Outline

- Malting 101
- Current Malting Barley Economy
- Opportunities for Improvement
- Pennsylvania Craft Malt®
- Key Success Factors
Brewing Process Summary

WATER
MALT
HOPS
(adjunct)

Brewhouse
(mash, boil, filter)

Wort
(w/hops)

Fermentation

YEAST

Carbon Dioxide

Young
Beer

Storage / Finishing

Finished
Beer

Spent Grain

Surplus Yeast

Deer Creek Malthouse, LLC
Pennsylvania Craft Malt®
No Malt means No Beer

Water, hops, and yeast alone cannot make a beer!
Brewing Fundamentals

• Malted Barley Contributions to Brewing:
  – Source of modified carbohydrates
  – Enzymes to reduce modified carbohydrates to fermentable sugar
  – Soluble protein
  – Color and flavor
  – Filter material for wort clarification

This list of contributions is the very essence of the brewing process!
Unmalted barley cannot provide these attributes!
Malting Fundamentals

Plant Germination:

• Uncontrolled and unchecked, the germination process will consume the entire barley kernel and create a barley plant

• “Modification” – a comprehensive term that describes all of the physical and chemical changes that occur when barley is converted to malt
Malting Process Summary

An uncomplicated batch process with only a few inputs!
The only “ingredient” on a malt label is barley!
What is the barley kernel doing during Germination?

“Modification” is directional; not perfectly sequential:

- **Kernel Activation** – steeping
  - Embryo rehydration
  - Gibberellin hormone to the aleurone layer

- **Enzyme Creation Phase** – germination
  - Production of amylases, glucanases, proteases, lipases, and lipoxygenases

- **Substrate Digestion Phase** – germination
  - Protein reduction first, carbohydrate reduction second, glucans third
Schematic of Malt Production

- **Barley**
  - **Green Malt**
    - **Low Temperature Drying (80°F-125°F)**
      - **Smoking (<120°F)**
        - Smoked Malt
      - **Low Temperature Kilning (<175°F)**
        - Pilsner Malt
        - Distillers Malt
      - **Normal Temperature Kilning (<230°F)**
        - Pale Ale Malt
        - Vienna Malt
        - Munich Malt
    - **Stewing (100°F – 160°F)**
      - **High Temperature Kilning (230°F-300°F)**
        - Brown/Amer Malt
        - Chocolate Malt
        - Black Malt
      - **Drum Roasting (250°F-450°F)**
        - Crystal Malt
        - Caramel Malt
        - Roasted Barley
Malting Barley Countries
Millions of Tons

- **United States, 3.9**
- **Australia, 4.3**
- **Turkey, 9.6**
- **Canada, 9.6**
- **Ukraine, 11.3**
- **Russian Federation, 18.2**
- **EU, 56.2**
- **Other, 26**

2012 AMBA Data
Malting Barley States

1000s Acres of Malting Barley

- Colorado, 58
- Wyoming, 75
- Minnesota, 115
- North Dakota, 1,140
- Idaho, 610
- Montana, 900

2012 AMBA Data
Pennsylvania Production Data

Pennsylvania Agronomic Crop Acreage

- Soybeans: 29%
- Small Grains: 15%
- Corn: 55%
- Other: 1%

USDA 2012 Census
Pennsylvania Production Data

Small Grains, PA Acres (1000s)

- Wheat: 145
- Oats: 65
- Barley: 53
- Rye: 10

USDA 2012 Census
Pennsylvania Beer by Acres

4.07m barrels/yr ➔ ~133,000 acres of barley*

Pennsylvania Beer by Acres

2015

178
Craft Breweries
(RANKS 8th)

1.9
Breweries per Capita*
(RANKS 23rd)
*per 100,000 21+ Adults

ECONOMIC IMPACT
(2014)

$4,488
Million Economic Impact
(RANKS 2nd)

476.98
Impact per Capita
(RANKS 4th)

PRODUCTION

4,059,330
Barrels of Craft beer produced per year
(RANKS 1st)

13.4
Gallons per 21+ Adult
(RANKS 2nd)

NUMBER OF BREWERIES PER YEAR

*70 lbs of malt per barrel of craft beer; 60bu/acre yield malting barley; 80% malt yield; 15% dockage

Deer Creek Malthouse, LLC
Pennsylvania Craft Malt®
US Breweries

Brewers Association Statistics

2015 *Breweries: 4,269*
## U.S. Brewery Count

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>'14 to '15 % Change</th>
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<tbody>
<tr>
<td><strong>CRAFT</strong></td>
<td>2,401</td>
<td>2,863</td>
<td>3,676</td>
<td>4,225</td>
<td>+ 18.1</td>
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<tr>
<td>Regional Craft Breweries</td>
<td>97</td>
<td>119</td>
<td>135</td>
<td>178</td>
<td>+ 31.9</td>
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<tr>
<td>Microbreweries</td>
<td>1,149</td>
<td>1,464</td>
<td>2,041</td>
<td>2,397</td>
<td>+ 21.6</td>
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<td>Brewpubs</td>
<td>1,155</td>
<td>1,280</td>
<td>1,500</td>
<td>1,650</td>
<td>+ 12.2</td>
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<tr>
<td><strong>LARGE NON-CRAFT</strong></td>
<td>23</td>
<td>23</td>
<td>26</td>
<td>30</td>
<td></td>
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<tr>
<td><strong>OTHER NON-CRAFT</strong></td>
<td>32</td>
<td>31</td>
<td>20</td>
<td>14</td>
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<tr>
<td><strong>Total U.S. Breweries</strong></td>
<td>2,456</td>
<td>2,917</td>
<td>3,722</td>
<td>4,269</td>
<td>+ 17.9</td>
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*Brewers Association Statistics*
Barley Production by Year

US Barley Acreage

Complements of Mike Davis, AMBA
Barley Production by Year

Canadian Barley Acreage

Complements of Mike Davis, AMBA
Malting Barley Supply Chain Opportunities

• Industry demand outpacing supply
• Limited supply of LOCAL malt
• Craft brewers have different needs than large adjunct brewers
  – Specs
  – Storage / Logistics
  – Personalization / Customization
  – Scale
• R&D not focused on flavor origins, winter 2-row breeding, and non-barley malt product development
Pennsylvania Craft Malt®

Quality
• “Craft” specifications
• Small batches, process flexibility
• Analytical testing

Flavor
• Traditional floor malting
• Variety selection
• Pilot brewing

Local
• Responsibly sourced grain
• Malt produced in SE PA
• Consumed in the Mid-Atlantic
Great Barley → Great Malt → Great Beer
Variety Trials / Selection

• Agronomic factors
  – Winter hardiness
  – Disease resistance
  – Dormancy
    (resistance to PHS)

• Malting factors
  – Plumpness
  – Germination
  – Protein
  – DP
  – β-Glucan

• Flavor
  – Micro malting
  – Pilot brewing
  – Sensory analysis
Barley Growing Regions in PA

- Spring barley typically not grown in Area 3
- Winter barley varieties grow well with highest yields in Area 3
- Variable yield from PSU and Deer Creek MH variety trials
PA Malt Key Success Factors

• **Agronomic**
  – Winter hardiness
  – Disease resistance
  – Dormancy (resistance to PHS)

• **Infrastructure**
  – Quality
  – Scale
  – Variety

• **Collaboration**
  – Every node in the value chain
  – Change catalyst
Questions?
What’s on Tap?

• Beer releases with our malt
• Events
• Beer and malting news

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www.facebook.com/deercreekmalt
www.untappd.com/deercreekmalt

Other questions?
info@deercreekmalt.com
717-746-MALT
Craft Brewer Malt Barley Supply Gap Solutions

<table>
<thead>
<tr>
<th>Gap</th>
<th>R&amp;D</th>
<th>Farm</th>
<th>Malthouse</th>
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<td><img src="image" alt="Wheat" /></td>
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<tr>
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## Malting Barley Economic Shift

<table>
<thead>
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<th>Dimensions</th>
<th>Current</th>
<th>New</th>
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<tr>
<td>Customers</td>
<td>Large Adjunct</td>
<td>Small All-Malt</td>
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<tr>
<td>Farming</td>
<td>Centralized</td>
<td>Decentralized</td>
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<td>Distribution</td>
<td>Broad, Established</td>
<td>Local, Direct, New</td>
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<tr>
<td>Production</td>
<td>Large Scale</td>
<td>Small, Flexible, Local</td>
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<tr>
<td>Geography</td>
<td>Great Plains</td>
<td>Everywhere!</td>
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Malting Barley Characteristics for Craft Brewers

To produce all-malt beer brands, craft brewers seek barley malts with:

<table>
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<tr>
<th>Trait / Topic</th>
<th>Consensus Target</th>
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<tr>
<td>FAN</td>
<td>&lt;150 ppm</td>
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<tr>
<td>Diastatic Power</td>
<td>&lt;150 Linter</td>
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<tr>
<td>Protein Content</td>
<td>&lt;10.5%</td>
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<tr>
<td>Protein Modification (S/T)</td>
<td>35% - 45%</td>
</tr>
<tr>
<td>Beta Glucan</td>
<td>&lt;140 ppm</td>
</tr>
<tr>
<td>Flavor</td>
<td>Distinct!</td>
</tr>
</tbody>
</table>

The demand for such malts will grow as craft production increases.
MALT ANALYSIS

Product: Pennsylvania Dutch Malt
Lot: M15G022B
Source: Chester County, PA
Variety: 2-Row Winter Barley

General Description:
PA Dutch malt is produced from well-modified, two-rowed barley in the spirit of Pennsylvania German heritage and the traditional “Munich” style of malt. Sourced from only the highest quality locally grown barley, and handcrafted using traditional floor germination techniques, this artisanal malt produces a very clean, malty wort with nutty, toffee sweetness, dark amber color, and enough diastatic power to convert itself quickly. Notes of burnt straw, caramelized nuts, and toasted bread. It is perfect for Bock, Märzen, Altbier, or Oktoberfest recipes, or any beer (or spirit) where a malt-forward flavor profile is desired.

Utilization: Up to 100%
Kilned on: 22-Jul-2015

Wort Flavor Profile:
## Malt Quality Analysis:

<table>
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<th>Size Distribution</th>
<th>Extract Potential</th>
<th>Wort Characterization</th>
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</thead>
<tbody>
<tr>
<td>&gt;6/64” (%)</td>
<td>FGDB (%)</td>
<td>Color (SRM)</td>
</tr>
<tr>
<td>&gt;5/64” (%)</td>
<td>CGDB (%)</td>
<td>pH</td>
</tr>
<tr>
<td>&lt;5/64” (%)</td>
<td>FGDB/CGDB (%)</td>
<td>Viscosity (cP)</td>
</tr>
<tr>
<td>D.P. (°L)</td>
<td>115</td>
<td>Clarity</td>
</tr>
</tbody>
</table>

### Nitrogen Analysis

- α-amylase (D.U.) 80
- Protein (%) 11.5
- Conversion Time (min) <20
- S.G. 1.035
- Total Nitrogen (%) 11.3
- Moisture (%) 4-6
- Filtration Time [good, fair, poor]
- β-glucans (ppm) 50
- Friability (%) 80
- ADF (%) 80
- RDF (%) 64.8

* Coarse (CG) and fine grind (FG) extract from 1hr single infusion mash at 152°F
† FG result shown for S.G. from 1hr single infusion mash (CG = 1.034, 8.41 °P)
‡ Average result from unmalted barley analysis
§ Typical result from 5 gallon fermentation experiment after 7 days

Questions about quality analysis? Contact Mark at 717.746.MALT or mark@deercrekmalt.com

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