

# ASPECTS OF BREWING QUALITY CONTROL

ACIL ANNUAL MEETING

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ANHEUSER-BUSCH, INC.

# ASPECTS OF BREWING QUALITY CONTROL

- Review of Beer Brewing Industry
- Quality Control Aspects in Malting and Beer Brewing Processes
- Traceability Study Example
- Comparison of Process Similarities in Related Industries
- Networking Opportunities in the Malting and Beer Brewing Industries

# Review of Beer Brewing Industry

- Types of Breweries
- Numbers of Breweries
- Growth of Breweries
- Variability in Quality Control Resources

# Types of Breweries

- Contract / Brewpubs / Microbreweries / Regional / Large National Breweries / Craft vs Non-Craft
- Brewers Association (BA) Definition of a Craft Brewer:
  - An American craft brewer is small, independent and traditional.
  - Craft Brewer – Small:
    - Annual production of 6 million barrels of beer or less (approximately 3 percent of U.S. annual sales). Beer production is attributed to the rules of alternating proprietorships.
  - Craft Brewer – Independent:
    - Less than 25 percent of the craft brewery is owned or controlled (or equivalent economic interest) by an alcohol industry member that is not itself a craft brewer.
  - Craft Brewer – Traditional:
    - A brewer that has a majority of its total beverage alcohol volume in beers whose flavor derives from traditional or innovative brewing ingredients and their fermentation. Flavored malt beverages (FMBs) are not considered beers.

# Types of Breweries

- Craft Beer Industry Market Segments.
- The Brewers Association (BA) identifies four distinct craft beer industry market segments:
  - Brewpubs,
  - Microbreweries,
  - Contract Brewing Companies, and
  - Regional Craft Breweries.

# Types of Breweries

- Brewpub

A restaurant-brewery that sells 25 percent or more of its beer on site. The beer is brewed primarily for sale in the restaurant and bar. The beer is often dispensed directly from the brewery's storage tanks. Where allowed by law, brewpubs often sell beer "to go" and /or distribute to off site accounts. Note: BA re-categorizes a company as a microbrewery if its off-site (distributed) beer sales exceed 75 percent.

# Types of Breweries

- Microbrewery

A brewery that produces less than 15,000 barrels (17,600 hectoliters) of beer per year with 75 percent or more of its beer sold off-site. Microbreweries sell to the public by one or more of the following methods: the traditional three-tier system (brewer to wholesaler to retailer to consumer); the two-tier system (brewer acting as wholesaler to retailer to consumer); and, directly to the consumer through carry-outs and/or on-site tap-room or restaurant sales.

# Types of Breweries

- Contract Brewing Company

- A business that hires another brewery to produce its beer. It can also be a brewery that hires another brewery to produce additional beer. The contract brewing company handles marketing, sales and distribution of its beer, while generally leaving the brewing and packaging to its producer-brewery (which, confusingly, is also sometimes referred to as a contract brewery).

- Regional Craft Brewery

- An independent regional brewery with a majority of volume in “traditional” or “innovative” beer(s).

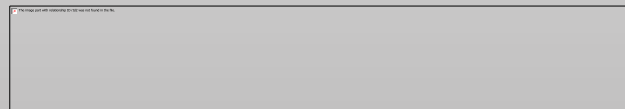


# Types of Breweries

- Regional (Non-Craft) Brewery
  - A brewery with an annual beer production of between 15,000 and 6,000,000 barrels.
- Large (Non-Craft) Brewery
  - A brewery with an annual beer production over 6,000,000 barrels.

# Numbers of Breweries - U.S. Brewery Count

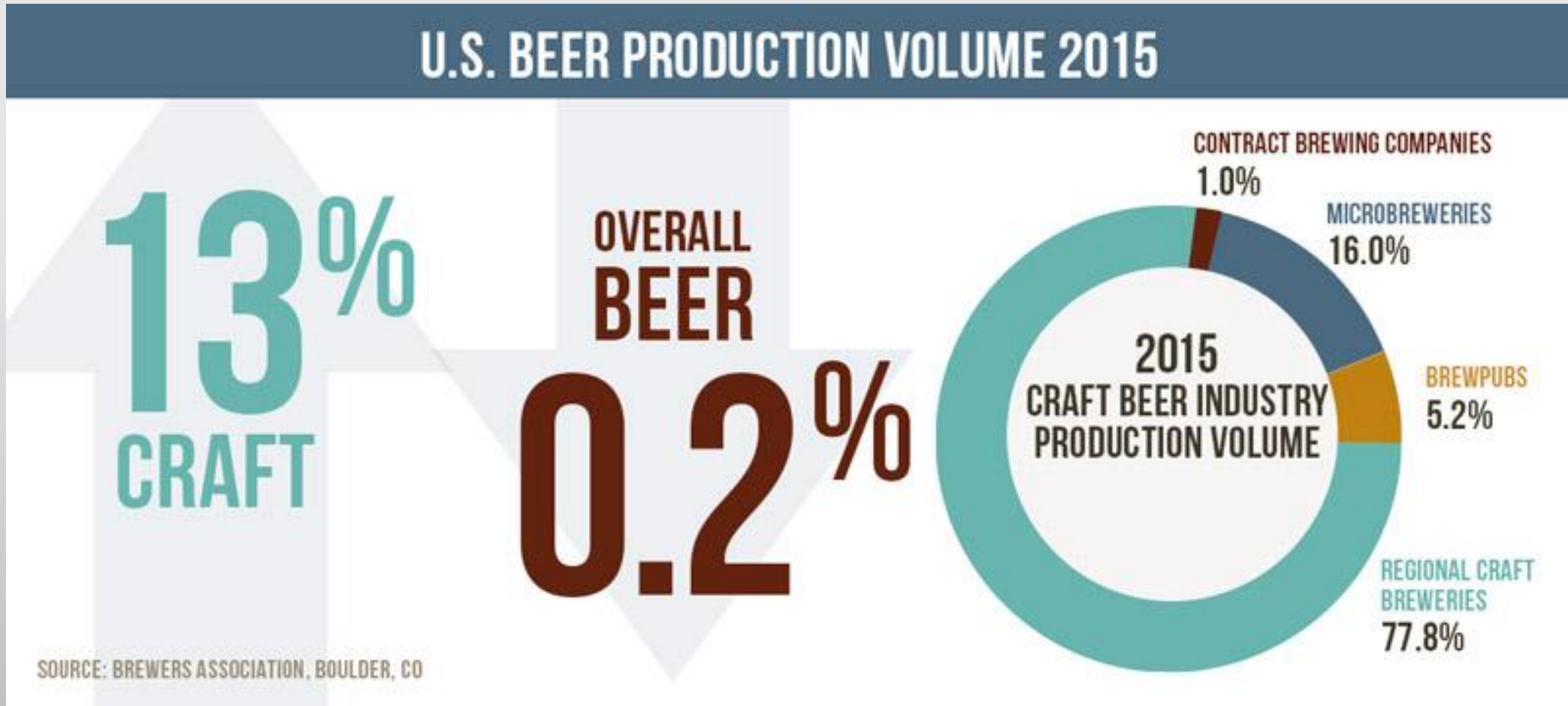
	2012	2013	2014	2015	'14 to '15 % Change
<b>CRAFT</b>	<b>2,401</b>	<b>2,863</b>	<b>3,676</b>	<b>4,225</b>	<b>+ 18.1</b>
Regional Craft Breweries	97	119	135	178	+ 31.9
Microbreweries	1,149	1,464	2,041	2,397	+ 21.6
Brewpubs	1,155	1,280	1,500	1,650	+ 12.2
LARGE NON-CRAFT	23	23	26	30	
OTHER NON-CRAFT	32	31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



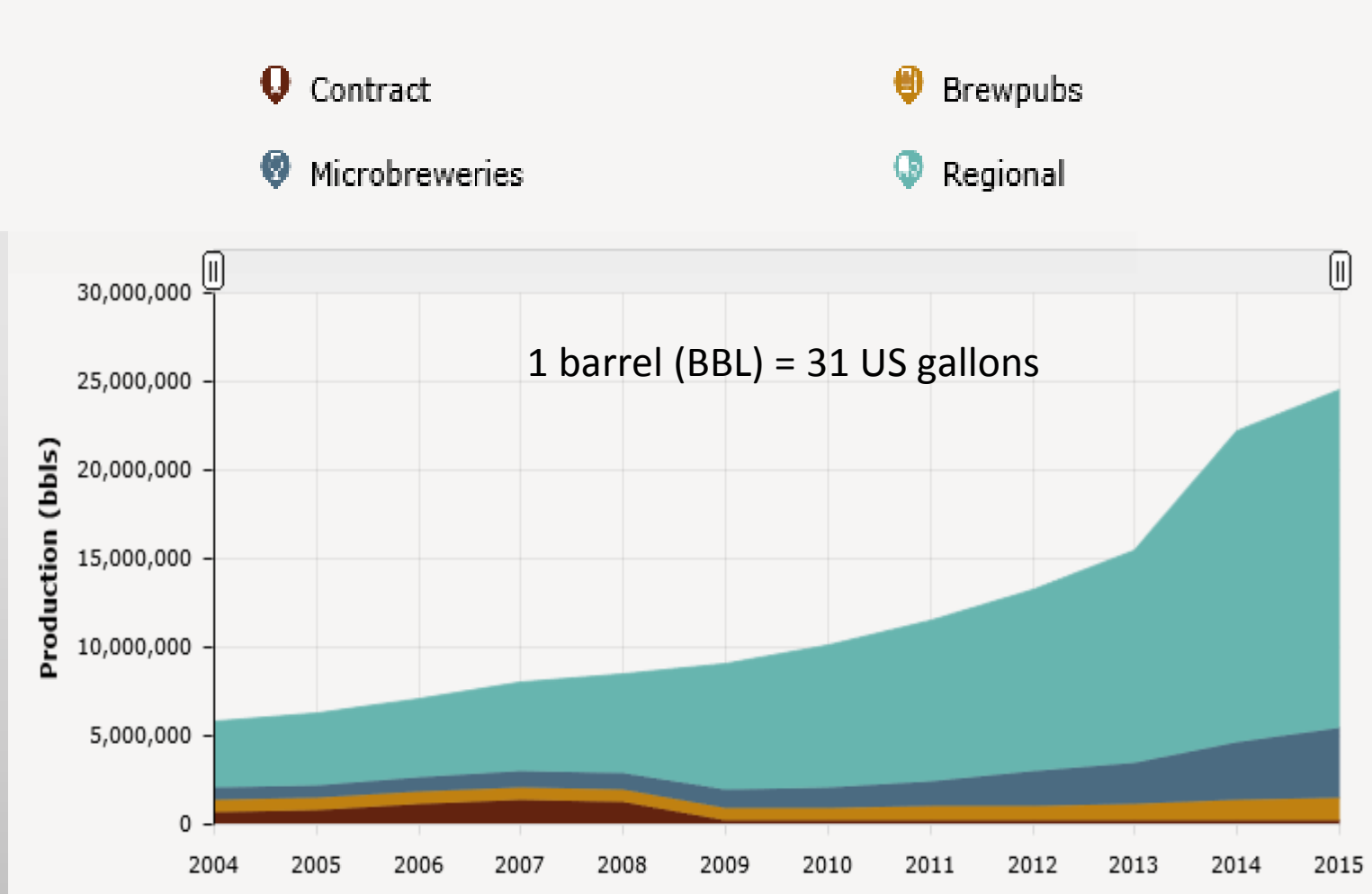
# Growth of Breweries – U.S. Beer Sales Volume Growth - 2015



# Growth of Breweries – U.S. Beer Production Volume - 2015



# Growth of Breweries – U.S. Beer Production Volume - 2015



Regional  
19,079,780 BBLs

Microbreweries  
3,927,063 BBLs

Brewpubs  
1,281,991 BBLs

Contract  
234,181 BBLs

SOURCE: BREWERS ASSOCIATION, BOULDER, CO

# Variability in Quality Control Resources

- There is a wide range of variability in the resources dedicated to Quality Control in the Brewing Process due to the diverse aspects of a brewery, including:
  - Size & Age
  - Degree of Process Complexity
  - Degree of Automation
  - Kinds of Beers Produced
  - Workforce Size and Degree of Skill
  - Availability of In-house Technical Resources:
    - Laboratory Analyses – Chemical, Physical, Microbiological
    - Instrument Calibration and Maintenance

# Quality Control Aspects in Malting and Beer Brewing Processes

- Definitions of Malting and Brewing
- The 3 Key Biochemical Processes
- Quality Control Aspects of Malting Process
- Quality Control Aspects of Brewing Process

# Definitions of Malting and Brewing

- **MALTING:**

- Malting is a process of converting raw grain into malt.
- The malt is mainly used for brewing or whiskey making, but can also be used to make malt vinegar or malt extract. Various grains are malted, the most common grains used are barley, sorghum, wheat and rye.

- **MALT:**

Malt is germinated cereal grains that have been dried.

- **BREWING:**

The production of beer by steeping a starch source (commonly cereal grains, the most popular of which is barley) in water and fermenting the resulting sweet liquid (wort) with yeast. It may be done in a brewery by a commercial brewer, at home by a homebrewer, or by a variety of traditional methods.

- **BEER:**

A generic name for alcoholic beverages produced when extracts from cereal grains and other starchy materials are fermented by yeast.



# The 3 Key Biochemical Processes

## 1. MALTING:

- Create Enzymes at Malt Plant (Malthouse)
- 3 Major Steps Involved:
  - Steeping
  - Germination
  - Kilning / Roasting
- Takes Approximately One Week

## 2. MASHING:

- Convert Starch, From Malt and Adjunct, to Fermentable Sugars in Brewhouse Mashing Step (Wort Production)
- Takes Hours

## 3. FERMENTATION:

- Yeast Ferments (Converts) Fermentable Sugars to Alcohol and Carbon Dioxide
- Takes Approximately One Month

# Quality Control Aspects of Malting Process

- Quality Control vs Quality Assurance
- Simplified Malting Process
- Malting Process Quality Control
- Simplified Brewing Process
- Brewing Process Quality Control

# Quality Control vs Quality Assurance

- **Quality Control** is a process by which entities review the quality of all factors involved in production. ISO 9000 defines quality control as "A part of quality management focused on fulfilling quality requirements".
- This approach places an emphasis on three aspects:
  1. Elements such as controls, job management, defined and well managed processes, performance and integrity criteria, and identification of records.
  2. Competence, such as knowledge, skills, experience, and qualifications.
  3. Soft elements, such as personnel, integrity, confidence, organizational culture, motivation, team spirit, and quality relationships.
- Controls include product inspection, where every product is examined in detail before the product is sold into the external market.
- The quality of the outputs is at risk if any of these three aspects is deficient in any way.
- **Quality Control** emphasizes testing of products to uncover defects and reporting to management who make the decision to allow or deny product release, whereas **Quality Assurance** attempts to improve and stabilize production (and associated processes) to avoid, or at least minimize, issues which led to the defect(s) in the first place.
- **Quality Assurance** assures the quality of the product (Beer) by systematic monitoring of raw materials, in-process product, and end product.

# The Quality Priority Pyramid



SOURCE: BREWERS ASSOCIATION

# Simplified Malting Process

- Harvest
- Barley Intake (Barley Elevator)
  - Receiving, Inspecting, and Cleaning Barley
  - Storing & Handling Barley and Byproducts
- Malting Wet Process (Malt House)
  - Steeping
  - Germination
  - Kilning/ Roasting
- Malting Dry Process (Malt Elevator)
  - Cleaning, Storing, Blending, and Shipping Malt
  - Storing & Handling Byproducts

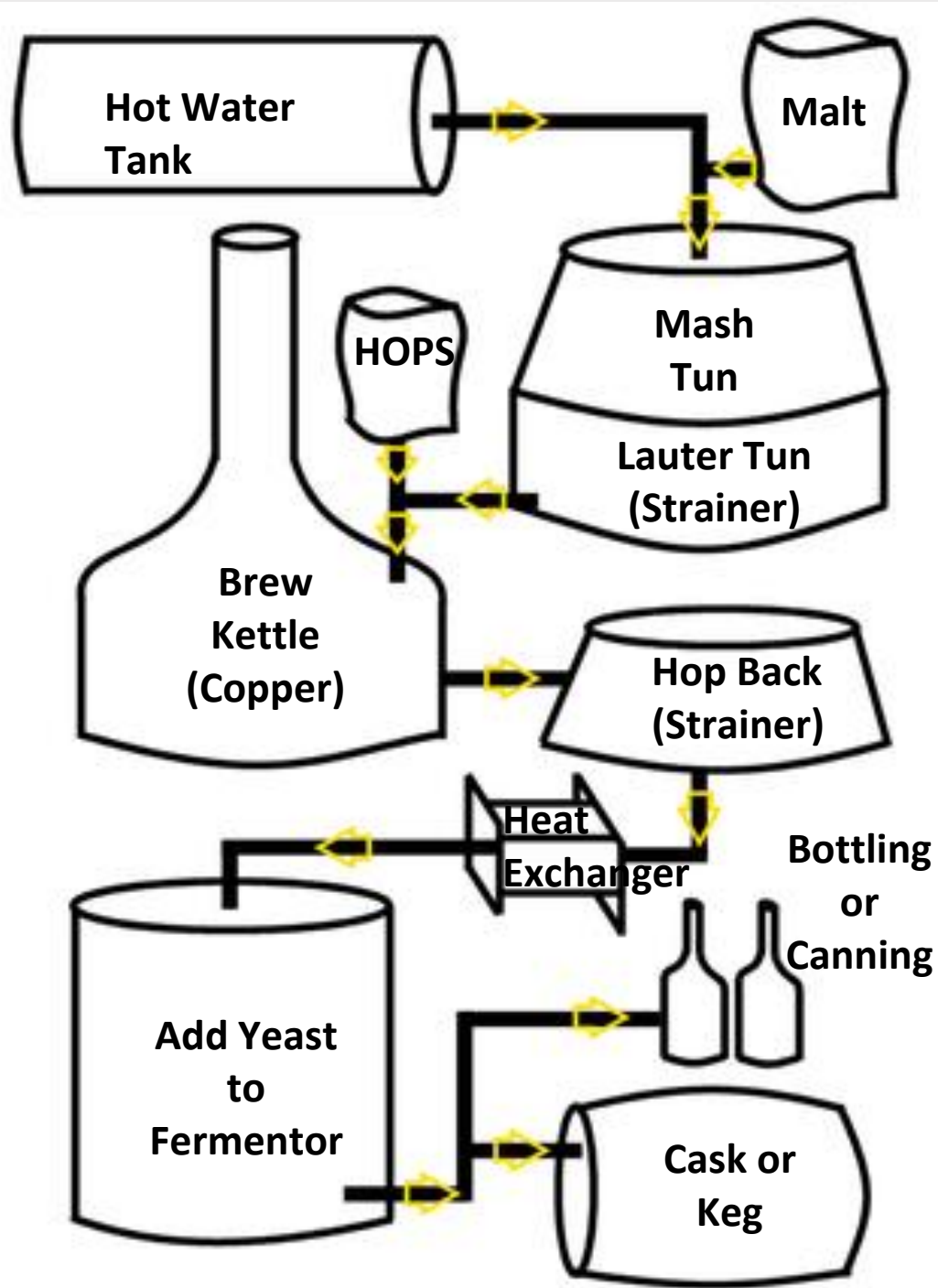
# Malting Process Quality Control

- The **barley** is tested to check for suitability for malting and to prevent dead or unfit barley from entering the process. Some of the typical quality checks include:
  - Color & Odor
  - % Moisture & Water sensitivity
  - Nitrogen content (Total Nitrogen) & Protein
  - % foreign seeds & materials
  - Absence of damage & fungal growth
  - Germinative capacity & Germination energy

# Malting Process Quality Control

- Barley Type & Variety
- Barley & Malt Kernel Size
- Time
- % Kernel Moisture
- Temperature & Flowrate of Water and Air
- Color of Malt
- Protein, Starch, & Enzyme Levels
- Sensory Evaluation

# Simplified Brewing Process



SOURCE: WIKIPEDIA



# Brewing Process Quality Controls

- Time (Manual Stopwatch vs Automation)
- Temperature (Thermometer vs Resistance Thermal Detector)
- Pressure
- Gravity of Wort and Beer (Hydrometer vs Handheld Digital Density Meter vs Inline Meter)
- pH
- Level (Sight Glass vs Level Sensor)
- Air Injection into Wort
- Yeast Injection and Pitching Rates
- Yeast Cell Counts
- Yeast Culture and Propagation
- Yeast Viability
- Dissolved Oxygen, Carbon Dioxide, Sulfur Dioxide
- Aerobic and Anaerobic Bacteria Counts
- Microbiological Culturing Media
- Turbidity
- Color (Color Table vs Spectrophotometer)
- IBU (International Bitterness Units) (Spectrophotometer)
- Alcohol (Alcohol by Weight vs Alcohol by Volume)
- Foam Collapse
- Standard Operating Procedures
- Sanitation
- Sensory Evaluation
- Many, many, many, more ....!

# Traceability Study

- Importance and need for a Food Safety Policy:
  - To provide customers with safe and wholesome products.
  - To comply with all relevant legislation relating to product integrity and overall food safety.
  - To avoid negative consequences of a product recall for safety reasons.
- These goals are achieved by implementing a Food Safety Policy, at all production sites, consisting of policies and programs:
  - Codex Alimentarius
  - Good Manufacturing Practices (GMP)
  - Hazard Analysis and Critical Control Point system (HACCP)
  - Global Food Safety Initiative (GFSI)
  - British Retail Consortium (BRC)
- Brewing Example

# Traceability Study – Brewing Example

- **EXAMPLE:**  
A product withdrawal or recall is announced for a beer found in the trade with a suspected safety hazard.
- The tracking process begins with the code labeling on the product:
  - **'born on date' or 'freshest before' date**
- The labeling code will determine the source brewery location, and the production date, time, and packaging line of the suspect product.
- The source brewery is notified and the product recovery procedure is implemented.
- A Traceability Study is ordered:  
Once the minimum information is gathered, all pertinent parties are notified and go into action to compile all relevant information regarding the product in question (e.g., suppliers; brewery; distributors; retailers).

# Traceability Study – Brewing Example

- Suppliers: Up-Stream & Down-Stream
  - Raw Materials & Yeast
  - Process & Cleaning Aids
  - Packaging Materials
- Brewery Product & Co-product Stream
  - Wort, In-process, and Finished Beer Processing
  - Packaging and Shipping
- Product Delivery Stream
  - Storage & Transportation
  - Distributor(s)
  - Retailer(s)
  - Customer
- Suspect Product Traceability Information

# Traceability Study – Brewing Example

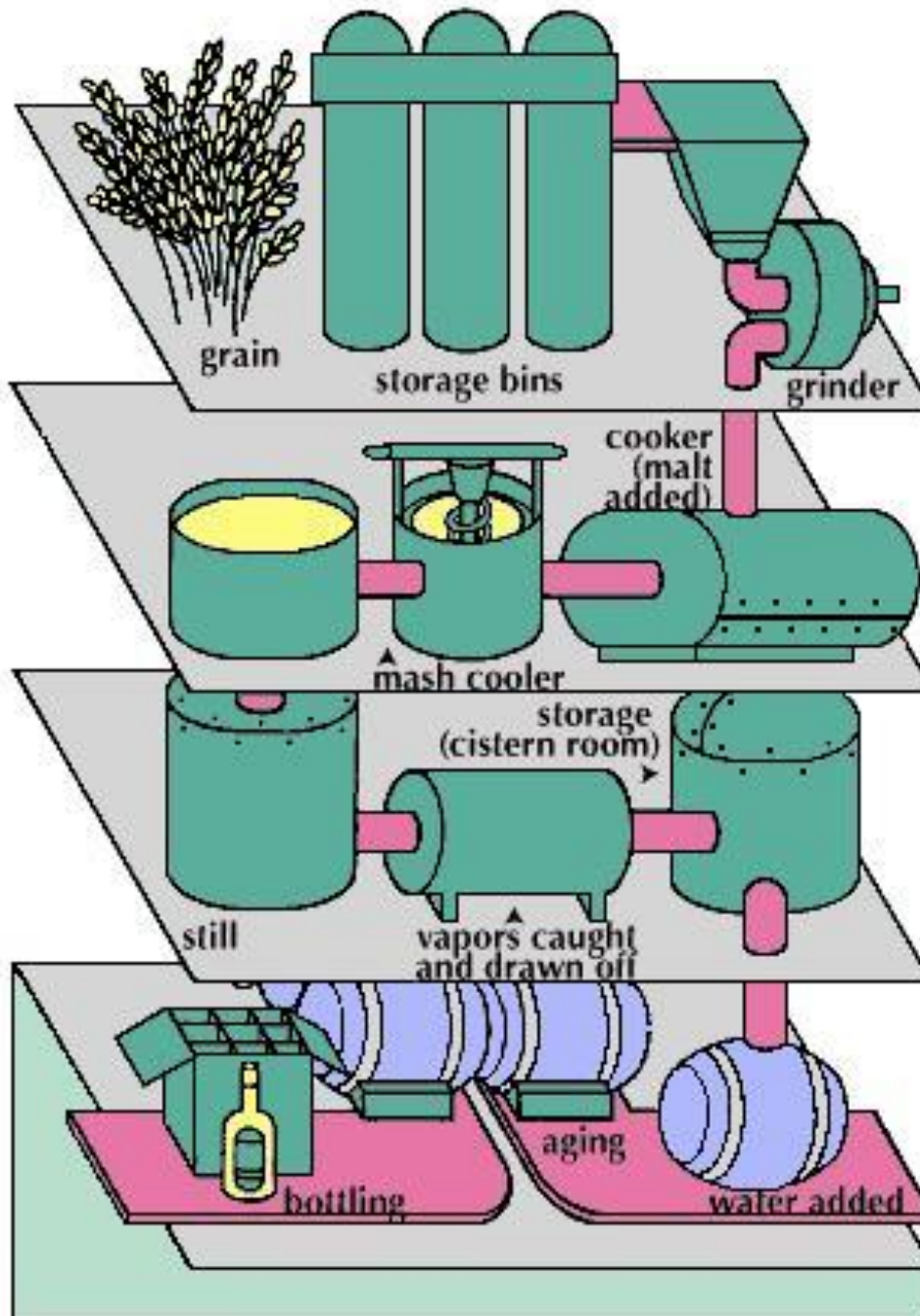
- Key Records to be Located for Supplier Stream
  - (e.g., for Raw Materials, Process & Cleaning Aids, Packaging Materials)
- Description
- Quantity
- Origin
- Tracking #
- Date and Method of Delivery
- Analytical Certification and Quality Control Data

# Comparison of Process Similarities in Related Industries

- Beer Production
- Wine Production
- Distilled Spirits Production (e.g., Brandy, Whisky, Rum, or Arrack)
- Bio-Fuel Ethanol Production

# Simplified Whiskey Production

## WHISKEY PRODUCTION



SOURCE: [www.britannica.com](http://www.britannica.com)

# Comparison of Process Similarities in Related Industries

- **INPUTS –**

**RAW  
MATERIAL  
FEED-  
SOURCES**

QUALITY CONTROL ELEMENT	BEER	WINE	DISTILLED SPIRITS	BIO-FUEL ETHANOL
Barley / Barley Malt	Y		Y	Y
Corn (Maize)	Y		Y	Y
Wheat	Y			Y
Sorghum	Y			Y
Rye	Y		Y	Y
Rice	Y		Y	Y
Grapes		Y	Y	Y
Non-grape Fruits		Y	Y	Y
Starchy Grains				Y
Molasses			Y	Y
Cassava				Y
Sugar cane			Y	Y
Sugar Beets			Y	Y
Sweet potato				Y
Potatoes			Y	
Coconut Flower Sap			Y	
Cellulosic (Non-food) Biomass: Straw; Corn Stalks; Leaves; Cobs and Husks; Forestry Waste - Wood Chips, Bark and Sawdust; Paper Pulp; Switchgrass; Algae.				Y
Culture Yeast	Y	Y	Y	Y
Culture Bacteria			Y	
Hops	Y			



# Comparison of Process Similarities in Related Industries

- KEY ANALYTICS**

QUALITY CONTROL ELEMENT	BEER	WINE	DISTILLED SPIRITS	BIO-FUEL ETHANOL
Gravity / Density / Specific Gravity	Y	Y	Y	Y
Alcohol	Y	Y	Y	Y
Color	Y	Y	Y	Y
Turbidity	Y	Y	Y	Y
pH	Y	Y	Y	Y
Sulphur Dioxide	Y	Y		
Dissolved Carbon Dioxide	Y	Y		
Protein Stability	Y	Y	Y	
Potassium Bitartrate Stability		Y		
Control of Phenol Extraction		Y		
Microbiological	Y	Y	Y	Y

# Comparison of Process Similarities in Related Industries

- **PROCESS CONTROL**
- **SANITATION**
- **PRODUCT LABELING**
- **SENSORY**

QUALITY CONTROL ELEMENT	BEER	WINE	DISTILLED SPIRITS	BIO-FUEL ETHANOL
Time, Temperature, and Pressure Control	Y	Y	Y	Y
Crushing / Pressing		Y	Y	Y
Grain Milling	Y		Y	Y
Conversion of Starches to Sugars	Y	Y	Y	Y
Fermentation of Sugars to Alcohol	Y	Y	Y	Y
Distillation			Y	Y
Oxidative Degradation / Dissolved Oxygen	Y	Y	Y	Y
Accurate Recordkeeping	Y	Y	Y	Y
Sanitation	Y	Y	Y	Y
Label Coding	Y	Y	Y	Y
Sensory Analysis / Palatability	Y	Y	Y	?

# Networking Opportunities in the Malting and Beer Brewing Industries

- Malting and Brewing Associations:
  - Trade
  - Technical / Analytical
  - Beer Distribution
  - Industry Lobbying

# AHA

## **American Homebrewers Association (AHA)**

- Not-for-profit organization.
- Dedicated to promoting the community of homebrewers and empowering homebrewers to make the best beer in the world.

# AMBA

## **American Malting Barley Association, Inc. (AMBA)**

Mission:

To encourage and support production of an adequate supply of high-quality malting barley for the malting and brewing industry and to increase our understanding of malting barley.

# ASBC

## **American Society of Brewing Chemists (ASBC)**

- A great resource in instrument usage and standard methods of analysis.
- One of the most widely used standard methods of analysis in the industry.
- Offers some Collaborative Analyses:
  - ASBC also offers a check sample program, which allows breweries to perform analysis of varying methods using sample kits sent to multiple breweries performing the same analysis. It verifies the consistency of the procedure as well as technical proficiency by the individual brewery. This is a valuable opportunity for any brewery to evaluate their interpretation and performance of the standard method.

BA

## **Brewers Association (BA)**

- Not-for-profit commercial brewers' trade association.
- Promoting Independent Craft Brewers.

BI

## **Beer Institute (BI)**

- Beer industry lobbying.



# EBC

## **European Brewing Convention (EBC)**

- A great resource in instrument usage and standard methods of analysis.
- One of the most widely used standard methods of analysis in the industry.

# MBAA

## **Master Brewers Association of the Americas (MBAA)**

- Trade and technical association.
- Purpose:  
Promoting, advancing, and improving the professional interest of brew and malt house production and technical personnel.

# NBWA

## **National Beer Wholesalers Association (NBWA)**

- Represents the independent beer distribution industry.

# TTB

## **Alcohol and Tobacco Tax and Trade Bureau (TTB)**

- Regulates:
  - Beer
  - Wine
  - Distilled Spirits
  - Other Alcohol (Denatured; Fuel; etc.)
  - Tobacco
  - Firearms / Ammunition

# REGULATIONS - Title 27: Alcohol, Tobacco Products and Firearms

## PART 25—BEER

### Subpart E—Measurement of Beer

- **§25.42 Testing of measuring devices.**
- (a) *General requirements.* If a measuring device such as a meter or gauge glass is used to measure beer, the brewer shall periodically test the measuring device and adjust or repair it, if necessary. The brewer shall keep records of tests available for inspection by appropriate TTB officers. Records of tests will include:
  - (1) Date of test;
  - (2) Identity of meter or measuring device;
  - (3) Result of test; and
  - (4) Corrective action taken, if necessary.
- (b) *Requirements for beer meters.* The allowable variation for beer meters as established by testing may not exceed  $\pm 0.5$  percent. If a meter test discloses an error in excess of the allowable variation, the brewer shall immediately adjust or repair the meter. Adjustments will reduce the error to as near zero as practicable.
- (c) *Authority to require tests.* If the appropriate TTB officer has reason to believe that the accuracy or reliability of a measuring device is not being properly maintained, he or she may require the brewer to test the measuring device and, if necessary, adjust or repair the measuring device.
- [Sec. 201, Pub. L. 85-859, 72 Stat. 1395, as amended (26 U.S.C. 5552)]

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Thank you!

**QUESTIONS?**