Improving Global Beer Quality Through Fermentation Control & Consistency

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UNITED WE BREW™

Objectives

- Why Focus on Fermentation Control & Consistency?
- Practical Approach using DMAIC Methodology
- Managing Across Multiple Brewing Locations
- Q&A

Question: What % of a Beer's Flavor is Attributed to Fermention vs. Brewhouse and Filtration?

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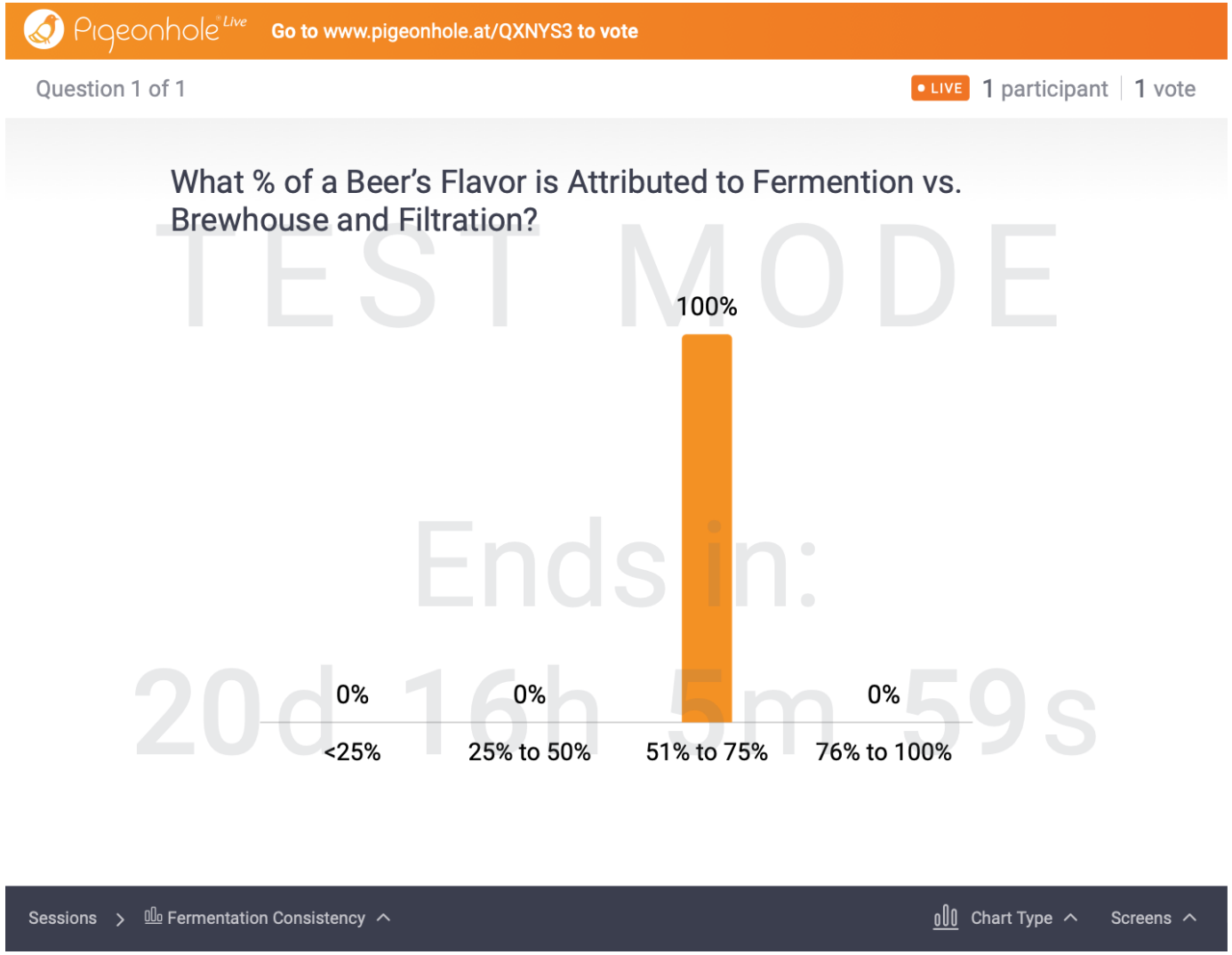
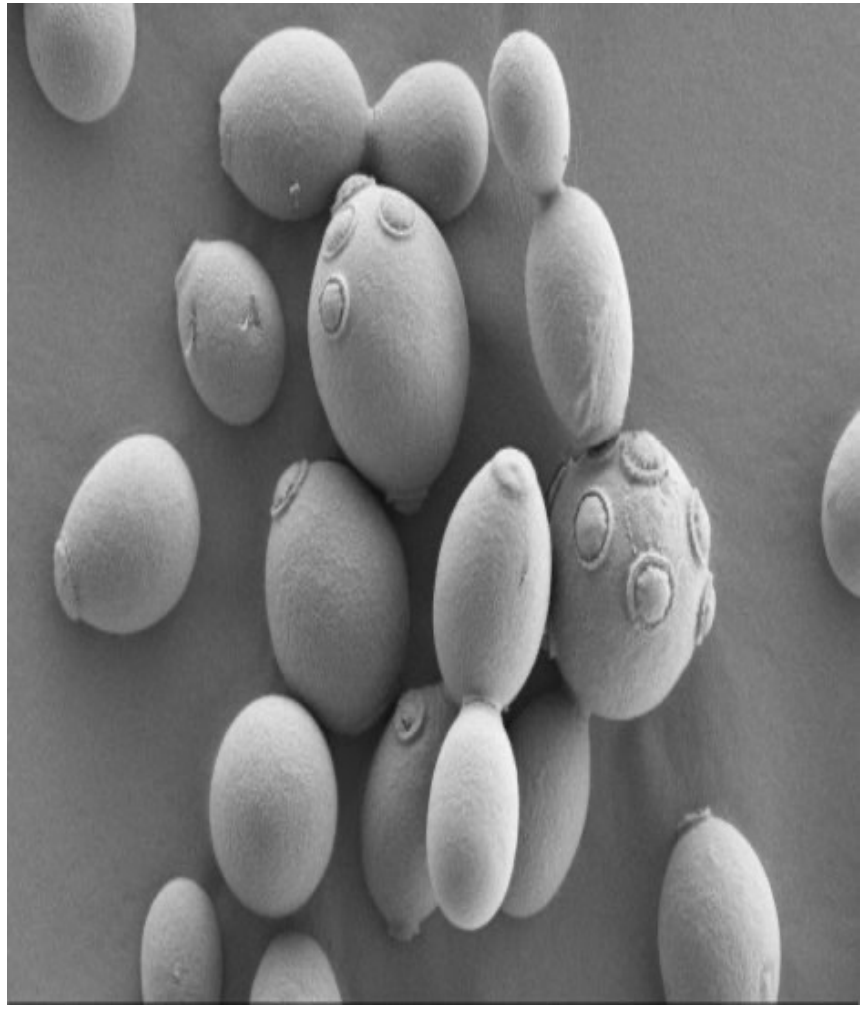


Why Focus on Fermentation Control & Consistency?

Significant impact on overall sensory perception

- **Aroma**
  - Alcohols, Sulfurs, Esters, VDK's, Aldehydes, etc.
- **Body/Mouthfeel**
  - CO2, RDF, Attenuation, Astringency, pH
- **Appearance**
  - Foam, Haze, Particulates
- **Freshness & Flavor Stability**
  - Reduction of Carbonyls, SO2



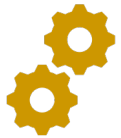
Why Focus on Fermentation Control & Consistency?

- **Operational Considerations**
  - **Capacity**
    - Overall Fermentation and Maturation Time
    - Fermenter Volume Utilization
  - **Extract Recovery**
    - Yeast Flocculation & Recovery
    - Over-foaming
  - **Consistency and Repeatability**
    - Single Brewery - Batch to Batch Consistency
    - Multiple Brewery – Brand Consistency
    - Ideal for Process Improvement and Optimization

Our Continuous Improvement Approach

Focus on Fermentation Consistency

Identify Main Drivers of Fermentation Performance



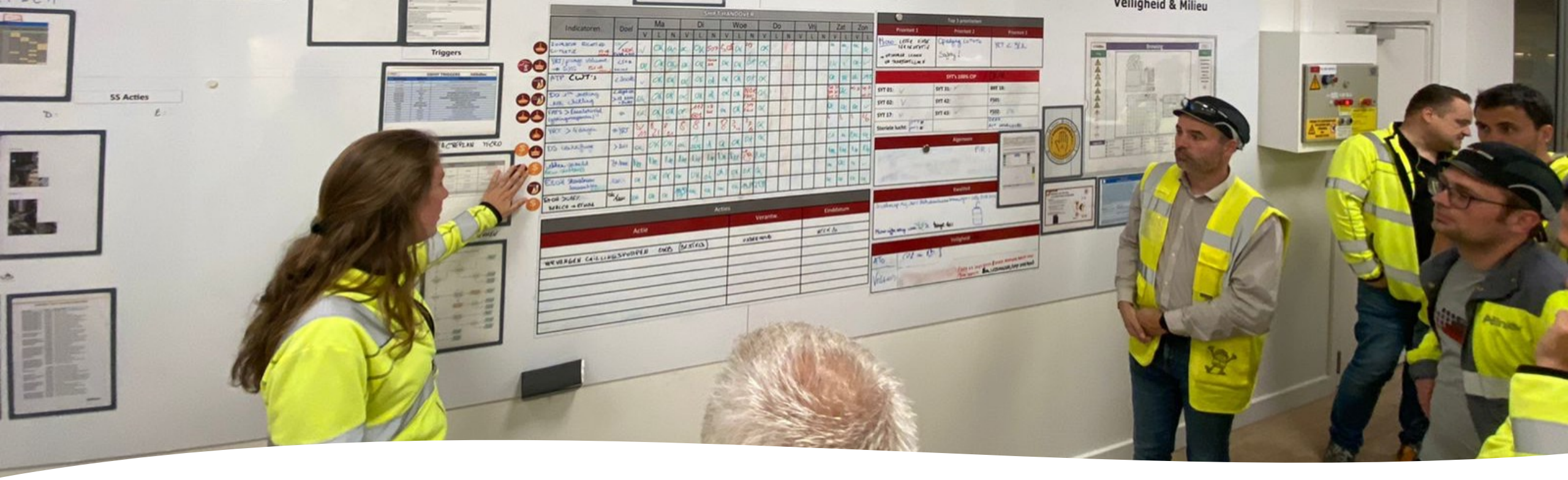
Keep it Simple – Identify Critical Few Process Drivers

Standardize Engineering Design & Implementation Plan

Must be "Frontline" Understandable and Monitored

Support with Full Education & Training to "Frontlines". Teach the "WHY"!

Leverage DMAIC Methodology

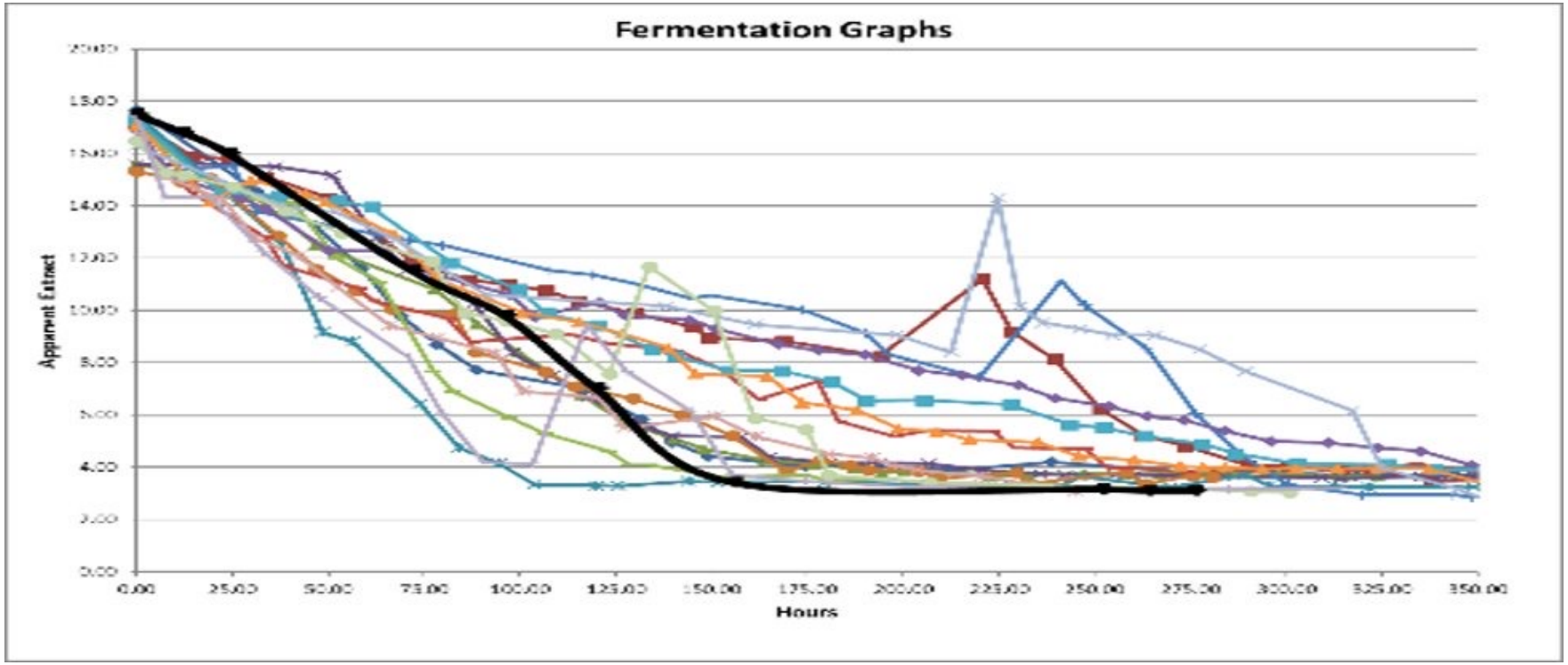


QUICK PRIMER ON DMAIC

- Lean Six Sigma Problem Solving Methodology
- More advanced form of PDCA (Plan, Do, Check, Act)

- D – Define
- M – Measure
- A – Analyze
- I – Improve
- C - Control

Define The Problem and Scope



Process Variability

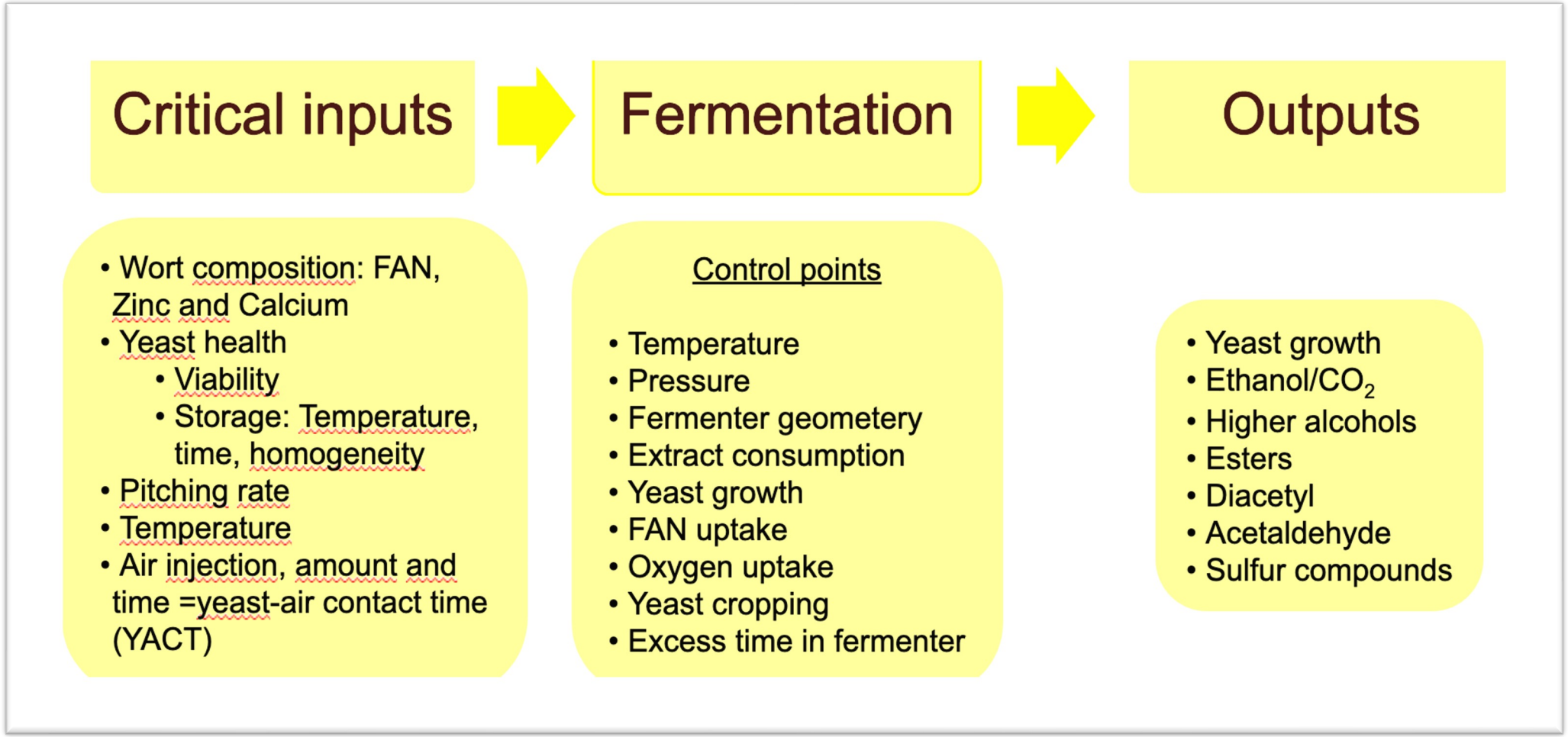
Lack of Process Control

No Standard Tracking and Monitoring

Critical Inputs & Outputs Not Defined

Technical Knowledge Gap

Define The Problem and Scope (Key Drivers)

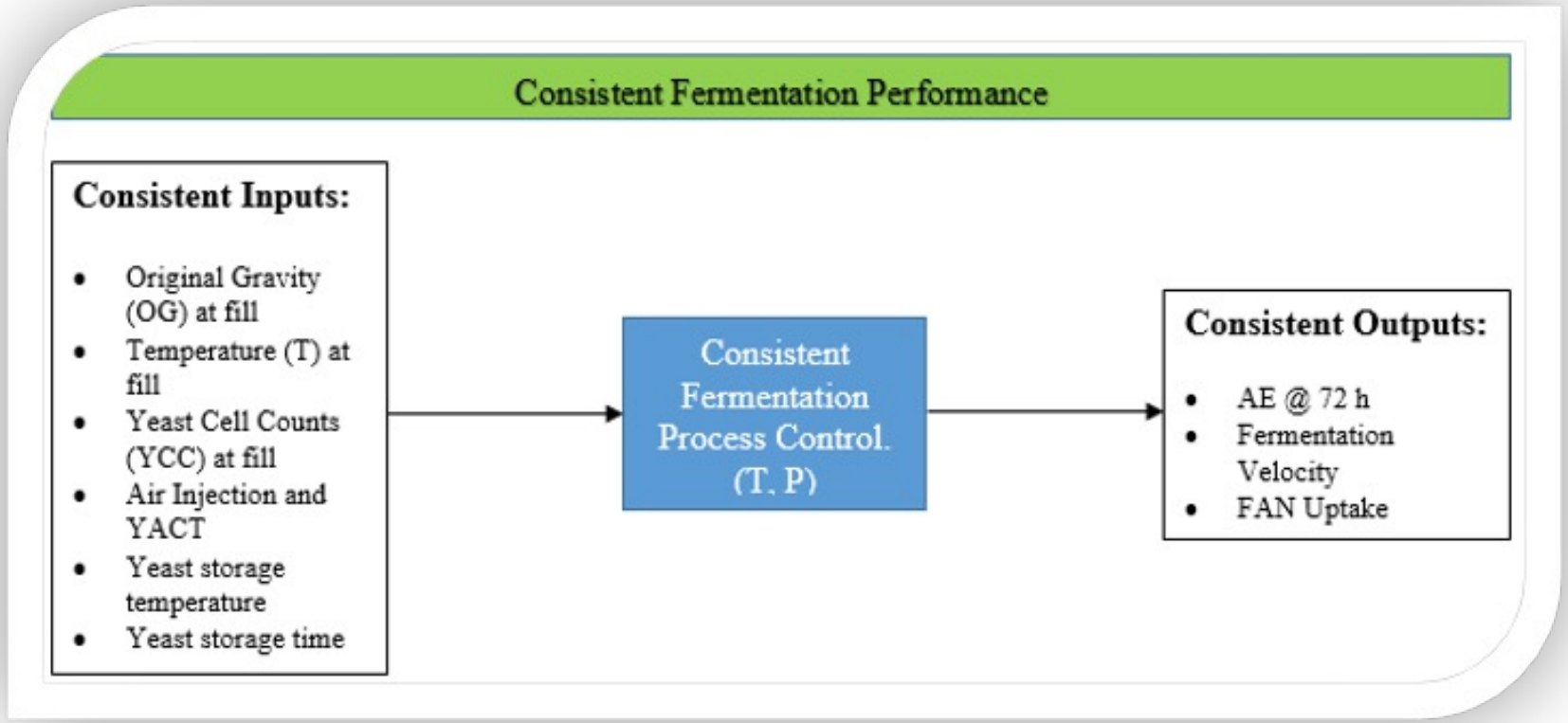


Define The Problem and Scope

Narrowed Focus Areas to Three Blocks to Improve Fermentation Consistency:

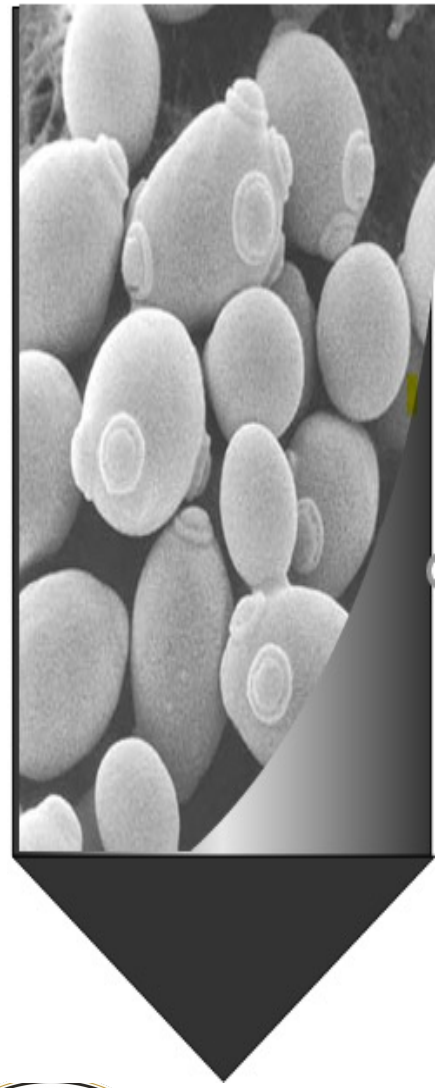
- Technical Knowledge
- Minimum Mandatory Equipment
- Fermentation Consistency Index

Measure – The Fermentation Consistency Index



- FCI developed to drive consistency in the fermentation process
- Process Indicators (PI's) within FCI are highly related to the brewer's involvement and basic understanding of the fermentation process.
- Only 2 PI's (YCC and FAN) requires laboratory support.
- FCI Policy, calculation tool and training material for brewers were developed.

Analyze – Global Consolidated FCI Scores



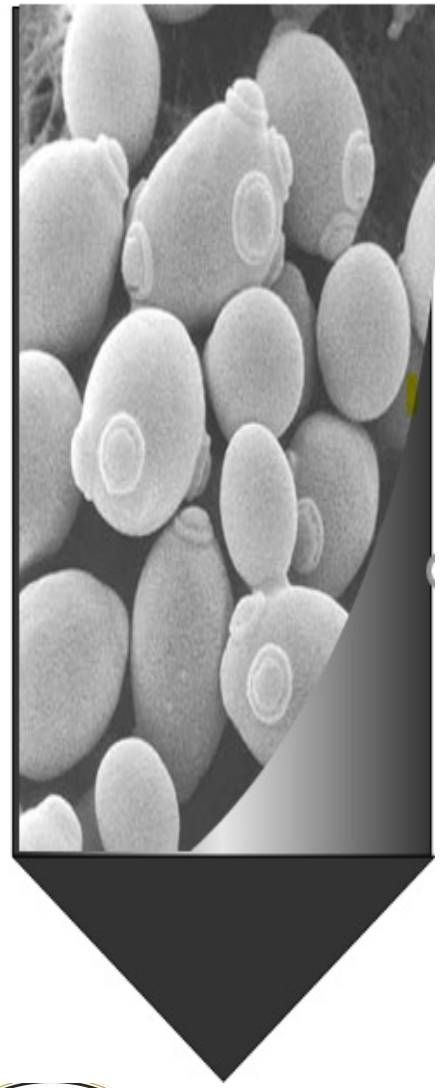
Fermentation Consistency Index Dashboard											
Zone	OG at fill	T at fill	YCC at fill	YACT	Yeast Storage Temp	Yeast Storage Time	AE @ 72hrs	Fermentation Velocity	FAN Uptake	FCI	Benchmark
Zone 1	86.03%	79.15%	3.98%	5.85%	48.55%	66.11%	55.53%	62.93%	75.00%	52.31%	100%
Zone 2	43.71%	35.08%	15.42%	7.83%	97.33%	89.25%	54.92%	56.25%	0.00%	40.37%	100%
Zone 3	37.67%	34.00%	0.00%	0.00%	21.00%	100.00%	20.00%	54.33%	17.67%	31.63%	100%
Zone 4	35.60%	29.90%	12.65%	6.94%	34.33%	77.16%	40.07%	73.31%	83.84%	43.93%	100%
Zone 5	89.18%	63.21%	9.28%	6.97%	59.71%	98.19%	63.10%	62.56%	65.40%	55.30%	100%
Zone 6	44.42%	63.48%	7.65%	8.03%	71.47%	87.36%	22.53%	54.62%	46.69%	40.50%	100%
Global	56.10%	50.80%	8.16%	5.94%	55.40%	86.35%	42.69%	60.67%	48.10%	44.01%	100%

FCI calculation:

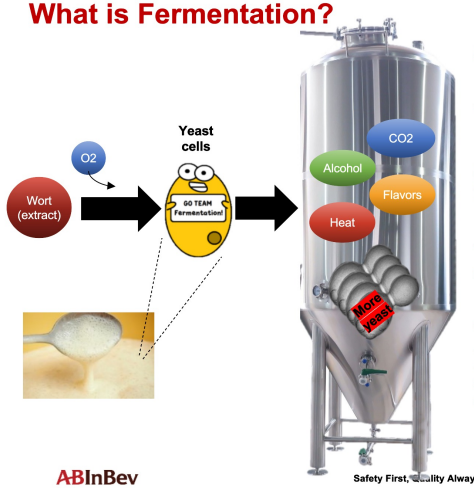
Fermentor No	Brand	OG at Fill (10%)	T at Fill (10%)	YCC at fill (10%)	Air Injection & YACT (15%)	Yeast storage Temp. (10%)	Yeast Storage time (10%)	AE@ 72 h (10%)	Fermentation Velocity (10%)	FAN Uptake (15%)	**FCI (%)**

- ***Results confirm initial predictions!***
- **2 critical control points - Air injection control, Pitching rate and yeast growth are the biggest gap.**
- **4 control points – OG at fill, T at fill, Yeast storage temp and Yeast storage time do not require capex and are simple to correct.**

Improve – Increase Technical Knowledge



What is Fermentation?



Air (oxygen) is added to wort from brewhouse

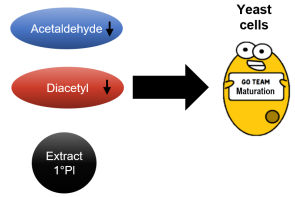
Yeast is added to the aerated wort

At the start of the fermentation, yeast takes up first the oxygen

Then yeast consumes the extract in several days and the magic happens, wort becomes beer!

Yeast produces during this time also:
- More yeast (yeast grows)
- CO2
- Alcohol
- Beer flavors

What is Warm Maturation?



The warm maturation is the phase after the main fermentation, when only small amount of extract is left

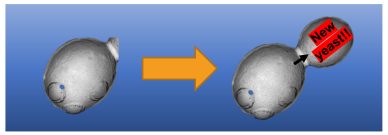
During the warm maturation, unwanted flavours as Diacetyl and Acetaldehyde are removed from the beer by yeast

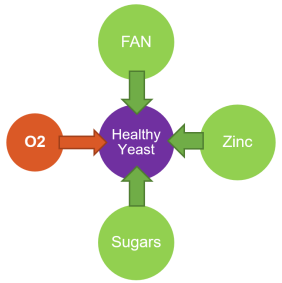
Fermentation and warm maturation happens usually in the same vessel. Sometimes it is done in 2 seperate vessels

It takes several days to remove enough Diacetyl

A lower pH speeds up the diacetyl reduction! This is mainly controlled by the wort pH.

Yeast Growth





To have good yeast growth during the main fermentation, 3 things are important

1. The added yeast must be healthy:
   - Recovered on time from FV (see brand spec)
   - Storage of less than 72hrs before addition
   - Stored between 1 and 3°C
2. Wort must contain sufficient minerals (Zinc) and Amino Acids (FAN)
3. There must be sufficient oxygen available

The amount of yeast growth is in practice fine-tuned by controlling the amount of added oxygen. This is done by the air injection system.

How applies this for fermentation?

KPI
- Taste Panel Score
- Brewery output
- Consistency Index

Lagging PIs
- Main fermentation time
- Fermentation and maturation cycle time
- Total diacetyl level in cold aging
- Fermentation flavors
- Recovered yeast viability

LEADING PIs – Scheduling Area
- Yeast storage time
- Yeast generation

LEADING PIs – Brewhouse Area
- Amount of injected air per hL of wort
- Yeast air contact time
- Which of the brews have been aerated in a multibrew fermenter
- Cold wort OE
- Cold wort pH
- Yeast dose rate in liters of viable yeast per hl wort
- In which brew the yeast has been pitched of a multibrew fermenter
- Quantity of Zn product dosed

LEADING PIs – Fermentation Area
- Pressure during the main fermentation (first 150 hrs)
- Moment (time) of cold trub purge after fermenter full
- Temperature directly after fermenter filling
- Main fermentation temperature
- Free rise temperature
- AE level at which the free rise done
- AE level at which the cone cooling applied
- AE level at which the cool back is done from main fermentation temp to warm maturation temp
- Pitching yeast storage temperature after 24h
- Time for yeast cropping after a certain trigger point (cone cooling or fermenter cooling)
- Pressure during the warm maturation
- Number of purges during warm maturation
- Warm maturation temperature
- Total diacetyl level end of warm maturation at which the fermenter cooling is done

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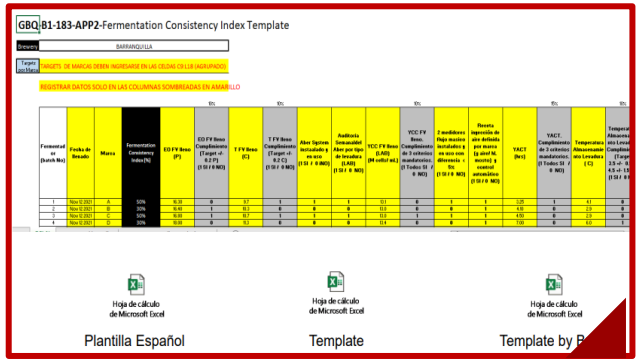
Improve: FCI | Implementation Example – Middle America Zone

KPI Cascade → Global Team
Dec21

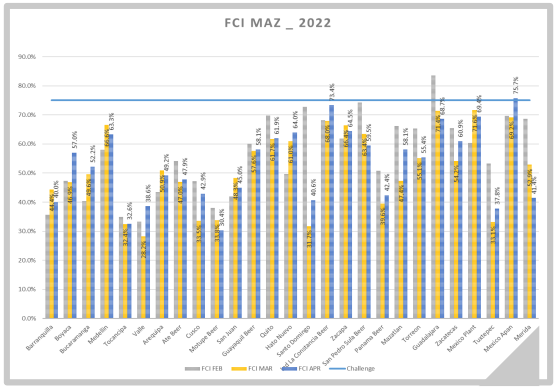
MAZ Policy translation
Jan22



Feedback Meeting with Global: concepts and calculations

MAZ: Excel template for calculation

Cascade meetings with MAZ Regions

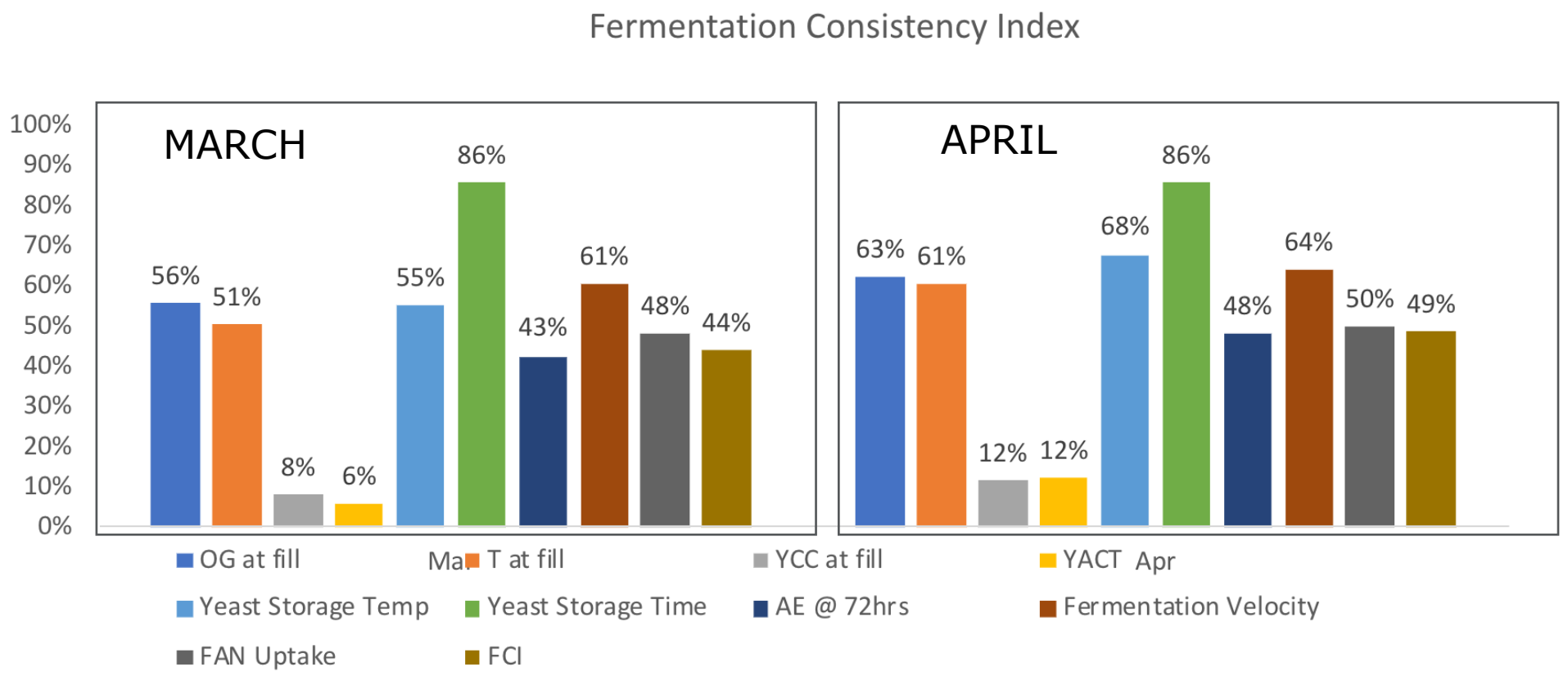


MAZ report started
Feb22

Workshop B&Q: **Reinforcement with breweries**
Apr22

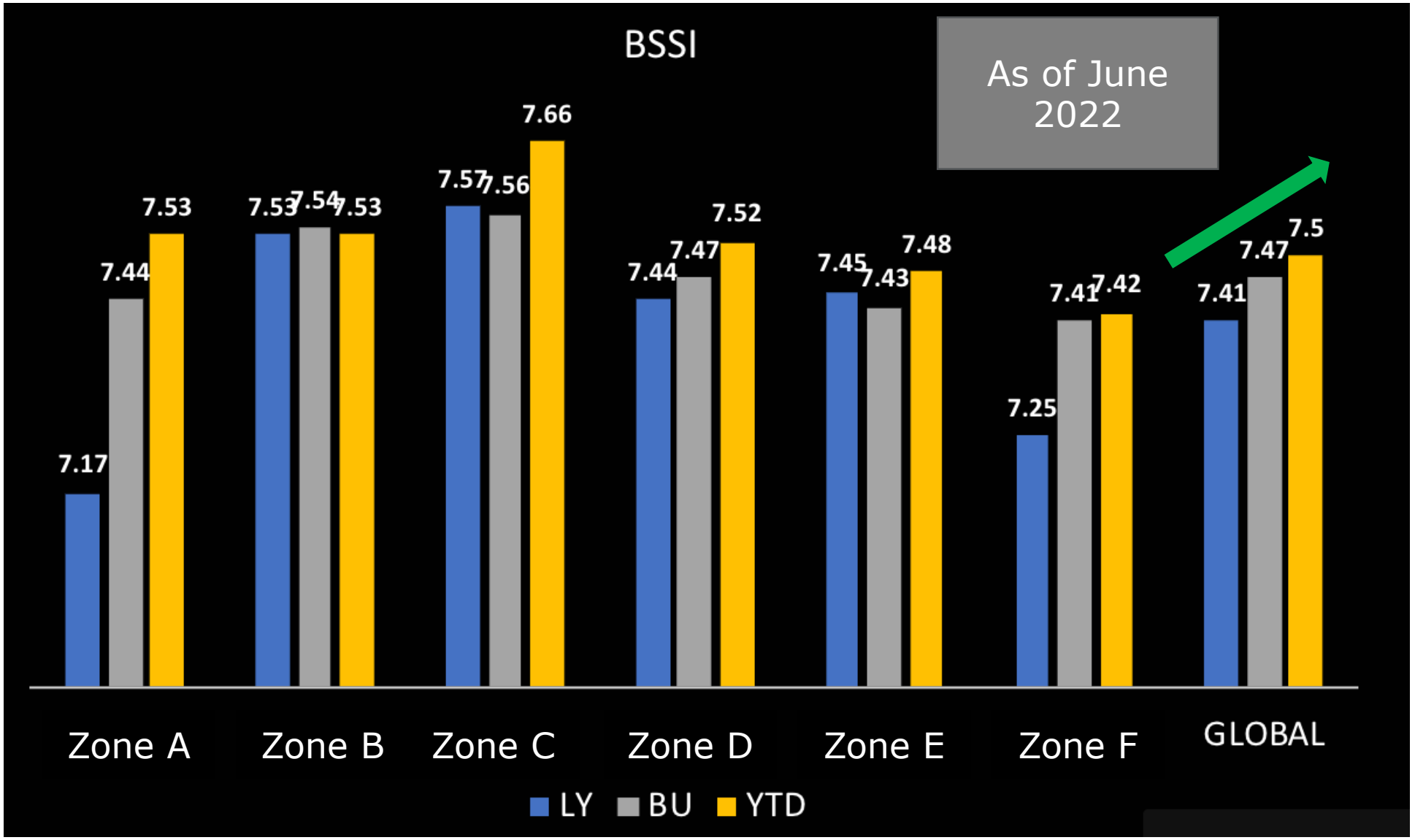
Improve: FCI | Cascade to Breweries

Control: Tracking & Monitoring



Improvement in 3 Parameters:
OG at Fill, Temp at Fill, and Yeast Storage Temperatures

Results: Global Beer Sensory Scores Improving!



Key Take-Aways

- Leverage Sensory Program to Drive Continuous Improvement
- Consistent Inputs + Consistent Outputs = Consistent Fermentations
- Technical Knowledge + Define Equipment + Standardize How to Measure
- Utilize Proven Problem Solving Methodologies – DMAIC
- Tracking and Monitoring Process Indicators (PI's) is critical for "Control" and Continuous Improvement
- Keep it Simple and Understandable
- Be Sure Teams Understand the "Why" Behind the "PI's"

Resources

- Contact info: Kristopher.Scholl@AB-InBev.com

CHEERS!

Thank You


Q&A