0	75.9	4.1	3.15	1.80	5.24	13.6	38.5	111	226	92.7	50.1	42.6	MI14R0011
83.3	0.0	0.0	80.0	78.6	1.4	3.11	1.55	6.17	13.8	44.7	151	171	86.7	43.2	39.6	HS EX 20W
88.3	0.0	0.0	80.1	77.5	2.6	3.75	1.53	6.32	14.3	44.2	164	167	90.6	50.8	39.1	Dyna-Gro WX17775

- No Extracts (FGDB) acceptable for wheat malt
- All Proteins high for winter wheat

Extract will increase as wheat protein is reduced

Is There Fertilizer Protocol to Reduce Protein and Increase Extract?

Can We Do It Losing Yields?

Wheat Malt Analysis Results

Fria %	PUG %	WUG %	FEDB %	CEBD %	DIFF %	COLOR SRM	VISC cps	SOL PROT %	Total PROT %	S/T %	FAN mg/L	DP L	Plump	>7/64 %	Test Wt LB/BU	Sample ID
96.7	0.0	0.0	81.0	79.1	1.9	2.62	1.60	5.37	14.5	37	127	147	90.9	46.6	42.3	L11639
86.5	0.0	0.0	81.3	79.3	2.0	2.86	1.62	5.56	14.6	38.1	126	210	98.4	79.5	43.6	Kokosing
96.3	0.0	0.0	81.8	80.7	1.1	3.25	1.47	5.77	12.8	45.1	158	153	88.4	45.0	40.2	W 304
90.6	0.2	0.1	83.4	81.8	1.6	2.76	1.62	5.19	13.2	39.3	130	142	88.6	44.9	43.0	Dyna-Gro 9362W
64.3	2.3	1.1	80.9	79.8	1.1	3.58	1.51	6.11	13.0	47	143	178	86.7	37.6	43.2	HS EX 18R
64.8	1.4	0.7	80.3	78.1	2.2	3.42	1.51	6.29	14.5	43.4	148	239	91	59.5	42.1	MI14W0190
58.1	1.8	0.9	79.3	77.2	2.1	3.64	1.46	6.03	14.1	42.8	151	176	83.7	33.9	37.5	AgriMAXX 485
66.1	2.8	0.7	80.4	79.2	1.2	2.96	1.55	5.77	14.3	40.3	143	176	90	42.9	38.7	SY 912
85.3	0.1	0.1	79.0	74.4	4.6	3.47	1.58	5.4	14.5	37.2	120	161	90.5	45.7	41.0	ISF 718
53.4	8.4	2.8	80.0	75.9	4.1	3.15	1.80	5.24	13.6	38.5	111	226	92.7	50.1	42.6	MI14R0011
83.3	0.0	0.0	80.0	78.6	1.4	3.11	1.55	6.17	13.8	44.7	151	171	86.7	43.2	39.6	HS EX 20W
88.3	0.0	0.0	80.1	77.5	2.6	3.75	1.53	6.32	14.3	44.2	164	167	90.6	50.8	39.1	Dyna-Gro WX17775

- Friability and Viscosity values are exceptional
- Kokosing Plumpness is exceptional

What Happens to other Malt Analytical Qualities as Wheat Protein is Reduced?

Continuing MI Brewing Wheat Research

Michigan Department of Agriculture & Rural Development

COVER SHEET
Research Proposal
Fiscal 2019 Funding
Project Activity Dates – May 1 - December 31, 2019

PROPOSALS DUE:
February 26, 2019, 3:00 p.m.
MSU Sponsor Code: 106187

Principal Investigator : Dennis Pennington

Proposal Title: Variety Selection and Agronomy Practices for Soft Winter Wheat Malting

Collaborators: Dr. Eric Olson, Vince Coonce

Mailing Address: 1066 Bogue Street, East Lansing, MI 48824

Email: pennin34@msu.edu

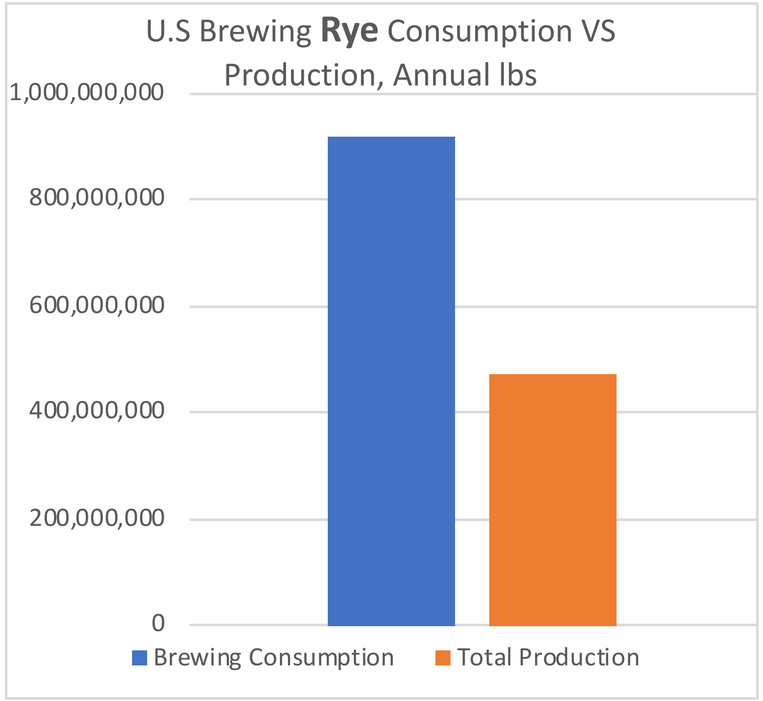
Phone #: 269-832-0497

Type of Project (check one)	Program Area (check all that apply)	Money and Duration of Project
New FY19 Proposal √	Beer √ Wine ☐ Spirits ☐ Hard Cider ☐	Growing season/year the project started or will start: September 2019 Growing season/year the project will be completed: August 2020
Continuation of Project funded by other sources ☐	Consumer and Market Research ☐	Money requested for FY19 only (max $50,000): $50,000
	Other ☐ Describe:	Total Estimated Cost of Project (if multi-year):

Fria %	PUG %	WUG %	FEDB %	DIFF %	COLOR SRM	VISC cps	SOL PROT %	Total PROT %	S/T %	FAN mg/L	DP L	Plump	>7/64 %	Test Wt LB/BU	Sample ID
96.7	0.0	0.0	81.0	1.9	2.62	1.60	5.37	14.5	37	127	147	90.9	46.6	42.3	L11639
86.5	0.0	0.0	81.3	2.0	2.86	1.62	5.56	14.6	38.1	126	210	98.4	79.5	43.6	Kokosing
96.3	0.0	0.0	81.8	1.1	3.25	1.47	5.77	12.8	45.1	158	153	88.4	45.0	40.2	W 304
90.6	0.2	0.1	83.4	1.6	2.76	1.62	5.19	13.2	39.3	130	142	88.6	44.9	43.0	Dyna-Gro 9362W
64.3	2.3	1.1	80.9	1.1	3.58	1.51	6.11	13.0	47	143	178	86.7	37.6	43.2	HS EX 18R
64.8	1.4	0.7	80.3	2.2	3.42	1.51	6.29	14.5	43.4	148	239	91	59.5	42.1	MI14W0190
58.1	1.8	0.9	79.3	2.1	3.64	1.46	6.03	14.1	42.8	151	176	83.7	33.9	37.5	AgriMAXX 485
66.1	2.8	0.7	80.4	1.2	2.96	1.55	5.77	14.3	40.3	143	176	90	42.9	38.7	SY 912
85.3	0.1	0.1	79.0	4.6	3.47	1.58	5.4	14.5	37.2	120	161	90.5	45.7	41.0	ISF 718
53.4	8.4	2.8	80.0	4.1	3.15	1.80	5.24	13.6	38.5	111	226	92.7	50.1	42.6	MI14R0011
83.3	0.0	0.0	80.0	1.4	3.11	1.55	6.17	13.8	44.7	151	171	86.7	43.2	39.6	HS EX 20W
88.3	0.0	0.0	80.1	2.6	3.75	1.53	6.32	14.3	44.2	164	167	90.6	50.8	39.1	Dyna-Gro WX17775

- Select top 4 brewing quality varieties
- Fertilizer treatments combo of 4 levels nitrogen and 2 levels potassium
- Grow test plots to harvest
- Measure Yield
- Pilot malt all samples
- Measure malt qualities

Rye



- Brewing rye used in production of beer and distilled products - lends a unique spicy flavor character
- Most US grain rye is used as animal feed (60%)
- ~40% is used in rye bread
- Highest rye Protein is not best for baking (low in gluten)
- Most rye imports from CAN and Germany
- Brassetto and Hazlet produced highest quality rye malt - super plump

NDSU Hettinger Research Extension Center

NDSU Carrington Research Extension Center
2019 Variety Trial Data

Winter Rye — **Carrington**

Variety	Winter Survival	Vigor	Early Plant Height	Jday of Heading	Plant Lodge	Plant Height	1000 KWT	Grain Protein	Test Weight	Grain Yield 2019	Grain Yield 3-yr. Avg.
	%	1-10	inch		0-9	inch	gram	%	lb/bu	bu/ac	bu/ac
Hancock	63.8	2.0	13.3	161.8	3.0	44.2	27.7	12.1	50.6	43.8	54.5
Spooner	80.0	5.8	13.8	161.0	3.3	44.1	25.0	12.2	49.3	44.6	50.1
Rymin	92.3	7.0	11.9	162.5	3.0	45.8	27.1	10.8	50.3	48.9	66.3
ND Dylan	93.8	4.5	12.0	163.0	2.5	44.7	24.0	11.2	49.4	45.5	64.2
Dacold	87.8	3.5	11.2	165.3	2.0	45.1	27.6	11.0	50.2	43.9	57.2
Aroostok	92.0	5.0	14.1	157.8	3.5	47.0	22.5	13.4	49.6	32.3	38.3
Hazlet	94.5	7.3	12.8	163.0	2.0	43.0	28.9	10.8	50.8	53.0	61.3
Wheeler	85.8	3.0	11.4	166.0	0.5	51.2	30.4	16.1	46.3	9.8	15.3
Brasetto	94.3	7.0	12.3	163.3	0.0	34.2	24.8	10.0	47.6	46.4	71.6
Bono	91.5	6.0	11.2	163.0	0.8	33.3	24.9	9.6	50.2	60.7	--
ND Gardner	95.5	8.5	14.4	156.8	3.5	43.9	22.7	12.5	49.7	42.3	--
Mean	88.3	42.1	12.6	162.1	2.2	43.3	25.9	11.8	49.5	42.8	--
C.V. (%)	7.0	5.4	10.5	0.5	34.5	5.4	5.0	1.8	0.9	16.0	--
LSD 0.10	7.5	2.7	1.6	1.0	0.9	2.9	1.6	0.3	0.6	8.2	--
LSD 0.05	9.0	3.3	1.9	1.2	1.1	3.5	1.9	0.3	0.7	9.9	--

Planting Date = September 18; Harvest Date = August 1; Previous Crop = Wheat

Cornell University
College of Agriculture and Life Sciences

Plant Breeding & Genetics Section
School of Integrative Plant Science
240 Emerson Hall, Ithaca, N.Y. 14853-1902
Telephone: (607) 255-1665
Fax (Dept.): (607) 255-6683
E-Mail: mes12@cornell.edu
Web Page: http://smallgrains.cals.cornell.edu

2018 Small Grains Performance Trials for New York

Enclosed are the results of our 2018 small grains regional trials and the cumulative summaries over years. Because the rankings of the varieties and lines often change from year to year, only the multiple year summaries should be considered to be useful indicators of varietal performance in this region. Reproduction of any table in this report must include the entire table unless we approve the editing. The information herein is provided with the understanding that no discrimination is intended and no endorsement by Cornell University or its employees is implied.

Your comments and suggestions concerning this report are welcome. If you would like additional information or do not wish to receive this report in the future, please contact us. Summaries and information about the Cornell Small Grains Breeding & Genetics Project are maintained on our small grains web page: http://smallgrains.cals.cornell.edu

We have continued to develop and test selections from our molecular marker-assisted breeding program in our soft winter wheat breeding program. Our most recent varieties are Medina (soft white) and Erie (soft red). These selections have improved resistance to preharvest sprouting and fusarium head blight combined with excellent agronomic performance. Erie is a soft red winter wheat variety released in collaboration with Ohio State University that has excellent grain yield and disease resistance to powdery mildew, leaf spot, glume blotch, leaf rust, wheat spindle streak mosaic virus, wheat soil borne mosaic virus, and moderate resistance to fusarium head blight (scab).

I wish to recognize the contributions of Research Support Specialist, David Benscher, Technical Assistant, James Tanaka, Field Assistant, Amy Fox and Extension Support Specialist Judy Singer and thank them for their dedication.

Sincerely,

Mark E. Sorrells
Professor of Plant Breeding & Genetics

Rye is Not Being Produced Specifically for Brewing Qualities

Continuing MI Brewing Rye Research

MICHIGAN CRAFT Beverage Council

Research Proposal
Fiscal 2020 Funding
Project Activity Dates – April 1 - December 31, 2020

PROPOSALS DUE:
October 17, 2019, 3:00 p.m. to
MDARD-CraftBev@michigan.gov

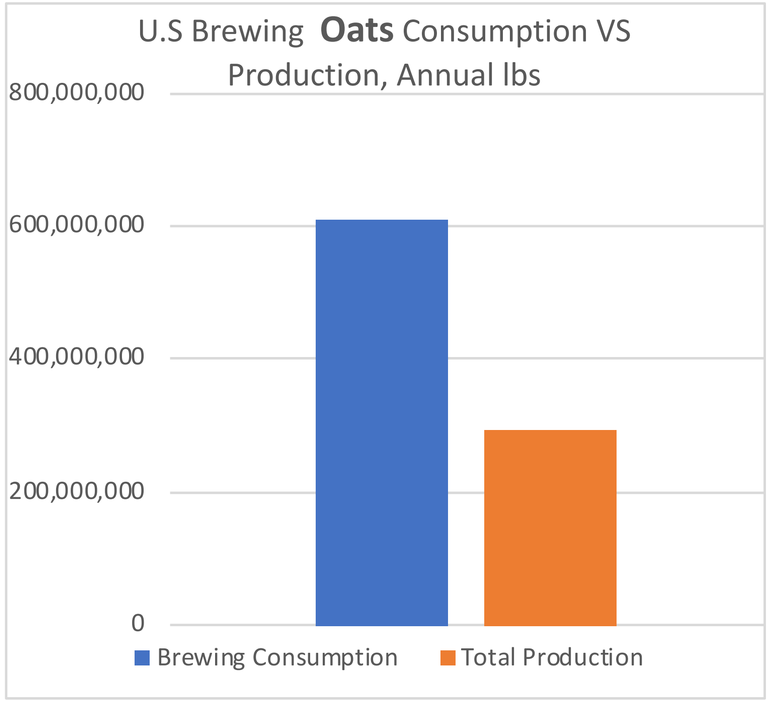
Principal Investigator : Dean Baas
Proposal Title: Evaluation of Cereal Rye Varieties for the Michigan Craft Distilling Industry

Collaborators: Martin Nagelkirk, Brook Wilke, James DeDecker, Christian Kapp, Monica Jean, Ryan Hamilton, Nicole Shriner, Martin Chilvers, Dennis Pennington, Megan Phillips Goldenberg
Mailing Address: Kellogg Farm, 10461 N 40th St., Hickory Corners, MI. 49060
Email: baasdean@msu.edu
Phone #: 269-967-9672

Type of Project (check one)	Program Area (check all that apply)	Money and Duration of Project
New FY20 Proposal ☐	Beer √ Wine ☐ Spirits √ Hard Cider ☐	Growing season/year the project started or will start: Click here to enter text. Growing season/year the project will be completed: Click here to enter text.
Continuation of Project - funded by MCBC FY19 √	Consumer and Market Research ☐	Money requested for FY20 only (max $50,000): $29,120
	Other ☐ Describe: Click here to enter text.	Total Estimated Cost of Project (if multi-year): $42,623

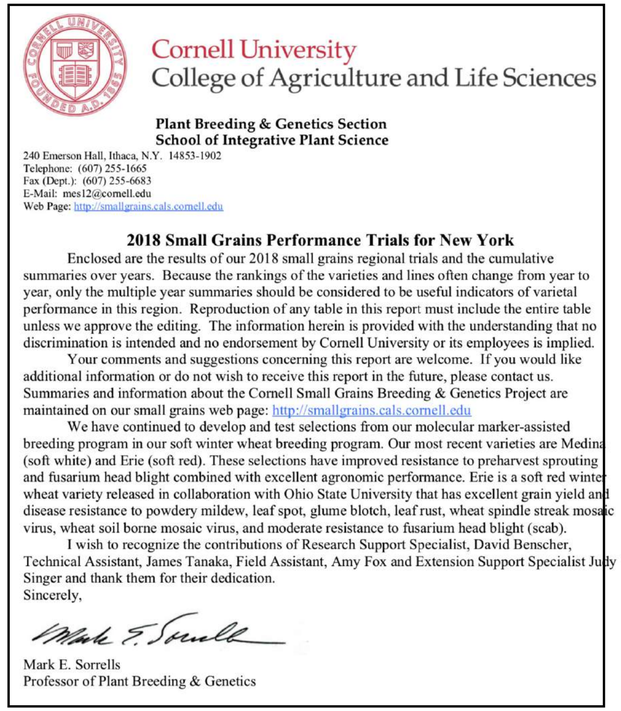
- 15 rye varieties
- Planted 3 MI nurseries
- Grow test plots to harvest
- Analyze grains for grain quality, Spirit Yield, and flavor
- Select samples to pilot distilling analysis and malting analysis

Oats



- OATS ARE HOT in craft brewing - unique flavors, mouth-feel softness and silkiness
- Most brewing oats in US are imported - oat flakes and malts from CAN and oat malts from Great Britain
- Imported oat products are expensive
- Revered product is Hulless (naked), very plump, low Protein
- Naked varieties bred in the US are too high Protein

Oat Variety Ag Performance



Cornell University
College of Agriculture and Life Sciences

Plant Breeding & Genetics Section
School of Integrative Plant Science

240 Emerson Hall, Ithaca, N.Y. 14853-1902
Telephone: (607) 255-1665
Fax (Dept.): (607) 255-6683
E-Mail: mes12@cornell.edu
Web Page: http://smallgrains.cals.cornell.edu

2018 Small Grains Performance Trials for New York

Enclosed are the results of our 2018 small grains regional trials and the cumulative summaries over years. Because the rankings of the varieties and lines often change from year to year, only the multiple year summaries should be considered to be useful indicators of varietal performance in this region. Reproduction of any table in this report must include the entire table unless we approve the editing. The information herein is provided with the understanding that no discrimination is intended and no endorsement by Cornell University or its employees is implied.

Your comments and suggestions concerning this report are welcome. If you would like additional information or do not wish to receive this report in the future, please contact us. Summaries and information about the Cornell Small Grains Breeding & Genetics Project are maintained on our small grains web page: http://smallgrains.cals.cornell.edu

We have continued to develop and test selections from our molecular marker-assisted breeding program in our soft winter wheat breeding program. Our most recent varieties are Medina (soft white) and Erie (soft red). These selections have improved resistance to preharvest sprouting and fusarium head blight combined with excellent agronomic performance. Erie is a soft red winter wheat variety released in collaboration with Ohio State University that has excellent grain yield and disease resistance to powdery mildew, leaf spot, glume blotch, leaf rust, wheat spindle streak mosaic virus, wheat soil borne mosaic virus, and moderate resistance to fusarium head blight (scab).

I wish to recognize the contributions of Research Support Specialist, David Benscher, Technical Assistant, James Tanaka, Field Assistant, Amy Fox and Extension Support Specialist Judy Singer and thank them for their dedication.

Sincerely,

Mark E. Sorrells
Professor of Plant Breeding & Genetics

ORGANIC OAT VARIETY TESTING IN MICHIGAN—2018

Authors: Lauren Voelker, Megan Goldenberg, Christian Kapp, Brook Wilke, & Dean Baas.

Trials featuring organic oats were initiated in 2018 at the W.K. Kellogg Biological Station (KBS) and the Upper Peninsula Research and Extension Center (UPREC), which are research stations of Michigan State University. Objectives included assessing oat varieties for yield and quality parameters related to malting, de-hulling, and human consumption. This report summarizes the data and observations made from the KBS trial through July 24, 2018. Once data is received back from UPREC and the processing and quality tests, another article will be released with further information.

Organic Oat's are the number one produced organic crop in the United Sates. Around 3.6% of all oats grown in the United States are organic.
-USDA

Figure 1. Harvesting oat plots at the Kellogg Biological Station.

Key Agronomic Practices for Organic Oats

1. Oats can be the first crops planted in the spring. They will germinate when soil reaches 38 degrees F.
2. Planting depth for oats should be approximately 1"
3. Planting as early as possible is important. Since oats are a fast growing crop, and can grow during cool weather, they have a better ability to outcompete weeds compared to other spring planted cereal crops.

ORGANIC VALLEY FARMER-OWNED

AgBioResearch MICHIGAN STATE UNIVERSITY

MICHIGAN STATE UNIVERSITY Extension

MICHIGAN STATE UNIVERSITY W.K. Kellogg Biological Station Kellogg Farm

Summary

- Key to agronomic and brewing performance is variety
- Ultimate MI barley production varieties not yet found
- Get Grain In the Ground: Plump and Protein analysis missing from available grain quality data
- Wheat, rye, and oat variety selection brewing specific cutting-edge
- Huge untapped opportunities in wheat, rye, and oats
- Measure Plump and Protein
- Understand Protein dry-basis and as-is

Special Thank You to All of the Expert Researchers and Financers for Helping to Improve Agronomic Economies in MI!