

BELL'S®



Inspired Brewing®

# No Barley, No Beer

Ed Ruble

Great Lakes Hop and Barley Conference



# The Soul of Beer

- Color
- Flavor
- Body
- Nutrients for Yeast
  - Vitamins, Minerals, Sugar

# Why Barley?

- Evidence of barley dating back 23,000 years.
- First domesticated about 10,000 years ago
  - Very broad environmental range.
- Reinheitsgebot (1487)
  - Specified the only ingredients that could be used in the production of beer were water, barley and hops (no yeast until late 19<sup>th</sup> century).
  - Prevent price competition with wheat and rye.







# The Evolution of Malting Barley

- Proper relationship between protein and starch
- Unique enzyme systems
- Husk to protect malted grain
- Husk to provide filter bed
- Characteristic flavor combination



# How do You use Malt?





Upper Hand Brewery – 25bbl



Bell's Comstock Brewery - 50bbl



# Malting Objectives

- Carbohydrate Modification
- Protein Modification
- Accessible Extract
- Sufficient Enzymes
- Desired Color/Flavor



# High Quality Barley

- Clean and free of silage and other grains.
- Bright.
- Low moisture ~14% upon delivery to the maltster
- Free of disease:
  - Fusarium Head Blight (FHB or scab) leads to high levels of mycotoxin deoxynivalenol (DON or vomitoxin)
  - Ergot leads to dark shriveled kernels.
- Minimal pre-sprout.

# Malting Process

- Steeping (in water)
  - Washes the grain
  - Increases the moisture from  $\pm 12\%$  to  $\pm 44\%$
- Germination (Sprouting)
  - Sprouting of barley seed
  - Increases enzymes
  - Softens grain
- Kilning (Drying)



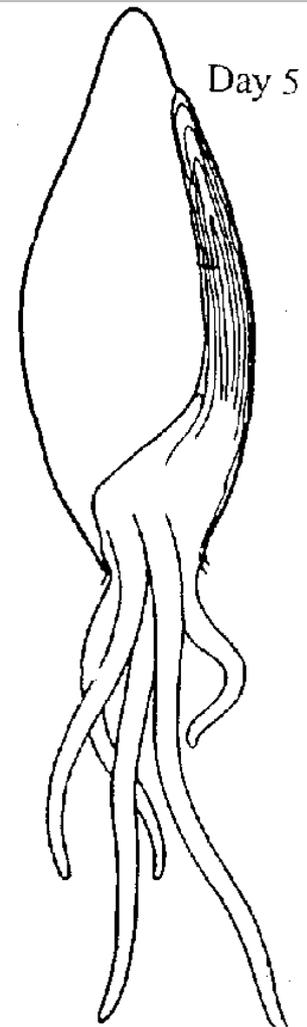
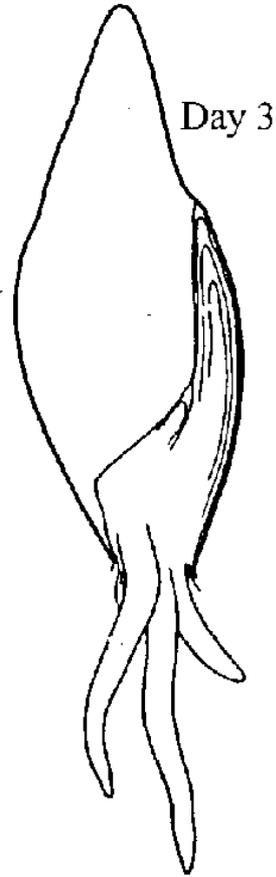
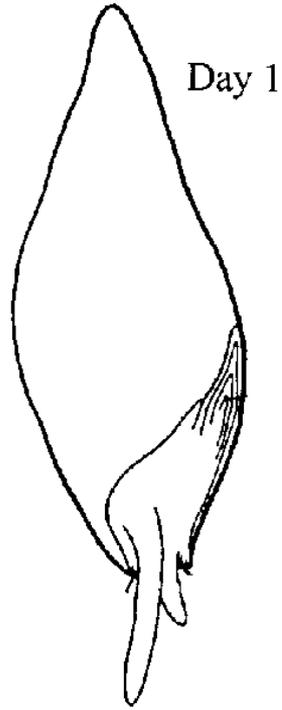


*Steep Tank*

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## Physical Changes in Germination



## Group of women maltsters, Bass, Burton-on-Trent



**Date:** 6 March 1917

**Description:** Women maltsters posing with their shovels and forks outside a Bass Malthouse. The picture would have been taken outside either Shobnall, Station Street or Wetmore Road Maltings.





SALADIN MALTING

SYSTEM

MANUFACTURED BY

SALADIN MALTING

CONSTRUCTION CO.

MINNEAPOLIS MINN. U.S.A.











# Malting Process

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  - Washes the grain
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  - Softens grain
- Kilning/Roasting (Drying)

# Kilning: Objectives

Arrest or terminate malting process

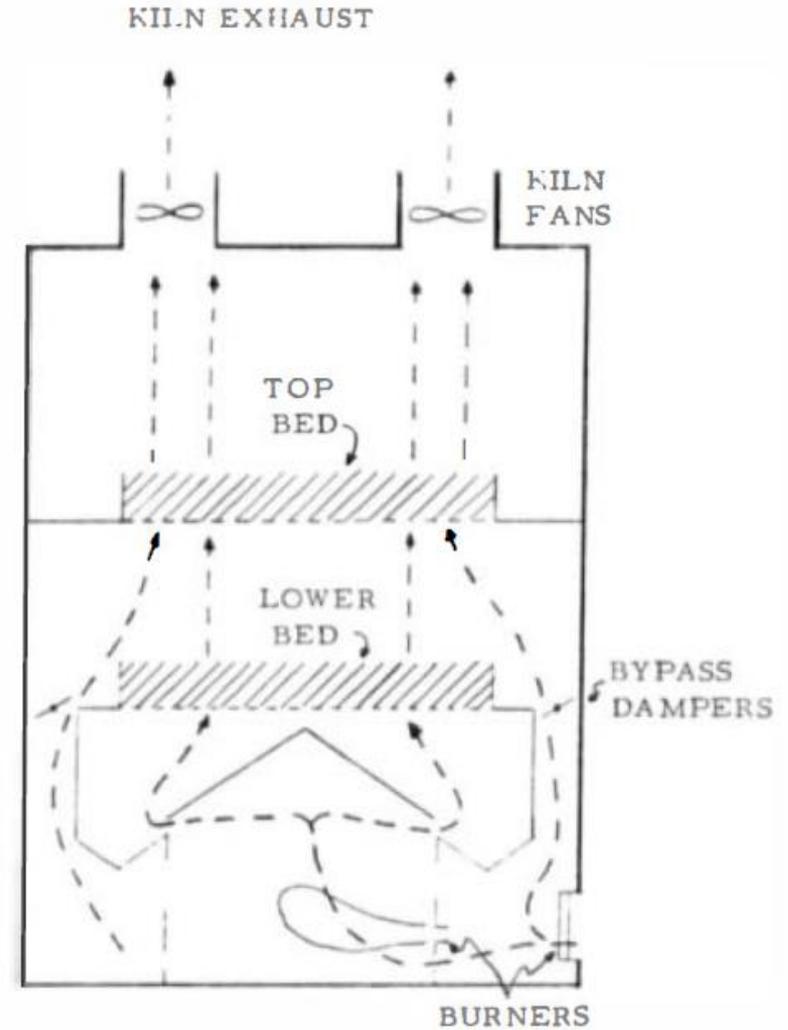
Reduce moisture to levels suitable for grain storage

Stabilize enzyme complexes developed during malting

Develop color and flavor (both taste and aroma)

characteristics as required by the brewer

# Direct Fire Kilning



# Nitrosamines in Malt

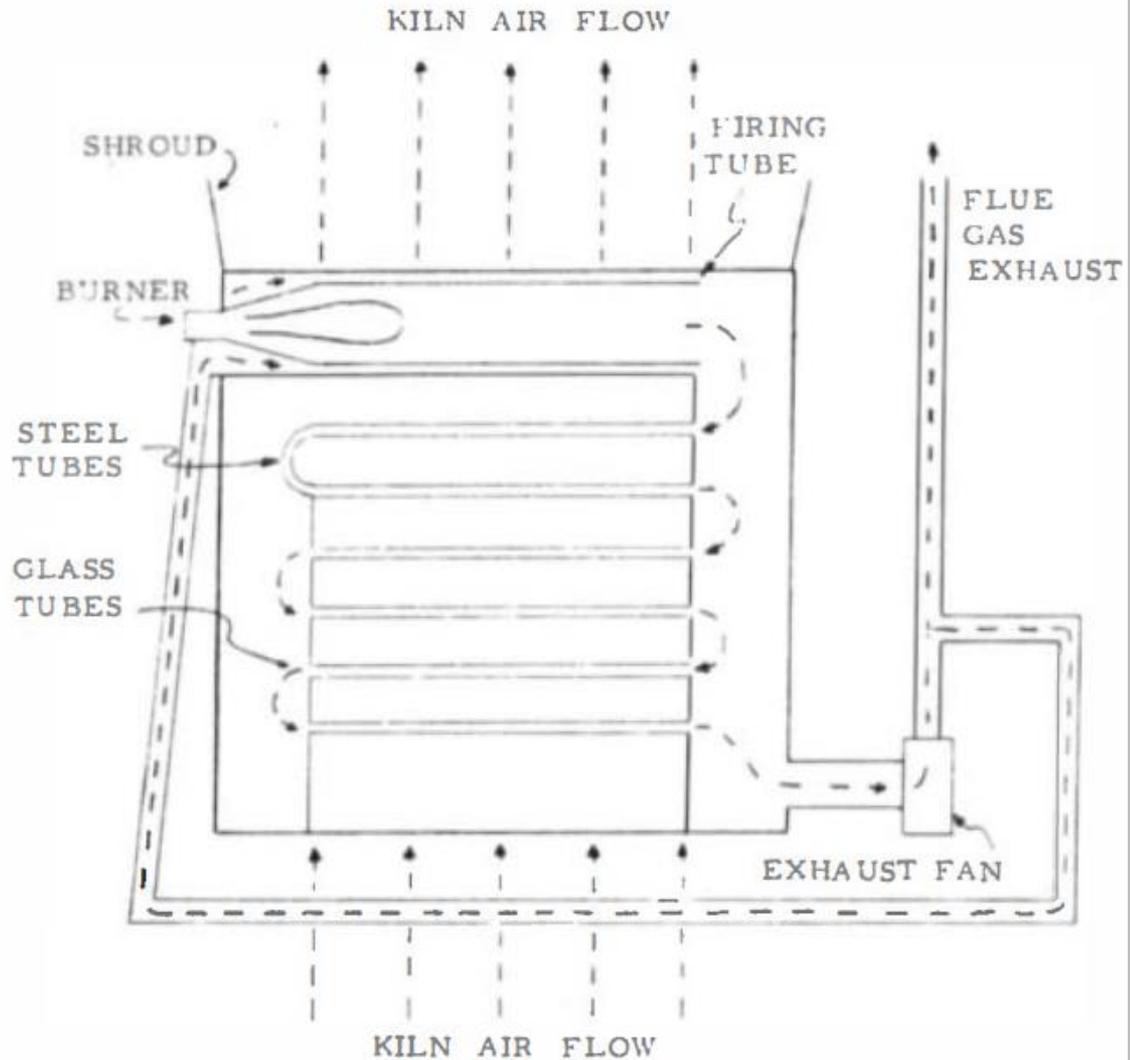
Nitrosamines are highly carcinogenic and are formed in malt that is roasted over open fire.

Nitrogen oxide gases react with amines in the malt to form nitrosamines such as NDMA.

Indirect heating has dropped levels by over 50x

Nitrosamines generated during malt production will pass into beer.

# Indirect Kilning











# Important Malt Specs

- Extract
  - Coarse Grind, As Is
- Color and Flavor
- Diastatic Power
- Kolbach Index
  - Soluble Protein/Total Protein
- Beta Glucan Level

# Extract

- Very dependent on variety and growing region.
- Is consumed during the malting process:
  - Keep to a minimum
  - Critical for color formation in Kilning

# Color and Flavor

- Low color factors:
  - Low Protein barley
  - Undermodification
  - Low temperature drying
- Heavily dependent on kilning or roasting process.



# Louis Camille Maillard

b.1878 – d.1936

French physician and chemist

Described the very important browning reactions responsible for the flavors of Coffee and Chocolate called the “Maillard reactions”

# Melanoidin Flavors

- Off flavours (bitter)
- Off aromas (burnt, onion, cabbage)
- Positive aromas (malty, bread crust-like, caramel, coffee, roasted).
- Sweet, Nutty, Butterscotch
  
- Molasses, coffee, fermented soy beans, cocoa products, green peas, cooked beef, Gouda, wine grapes, raw asparagus, beets, carrots, lettuce, Bell peppers

No class of flavor compounds has been shown to be as important in foods

# Diastatic Power

- Base 2 Row
  - 160 is supper hot
  - <140 is a problem
- 90-110 Pale Ale Malt (3.5 Lov.)
- 45-50 Munich

# Malting and Brewing Enzymes

## Protein Degradation Enzymes

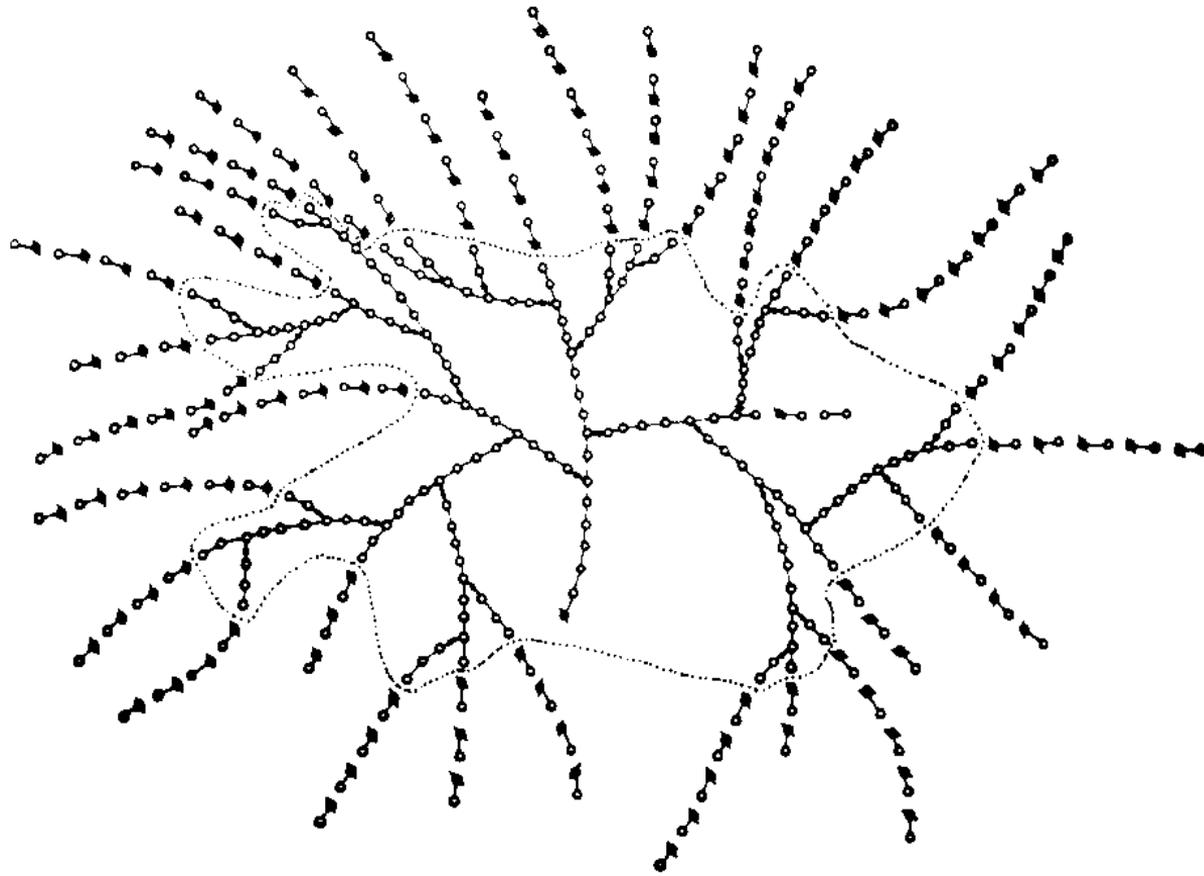
proteases - proteolytic enzymes

## Starch Degrading Enzymes

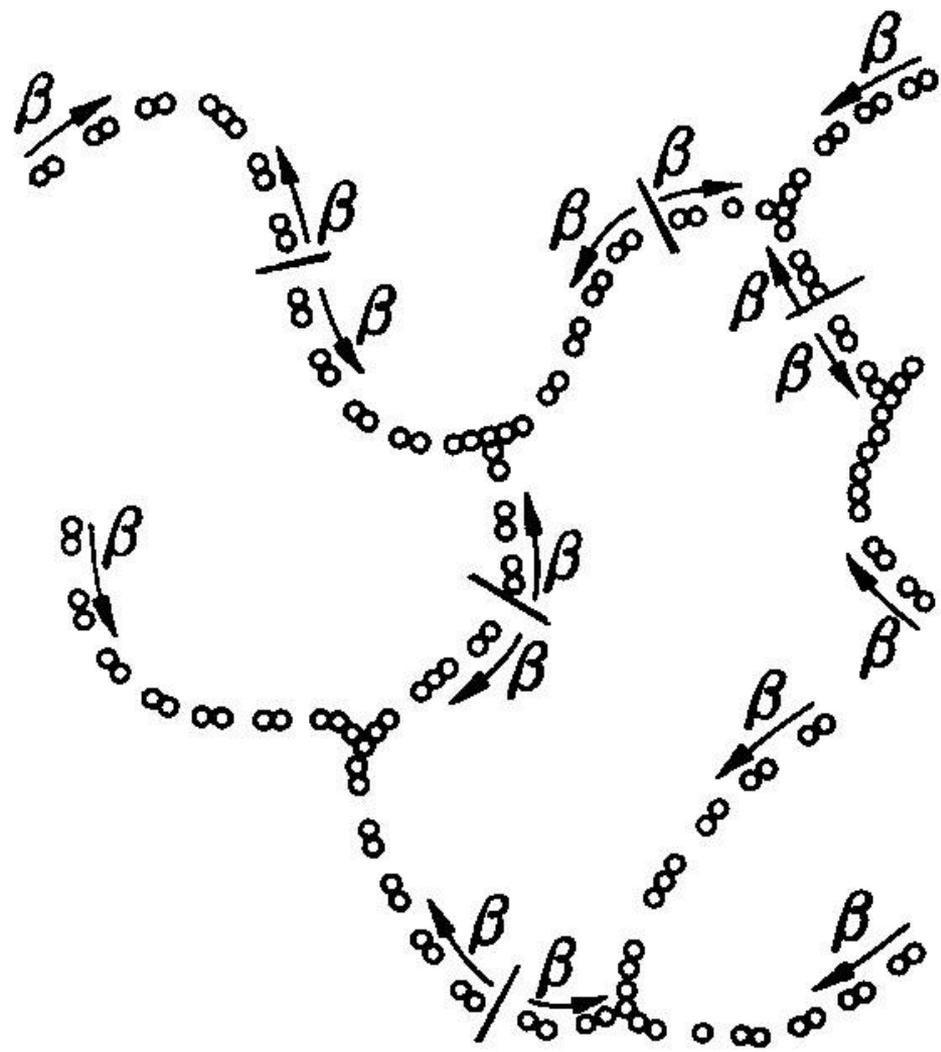
Amylases - Hydrolyze Starch  
in the Saccharification Stage

$\beta$  - amylase

$\alpha$  - amylase



*Figure 17. Hydrolysis of Amylopectin by Beta-Amylase. Dotted line delineates extent of hydrolysis.<sup>(58)</sup>*



# Barley Protein

- Lower protein barley helps to keep FAN down.
- Total Protein Specification for barley input
  - <10.5 in Europe
- Western Irrigated 2-row Barley is lowest
  - 10-9.8 protein is great.
- Will loose  $\sim 0.25\%$  through malting process

# Soluble Protein

Total Protein	12.0%	9.5%
S/T	48.0%	38.0%
Soluble Protein	5.8%	3.6%

# Beta Glucan

- “Best” measure of carbohydrate modification. Maltster don't want to be held to this but they run the malt house on it.
- No problems when  $<140$  on 2 row, 120 max. would be good, 80-90 would be best

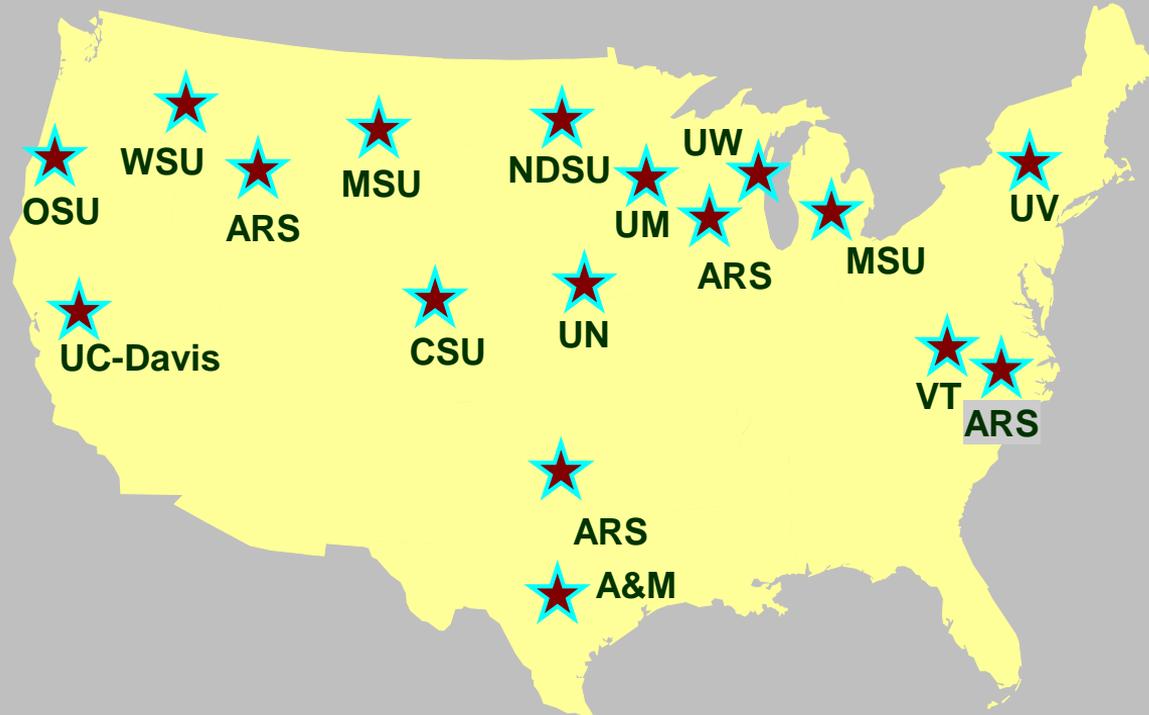
# AMBA

- American Malting Barley Association
  - “Encourage and support an adequate supply of high quality malting barley for the malting, brewing, distilling, and food industries and increase our understanding of malting barley”

# AMBA Research Grant Program



Direct funding of public sector breeding programs and supporting research



# Approved 2-Row Varieties

- AC Metcalfe
- CDC Copeland
- CDC Meredith
- Charles
- Conlon
- Conrad
- Expedition
- Harrington
- Hockett
- Merit
- Merit 57
- Moravian 37
- Moravian 69
- Pinnacle
- Scarlett
- Wintmalt.

# MALTING BARLEY BREEDING GUIDELINES

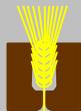
## IDEAL COMMERCIAL MALT CRITERIA

	<u>Six-Row</u>	<u>Adjunct Two-Row</u>	<u>All Malt Two-Row</u>
<b>AMBA Member Interest*</b>	<b>20%</b>	<b>55%</b>	<b>25%</b>

### Barley Factors

Plump Kernels (on 6/64)	> 80%	> 90%	> 90%
Thin Kernels (thru 5/64)	< 3%	< 3%	< 3%
Germination (4ml 72 hr. GE)	> 98%	> 98%	> 98%
Protein	≤ 13.0%	≤ 13.0%	≤ <b>12.0%</b>
Skinned & Broken Kernels	< 5%	< 5%	< 5%

\*Based on a survey of AMBA's regular members. June, 2014

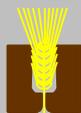


**American Malting Barley Association, Inc.**

# MALTING BARLEY BREEDING GUIDELINES

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<b>Malt Factors</b>			
Total Protein	≤ 12.8%	≤ 12.8%	≤ <b>11.8%</b>
on 7/64 screen	> 60%	> 70%	> 75%
<b>Measures of Malt Modification</b>			
Beta-Glucan (ppm)	< 120	< 100	< 100
F/C Difference	< 1.2	< 1.2	< 1.2
Soluble/Total Protein	42-47%	40-47%	<b>38-45%</b>
Turbidity (NTU)	< 10	< 10	< 10
Viscosity (absolute cp)	< 1.50	< 1.50	< 1.50



# MALTING BARLEY BREEDING GUIDELINES

## IDEAL COMMERCIAL MALT CRITERIA

	<u>Six-Row</u>	<u>Adjunct Two-Row</u>	<u>All Malt Two-Row</u>
<b>Congress Wort</b>			
Soluble Protein	5.2-5.7%	4.8-5.6%	< 5.3%
Extract (FG db)	> 79.0%	> 81.0%	> 81.0%
Color (°ASBC)	1.8-2.5	1.6-2.5	1.6-2.8
FAN	> 210	> 210	<b>140-190</b>
<b>Malt Enzymes</b>			
Diastatic Power (°ASBC)	> 150	> 120	<b>110-150</b>
Alpha Amylase (DU)	> 50	> 50	<b>40-70</b>

### General Comments

- Barley should mature rapidly, break dormancy quickly without pregermination and germinate uniformly.
- The hull should be thin, bright and adhere tightly during harvesting, cleaning and malting.
- Malted barley should exhibit a well-balanced, modification in a conventional malting schedule with four day germination.
- Malted barley must provide desired beer flavor.





# Malt Usage at Bell's



# Some Numbers

- 2015 Anticipated Usage ~25MM lbs
  - Bulk trucks – 50,000 lbs (10/week)
  - Super sacks – 2000 lbs
  - Bags – 50 lbs
- Capacity to store ~1MM lbs on site
  - 16 bulk bins, 2 silos (50k lbs each)
  - 10 specialty bins (4000 lbs each)







Item# 5422  
Net Wt. 50.00  
Gross Wt. 55.00  
18001 SS  
A

TO: BELL'S BREWERY INC  
8900 KIRUM AVE  
GALESDALE, MI 49633  
Customer P.O. 12345

Item# 5422  
Net Wt. 50.00  
Gross Wt. 55.00  
18001 SS  
A

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# Malt Handling

- As gentle as possible
  - Bucket elevators
  - Drag conveyors
  - Chain disc conveyors
- Controlled Pneumatic Transfers
  - Not to fast
  - Long radius elbows





# Michigan Malt



# Barley Farm

- Bell's Farm ~200 acres in Shepherd, MI
- Turnwald Farms
- Conrad barley
  - Developed as a Western 2-Row variety
  - Susceptible to higher protein levels
- Testing new varieties.







# **Barley Harvest 2014**

# Malting MI Barley

- Up to 80 bushels/acre (depending on season)
- Briess – Waterloo (Pale), Chilton (C-120 and flakes)
- Barley Quality (can vary depending on the season):
  - Higher protein 13.5-15 (nitrogen application)
  - Some staining is typical
  - Lower plumps 80-90%
  - Some pre-sprout is typical
  - Watch for increased DON levels

# New Varieties

- Alternate varieties tested:
  - Voyager – AB-I
  - Pinnacle - public
  - ND Genesis – public (still in development)
  - Expedition – MaltEurop
- Seed stock of more traditional MI lines.



established

**NO BARLEY  
NO BEER**



# Credits

- John Mallett
  - Director of Production at Bell's Brewery
  - Author of *Malt – A Practical Guide from Field to Brewhouse*
- Mike and Kevin Turnwald
- Scott Hiesel - AMBA

BELL'S®



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**Thank You!**

[eruble@bellsbeer.com](mailto:eruble@bellsbeer.com)

[www.bellsbeer.com](http://www.bellsbeer.com)