# AUTOCROPPING:

## Applied methodologies for top-cropping ale strains

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## PANELISTS

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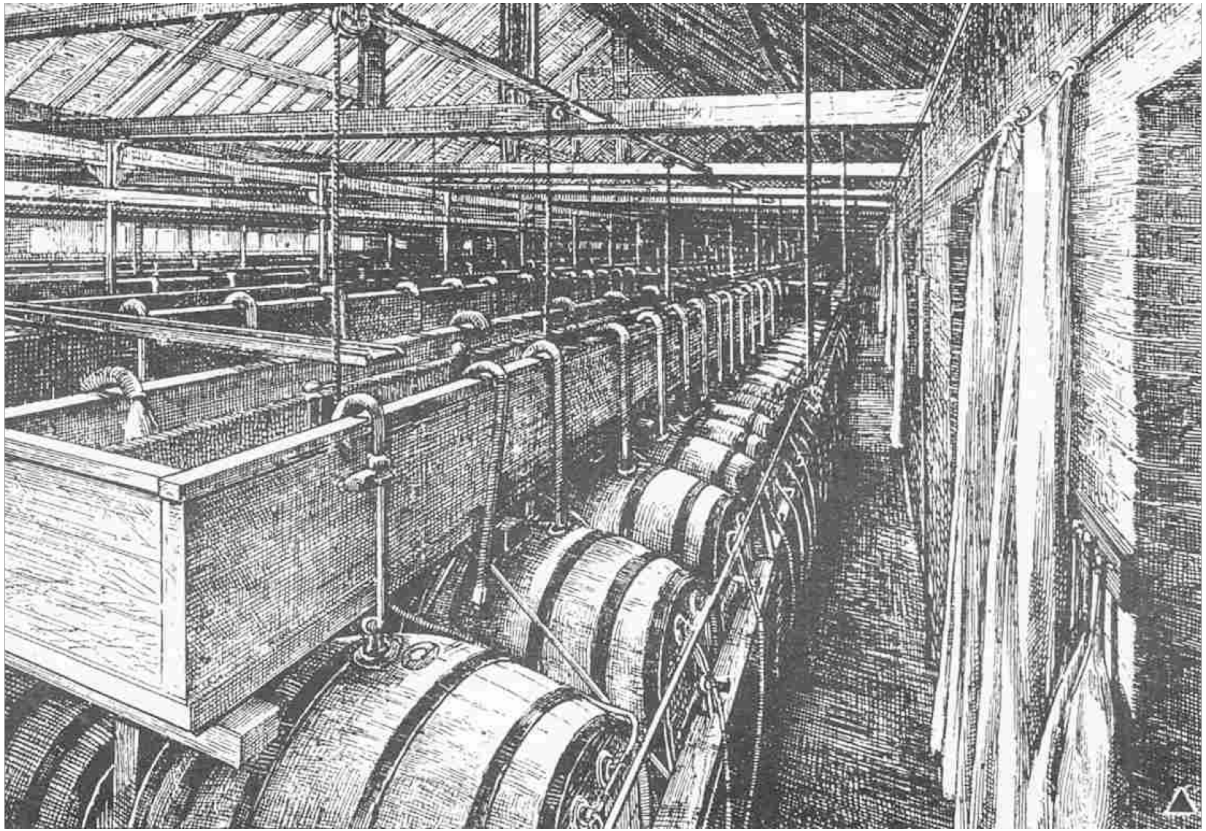
# There’s nothing radical or revolutionary at work here.

- Just a simple adaptation of a centuries-old methodology.
- Utilizes equipment on hand in most modern breweries.
- You’ve likely considered (or tried) employing a similar process.
- THE POINT: this is an easy and time-tested method of increasing yield, improving efficiency, and lowering costs in your brewery--and one you can initiate this afternoon.



Etching of the original Bass Union system.

via beerbrewer.blogspot.com

Firestone Union (2.0?) system on display in Paso Robles.
Photo courtesy Davestravelcorner.com.

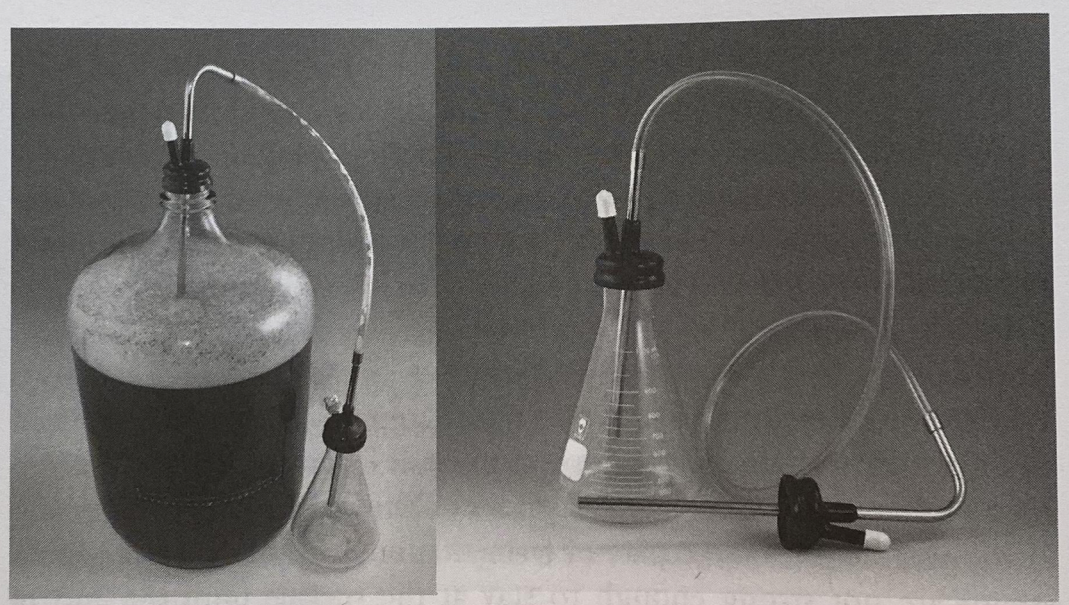


*Figure 5.11: Homebrew top cropping device. Photos courtesy of Samuel W. Scott.*

White, C., and J. Zainasheff, *Yeast*, Brewers Publications, 2010, 152.

# This is it.

- Relatively inexpensive: this system was assembled from scratch for less than $800 via Glacier Tanks, Sound Homebrew, and Haleson.
- Not visible: sprayball attached to the CIP/blow-off arm was pulled post-CIP and replaced with a concentric reducer.
- Once disconnected, a smaller airlock is installed.
- A dial-up, if you choose, is a small racking arm at the bottom of the brink.

# YEAST IMPACT

## AUTO/TOP-CROPPING

- Passive harvest.
- Self-selects healthiest cells.
- Harvest available for re-pitch in ~3 days.
- Higher viability and vitality. Lower concentration of trub.
- Exposed to fewer (or lesser levels of) stressors like ethanol, hydrostatic pressure, crash-cooling, CO2, etc.
- Removed prior to any mid-primary dry-hopping.
- Historically, top-cropping is a means of harvesting indefinitely. I've taken it 15 generations, a number limited only by tank availability.

## BOTTOM CROPPING

- Active harvest.
- Brewer estimates/selects healthiest cells.
- Harvest at/around terminal gravity and/or after cold-crashing, depending on strain. Process determinant: ~4-7 days at best?
- Lower viability/vitality. More trub.
- Potentially exposed to more (and/or higher levels of) stressors.
- Pitch potentially compromised by mid-primary dry-hopping.
- Can be harvested 8-15 generations, depending on efficacy of harvest/re-pitch execution.

# Yeast stress and transcriptional drift, via a layman

Last month, the MIT Technology Review reported on a recent study from the Brewing Yeast Research Group at Brazil's Federal University of Rio Grand do Sul, which detailed the following w/r/t lager yeast:

- Exposure to lower concentrations (<20%) of ethanol, like that in beer-making, stresses yeast, similar to the "heat shock" caused by elevated temps >35C.
- After ~250 generations, this stress impedes each cell's ability to fold its DNA into the correct shape.
- These stressors induce cells to use their cross-organelle response (CORE) signaling mechanism to correct mis-folding: these "chaperones" start working overtime.
- It's not yet known exactly how, but it makes sense: deploying CORE overtime to correct mass mis-folding during shock negatively impacts the cells' metabolism/vitality.
- This mis-folding eventually (~250 gens) leads to transcriptional drift and changes in gene expression.

# What about genetic drift?

In 2007, a team of researchers from Lallemand and BridgePort (RIP) demonstrated that serial repitching of their ale yeast didn't result in significant genetic variation, even after 98 bottom-cropped generations.

The same was true of BridgePort's lager strain over 135 generations.

Specifically: the study observed mostly macromorphological genomic variation and no changes to "fermentation characteristics."

However! As per episode 130 of the Master Brewers Podcast:

UW professor Maitreya Dunham and Tom Schmidlin from PostDoc Brewing have observed significant genetic mutation after serial repitching in as little as 30 bottom-cropped generations.

They observed that these mutations had profound consequences re: metabolism, growth, and stress tolerance.

I believe they're still investigating these mutations' impact on flavor.

# A hypothesis aka “the jump”

So while genetic mutations and transcriptional drift may or may not significantly impact flavor, they can demonstrably impact metabolism/vitality.

That, coupled with historical (and our recent) success with serial repitching top-cropped harvests, as opposed to bottom cropping, led me to believe the following:

Auto/top-cropping limits some stressors, presenting an opportunity for a more reliable yeast metabolism/vitality over an extended number of serial repitches, with no extraordinary (or, at least, a means of delaying) concern re: change to fermentation characteristics, genetic mutation, and/or transcriptional drift.

A caveat:

All research/counterpoints welcome! I’m just a layman--I would love to be proven wrong here. I’m very, *very* good at being wrong.

# But will it walk/climb?

**FACTORS:**

- Strain! LAIII sure will. S-04 will. And so will most ale strains, but not all.
- Tank geometry: skinny? Fat?
- Fill level. Use true tank volume.
- Fermentation temperature.
- Wort composition

**AS APPLIED AT MIRAGE WITH LAIII:**

- ➔ Controlled, reliable walking, after some initial trial and error. In cases of “error,” a bottom crop was always available.
- ➔ Portland Kettle Works’ standard 7bbl uni.
- ➔ Filled with 250 gallons, 90-95% of true tank volume:
- ➔ 66-67F, depending on desired yield, ambient temperature, and wort composition: 30-50% high-protein adjunct.

# BENEFITS

- Faster harvests, healthier yeast.
- Ability to dry-hop mid-primary without compromising harvest.
- Less time/labor spent harvesting.
- Less money spent on fresh pitches.
- And a not-so buried lede: this process nets a consistent ~8-10% increase in yield.

# HURDLES

- Cost of equipment.
- Habit! Sadly still a big factor in brewing.
- Training staff.
- Time spent in the lab.

# John Marti

Head Brewer, Lowercase Brewing

# My Experiences/Observations

True climber strains seem to work well.

- A01 House Ale (1098, S04) does not climb well enough to result in a pitch-worthy density...too flocculent?
- B44 Whiteout Belgian strain does climb well enough but is prone to sulfur if underpitched and back pressure is present.
- A38 Juice does work well, down side is slurry density but the upside is viability. Bottom crop Juice is not super dense (med. flocculator) anyways and definitely is less viable
- - Avg. of 5 bottom crops is .87 bill cells/mL with a viability of 83% = .72 bill cells/mL
- - Avg. of 54 top crops is .77 bill cells/mL with a viability of 94% = .72 bill cells/mL
- - Whoa, I just realized they have the same LIVE billion cells/mL

# IF you can’t count cells...

| As a last resort, use HOMOGENOUS amounts listed | | | |
|---|---|---|---|
| OG | Pitch Rate (Mcells/mL/°P wort) | Kg/bbl (not L/bbl) into tank | |
| 1.04 | 0.75 | 1.22 | |
| 1.044 | 0.75 | 1.34 | |
| 1.048 | 0.75 | 1.45 | |
| 1.052 | 0.75 | 1.56 | |
| 1.056 | 0.75 | 1.69 | |
| 1.06 | 0.75 | 1.81 | |
| 1.064 | 1 | 2.56 | |
| 1.068 | 1 | 2.7 | |
| 1.072 | 1 | 2.85 | |
| 1.076 | 1 | 3 | |
| 1.08 | 1 | 3.15 | |

# Averages based on beer-type (min. 4 harvest each)

Pale Ale: .73 bill cells/mL with a viability of 94%

IPA: .87 bill cells/mL with a viability of 94%

2xIPA: .69 bill cells/mL with a viability of 95%

Brown Ale: .83 bill cells/mL with a viability of 93%

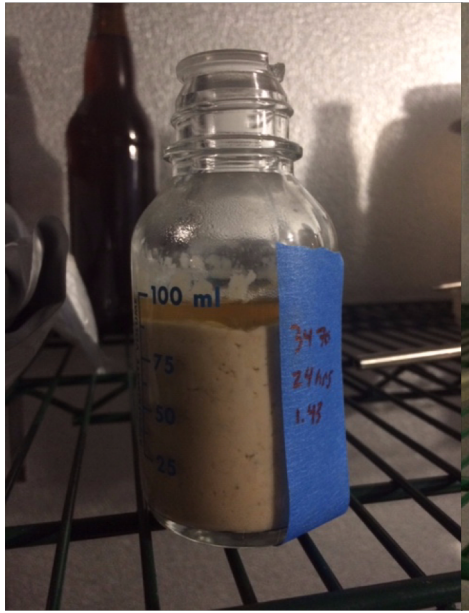
Rye IPA: .82 bill cells/mL with a viability of 93%

ESB : .57 bill cells/mL with a viability of 94%

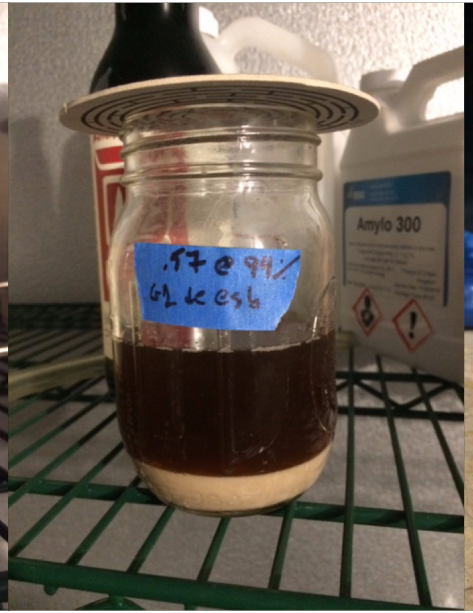
Stout: .72 bill cells/mL with a viability of 97%

Goal here is to convince you to count cells each time...there is variation amongst recipes.

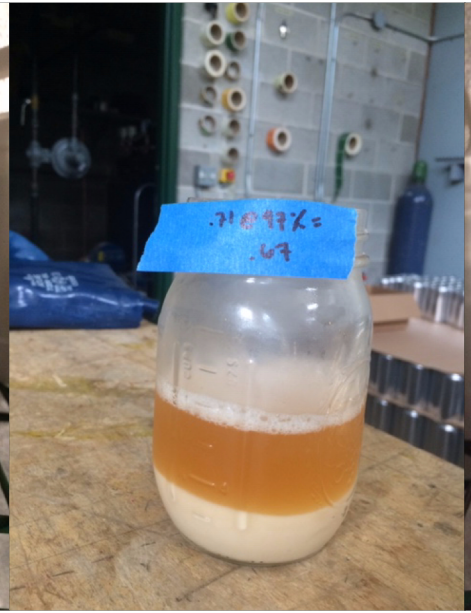
# Poor Man’s Yeast Count (24 hrs post-harvest)



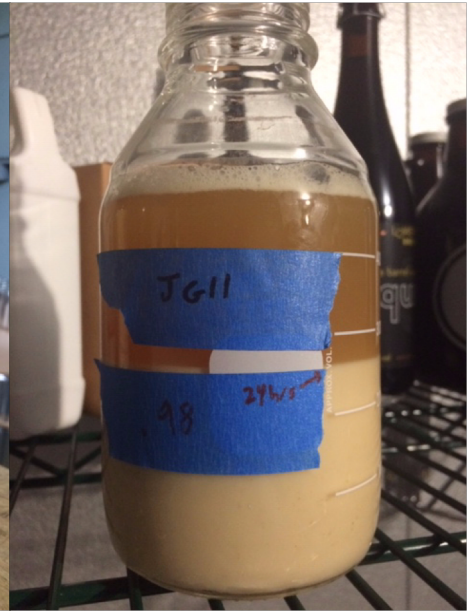

Lager 1.43 bill cells/mL




Juice .57 bill cells/mL




Juice .71 bill cells/mL




Juice .98 bill cells/mL

Genetic Drift? Doubt it based on Bridgeport study but we'll find out.

-Jack Vincent and UW Tacoma Beer Program/Imperial offered drift research.

-Try other strains...Kolsch? I haven't tried lager yet...sulfur scares me.

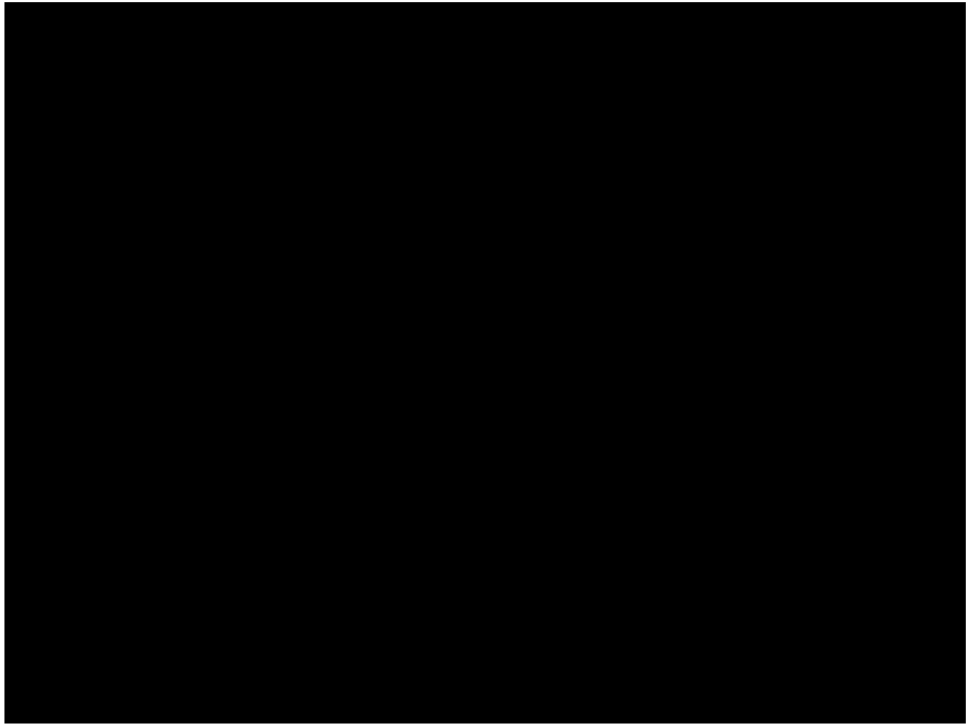
-Email any of us … john@lowercasebrewing.com

# Frank Trosset

Co-Founder/Head Brewer, Aslan Brewing Co.

## 60BBL AUTOCROP

- This tank was filled to 85% of its true volume with pale ale.
- Fermented with Juice/LAIII.
- A success: we harvested at least enough for a 0.75 million cells/ml pitch into 60bbls of IPA.



## 30BBL AUTOCROP

- Fermented with Barbarian/Conan.
- Tank was filled to 91% of its true vol.

# ...a failure.

- This demonstrated that Barbarian is not an ideal auto/top-cropping candidate.
- We were surprised to observe that, unlike most ale strains, Barbarian lives at the bottom.
- Accordingly, we still found it to be a great candidate for early harvests: we typically harvest from the cone on Day 2.
- That said, after 15-17 generations, we see a demonstrable drop in vitality.
- Know your strain.

# Justin Gerardy

Head Brewer/Owner, Standard Brewing

# Standard Brewing

## Monoculture cellar at the brewpub

- 7 bbl system
- 9 Unitanks
- Autocropping

## Mixed culture cellar

- 6 single walled dish bottom tanks
- ~100 barrels/puncheons
- Not currently autocropping

## Original mixed ferm cellar at the brewpub

- 22 barrels, upstairs
- Limited space meant using oak mostly to ferment, almost no long term aging
- Fermentation left a mess, needed to control the yeast
- Began collecting culture into kegs for repitching

# First effort

- Inspired by Firestone and original Burton Union set
- Initially on wild beer only, to encourage yeast population density
- Elevated tubing worked like a swan neck
- Connection between barrels allowed for 1st krausen to exchange between barrels

# Krausen porn

## Initial growth phase pressure differential

- Barrels “breathed”
- Genetic uniformity between barrels
- Faster starts for slower barrels
- Healthier repitches
- More yeast than bacteria

## During primary

- Better yeast separation from wort (slightly)
- High density of the healthiest yeast possible

# Current “Clean Beer” Practices

Rotated blowoff arm

Port to blowoff/FV assembly

- Elbow
- Spool
- Wye
- TC > 1” barb
- 1” **braided** silicone
- TC > 1” barb in thermometer port

Blowoff to brink

- 1” barb > TC (x2), 1” silicone hose

# Why the wye?

Wye operates like a swan-neck, provides better separation of yeast from wort

Head pressure blows lightest, densest yeast upward and out, heavier, liquid wort drains back into fermenter

# Benefits:

- Highest concentration of cells without beer/trub
- Less alcohol produced in the brink
- Lower losses of beer exiting FV with blowoff
- Magical site gauge that wasn’t there before

# Bummers:

- Silicone needs extra attention during CIP, could be more sanitary
- That said, it’s not *that* bad, especially if you don’t package and/or use diastatic strains
  - Use thorough CIP procedures

# Results

1st few batches were kind of bonkers

- Over 5-7 batches, decreased tank time down to 10-day turnaround on IPA, dry-hopping just after brink removed
- pH drop from 5.0 to as low as 3.75 before creeping back up
- Ability to clean up poor performing generations

Successive generations:

- Currently on 43rd generation, with lots of splits along the way

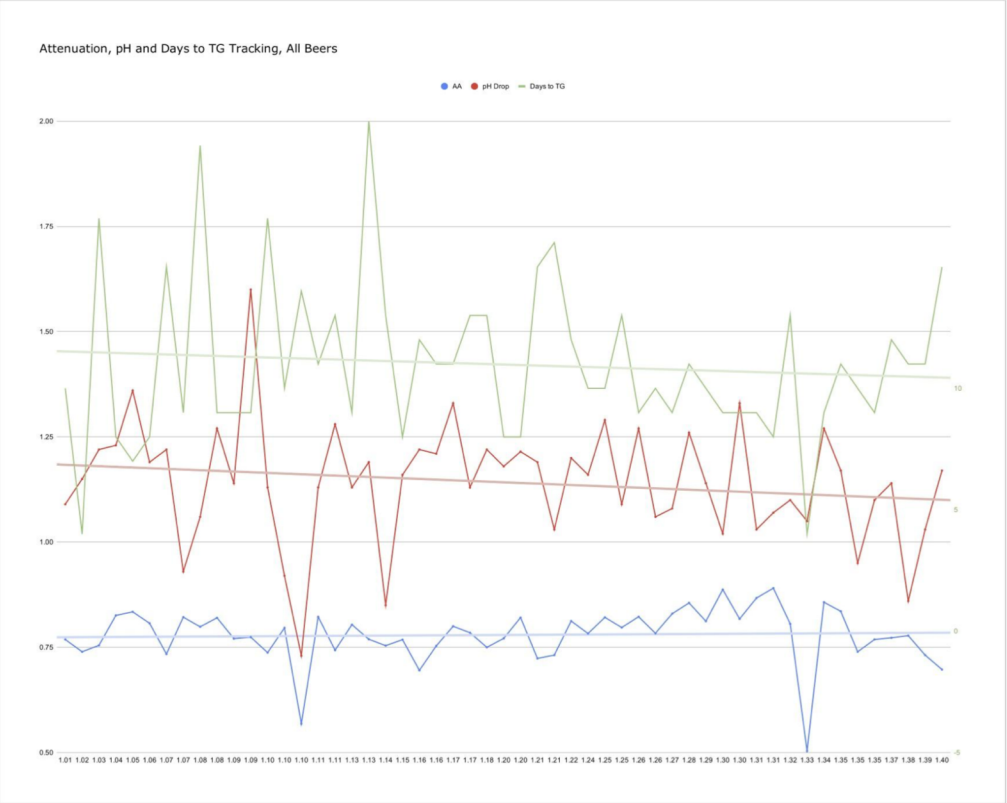
**ALL BEERS**:
East and west IPAs, pales, fruited beer, stouts, milds

Green = Days to TG
- High: 21 Low: 4

Red = pH Drop
- High: 1.62 Low: .7

Blue = Apparent Atten.
- High: 89% Low: 50%

**TRENDS**:
General Improvement, but concerns about recent performance



# NE IPAs:

Fairly even distribution of recipe profiles

## Green = Days to TG

- High: 21 Low: 8

## Red = pH Drop

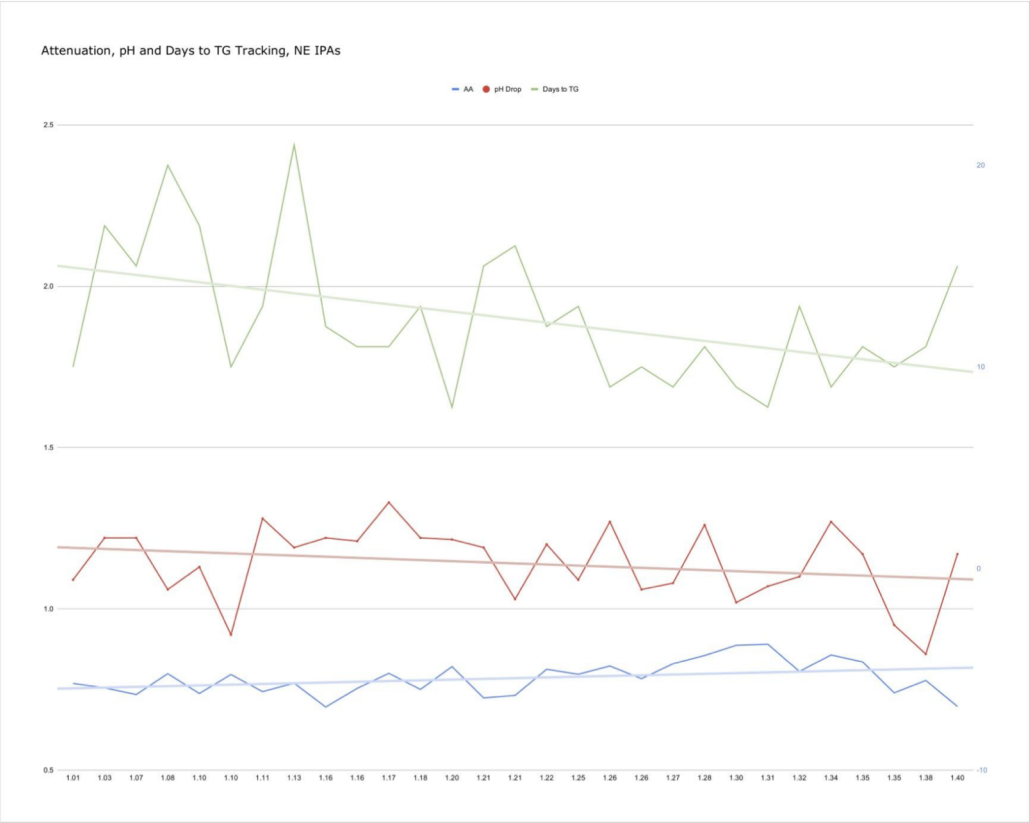
- High: 1.3 Low: .8

## Blue = Apparent Atten.

- High: 89% Low: 70%

**TRENDS**:

- 6 days less fermentation time
- pH drop increase of .1
- Attenuation increase of 6%



## **WC IPAs**:

Inconclusive results, might've been affected by slowly changing grain profile during this time.

### Green = Days to TG

- High: 13 Low: 7

### Red = pH Drop

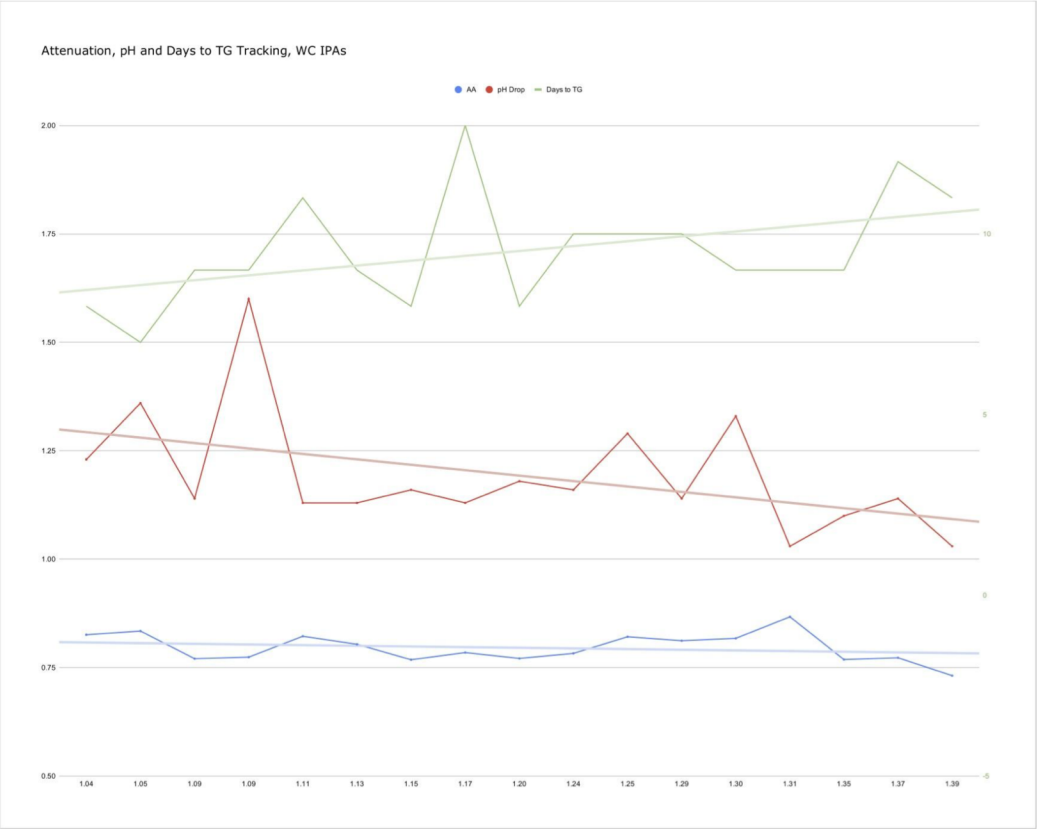
- High: 1.6 Low: 1.1

### Blue = Apparent Atten.

- High: 86% Low: 73%

**TRENDS**:

- 3 days more fermentation time
- pH drop increase of .3
- Attenuation decrease of 3%



# Strains/Scenarios Tested

English Ale / excellent

Belgian Wit / good so far, need more data

Kveik, Framgarten / seems great, but who cares, you only need 5 cells anyway

Lager strains / as expected, very low cell counts in “krausen”

High Gravity / only tested once, 22 plato stout into 15 plato IPA, did fine

# Recommendations

- Blend generations, invite a variety of kids to the party
- Collect data, so you can parse facts
- Stick to the most top-croppy strains for best results
- Do you own tests and share the results!

# Future Projects

- All stainless to brink, for sanitation
- Lab analysis of genetic shift (MBAA, UW?) and population changes in mixed ferms
- Can this make high gravity repitching viable?
- What is the real power to improve a struggling strain?
- Which other strains can be treated this way?
- What real effects can this have on increasing yeast in mixed fermentation?

# References

MIT Technology Review report: https://www.technologyreview.com/s/614577/the-secret-to-better-beer-could-lie-in-cell-signaling-networks/

Lallemand/BridgePort study: https://onlinelibrary.wiley.com/doi/epdf/10.1002/j.2050-0416.2007.tb00258.x

Master Brewers Podcast, episode 130: https://www.masterbrewerspodcast.com/130