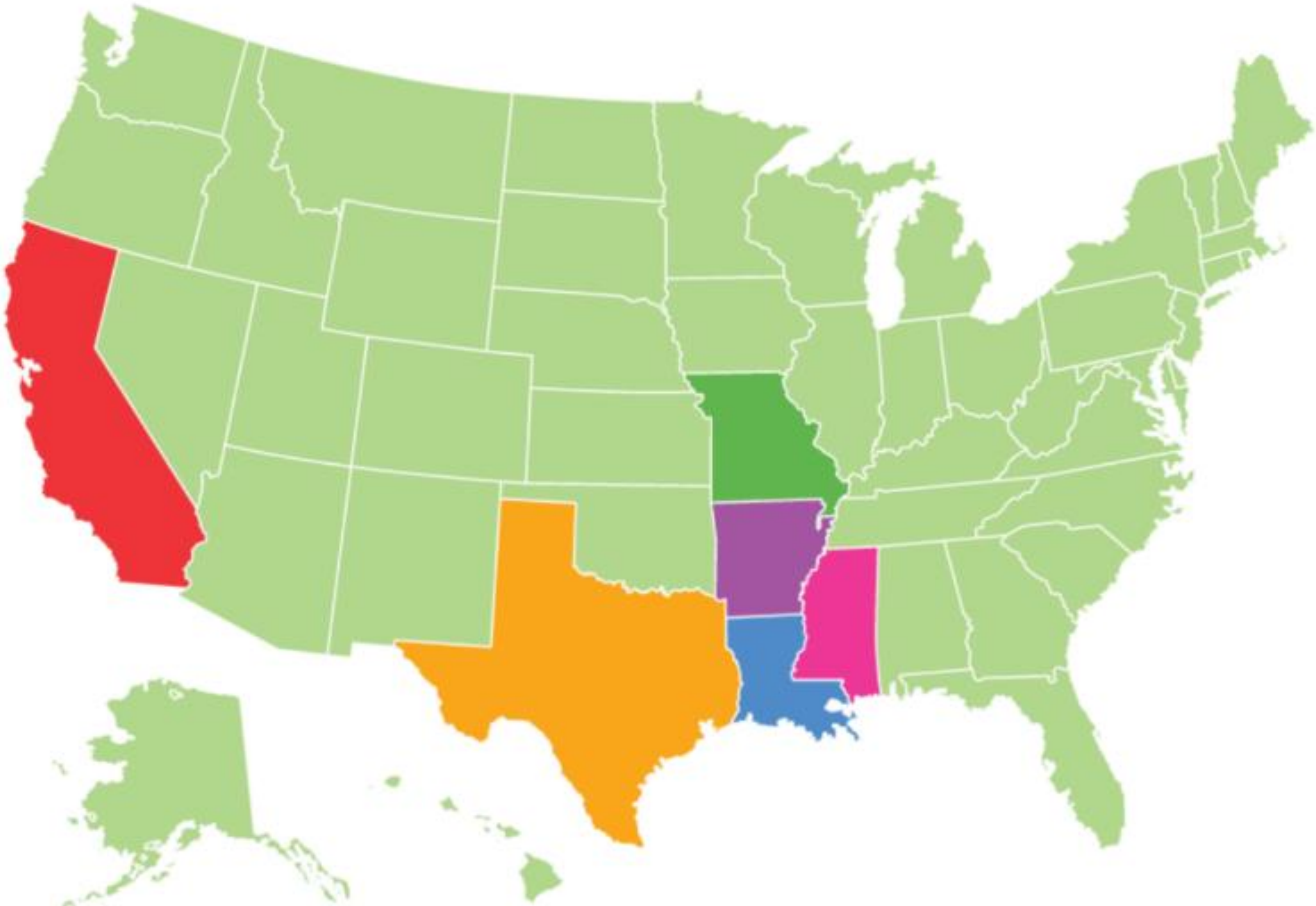
USA Rice®

The Rice Renaissance: Flavor, Function, and Innovation for Modern Brewers

More than **80%** of the rice we eat in the USA is grown here with **20 billion pounds** of rice grown and harvested by local farmers annually.

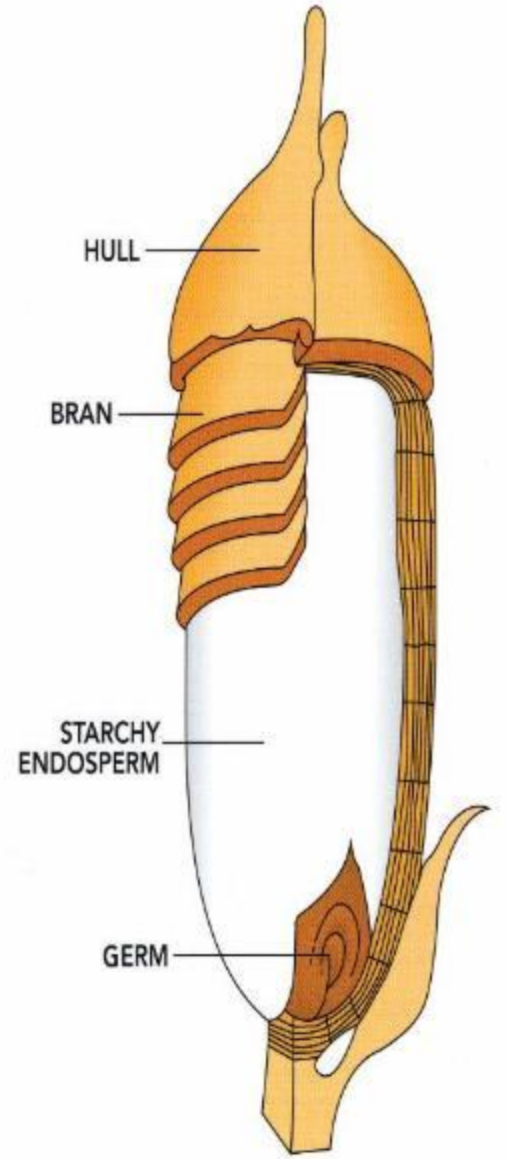


What is Rice?

The seed of a semi-aquatic grass that thrives in warm and sub-tropical climates and officially classified as **Oryza Sativa**

<u>**Grain Anatomy**</u>

- Grain is enclosed with in a tough outer hull/husk
- Under the hull are the bran and germ. Rice at this stage is 100% whole grain
- Remove the bran and germ and what remains is the endosperm which is the white rice consumed throughout the world



Rice Production Cycle

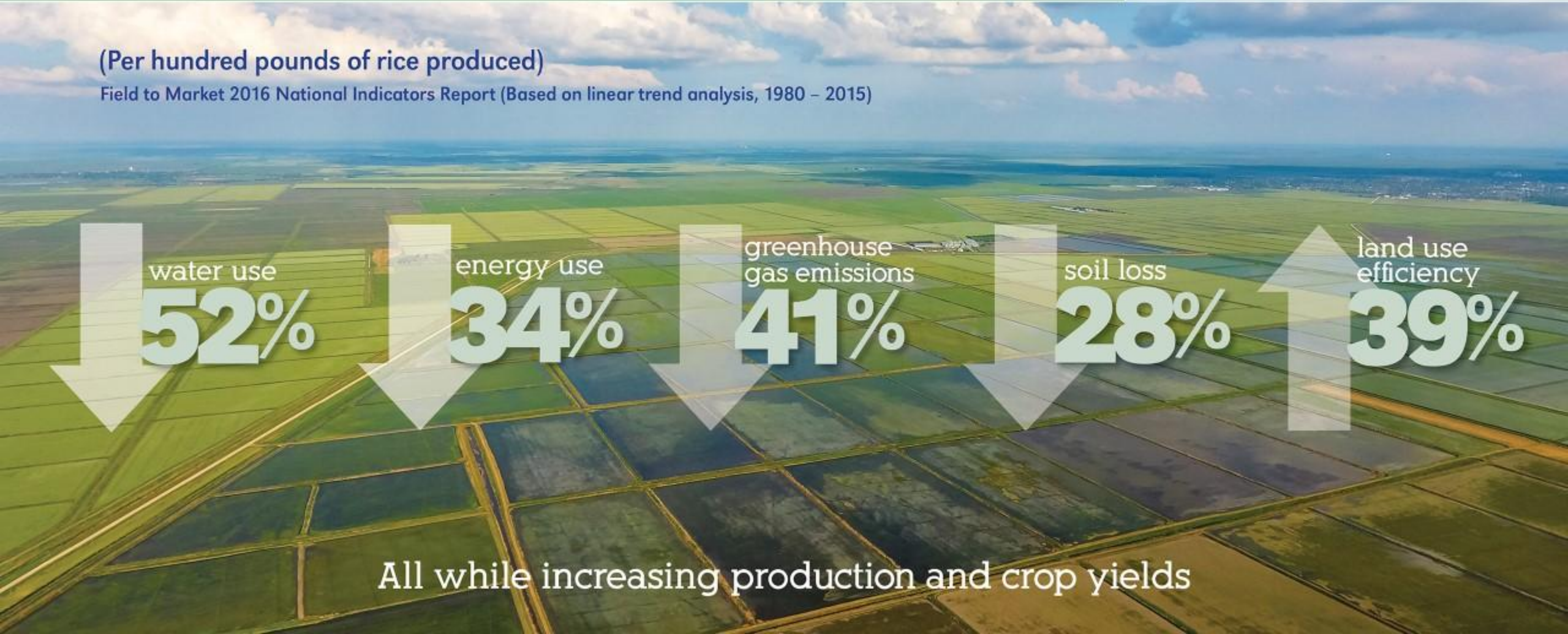
- Planting, March-May
- Field Irrigation, May-August
- Rice Harvest, August-November

The U.S.-grown Difference

- Locally Grown, Globally Recognized
- Tightest Rice Supply Chain in the World
- Food Safety
- Stringent farming and milling standards
- Commitment to Sustainability
- Supporting American Farmers

U.S. Rice Industry Sustainability

A History of Resource Stewardship



The Why?

Product Storytelling

Craft a distinct and authentic story for your beer.

Consumer Values

- 65%-75% prioritize buying locally grown & willing to pay more for it
- 78% of consumer prioritize U.S.-grown, 83% consider U.S. farmers the most trusted source for food safety

Consumer Demand

- Variety, Innovation, “Premium” positioning

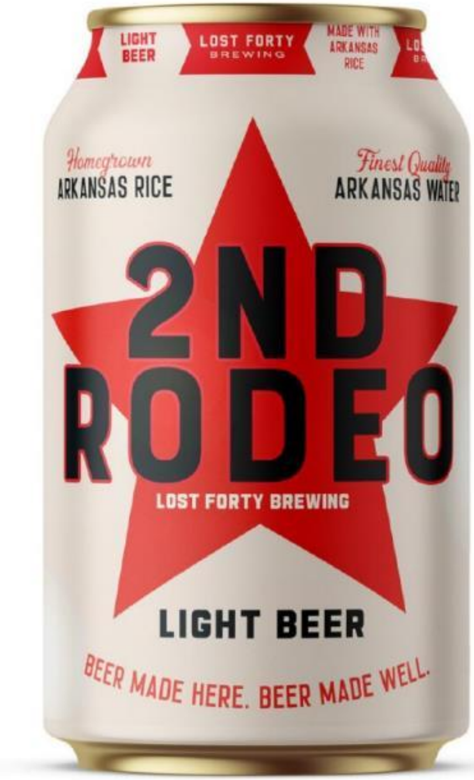
Sustainability

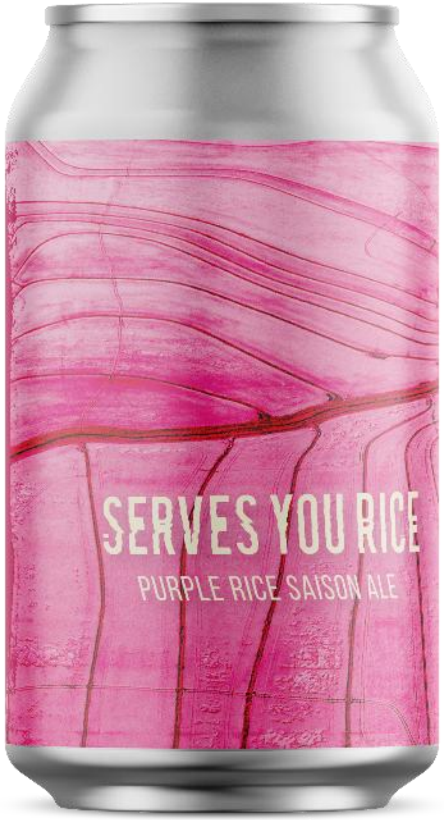
- 73% of beer consumers pay attention to environmental factors
- 61% of consumers are willing to pay more for sustainably grown

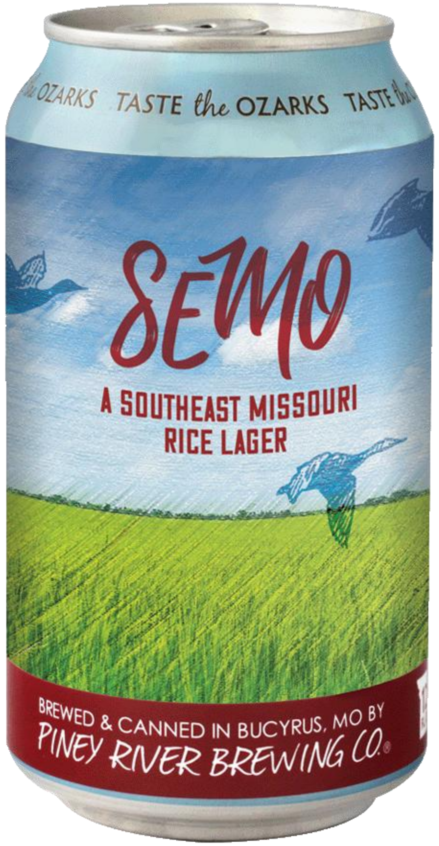
Operationally

- Stable supply chain, Climate change resistant ingredient
- Price tag-75% of beer consumers open to pay premiums for beers brewed more sustainably

Industry Examples

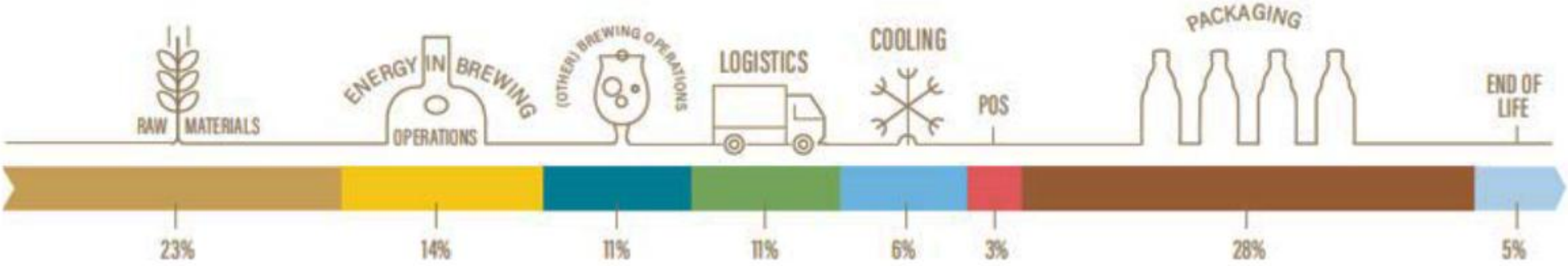






Breweries are Developing Sustainability Missions

- Raw materials and logistics account for ~1/3 of a breweries carbon footprint
- Potential ways to reduce?
  - Source more local raw materials
  - Develop more efficient agricultural practices for key raw materials



https://www.duvelmoortgat.com/uploads/images/Duvel-Moortgat-Sustainability-report-2023.pdf

Major cereals used in brewing

Grain type	Region	Type	Yield [t/ha]	Production [t]	GWP [t CO_2e/ t grain]
Fonio	Western Africa	All	0.75	644,903	
Millet	USA	All	1.64	319,966	1.51
Intermediate wheatgrass (Kernza)	USA	All	1.68	336	
Sorghum	USA	All	3.26	9,921,496	0.08–0.99
Wheat	USA	All	3.28	51,980,823	0.08–1.57
Barley	USA	Feed barley and malting barley	3.92	3,827,161	0.26–0.88
Rice	USA	All	9.48	9,122,161	0.23–5.55
Corn	USA	All	11.13	363,449,448	0.05–1.18

https://www.nature.com/articles/s44264-025-00060-6

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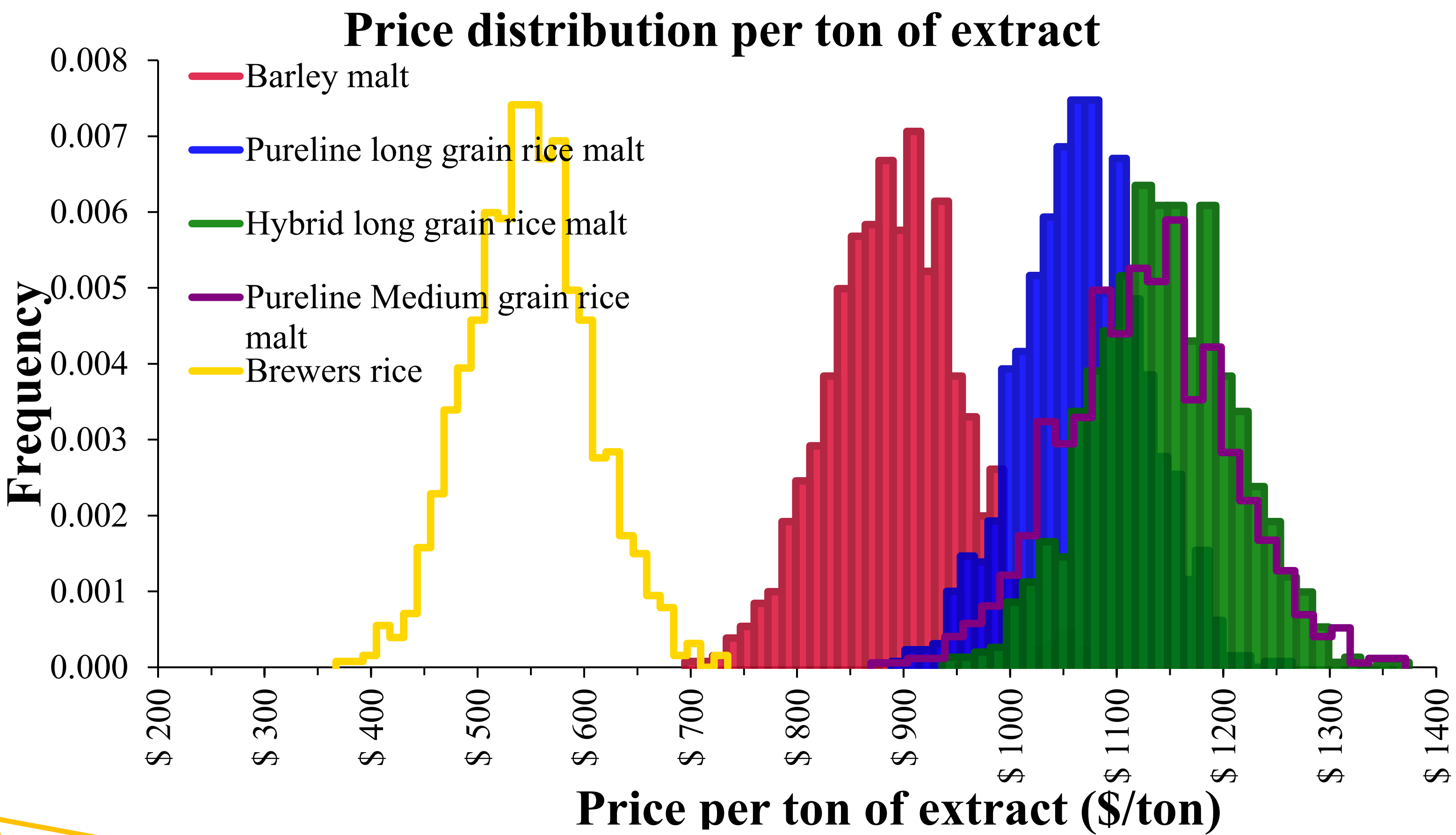
Extract cost

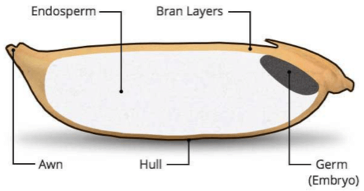
- Extract from malted rice **costs ~1.2x malted barley**
  - Barley malt ~$892/ton*E
  - Pureline LG rice malt ~$1068/ton*E
  - Milled head rice ~$813/ton*E
  - Milled brewers' rice ~549/ton*E

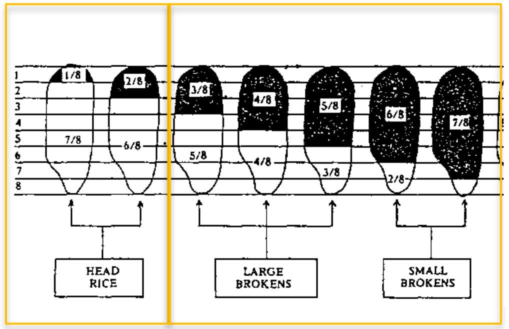


In comparison to barley:

- Milled head rice ~9% less expensive
- Milled brewers' rice ~39% less expensive
- Rice malt ~20% more expensive

Parameters:
Price - $/ton
Fine Extract (%d.b.)
Malting loss (% d.b.)





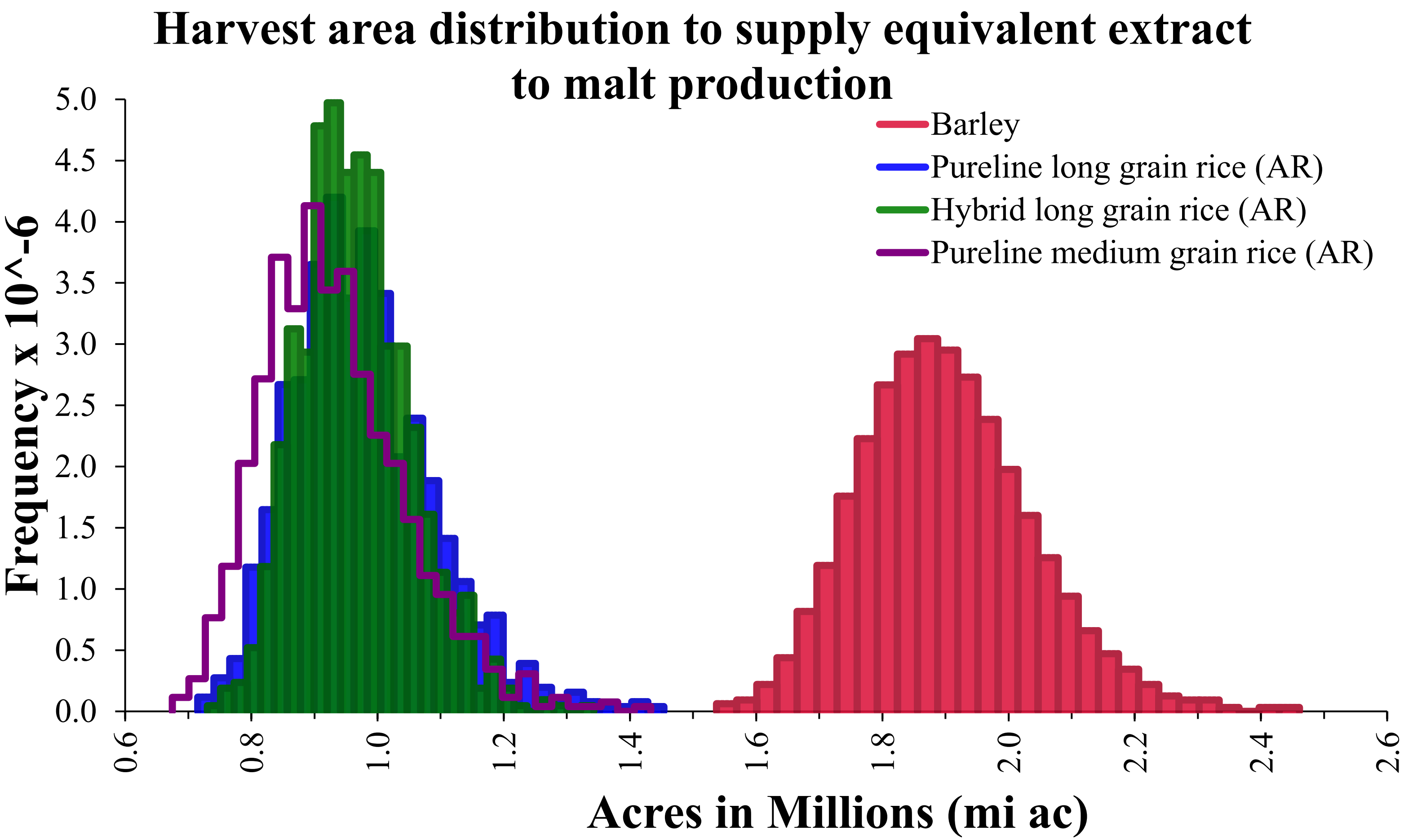
https://www.nature.com/articles/s44264-025-00060-6

Harvest area

- ➢ Extract from malted rice **costs ~1.2x malted barley**
  - ➢ Pureline LG malt ~$1068/ton*E
  - ➢ Barley malt ~$892/ton*E
  - ➢ Milled head rice ~$813/ton*E
  - ➢ Milled brewers' rice ~549/ton*E

- ➢ Cost equivalent in **15%** of the cases

- ➢ **Rice malt requires 50% of barley's acreage for equivalent extract**



Parameters:
Yield: ton/ac
Fine Extract (% d.b.)
Malting loss (% d.b.)

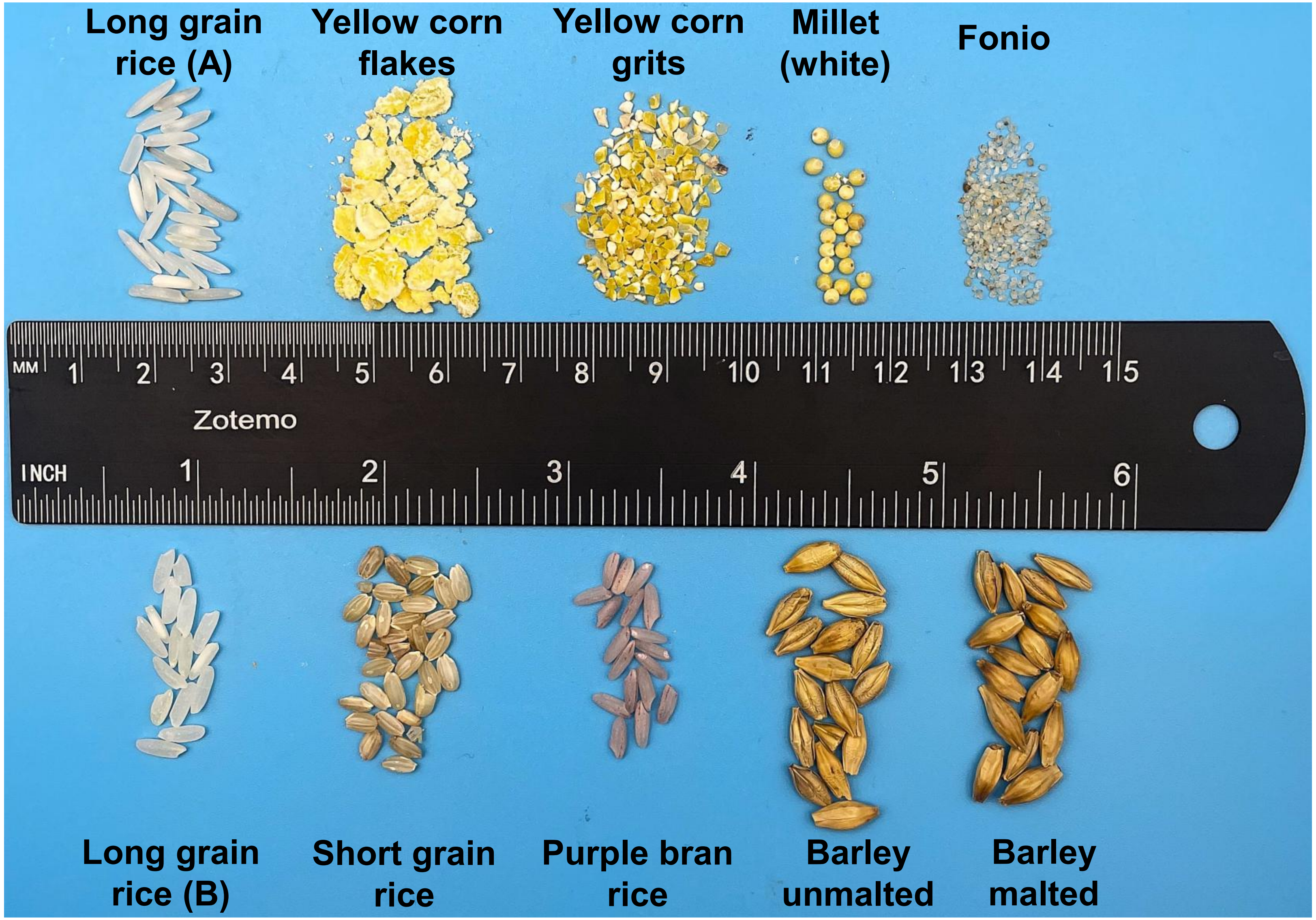
https://www.nature.com/articles/s44264-025-00060-6

Considerations in the brewery when working with alternative grains

- **Grain size & handling:** Small grains (e.g., fonio, millet) create challenges in cleaning, malting, milling, and lautering due to kernel size and flow properties.

- **Starch gelatinization:** Adjuncts like rice and corn have high gelatinization temperatures, often requiring cereal cooking or additional energy input and can cause issues with high pasting temperatures/ starch liquifcation

- **Enzyme availability:** Many alternative grains have low enzymatic power, requiring malt inclusion, exogenous enzymes, or mash adjustments.



History of rice in brewing

- 1857: Adolphus Busch immigrated to America and settled in St. Louis.
- 1860: Approximately 1.3 million German-born immigrants are in the United States.
- Desire to make a beer reminiscent of their homeland
- Germans begin brewing and quickly realize raw material limitations of brewing with 6-Row barley in America

6-Row Barley → High Protein Content → Lower Protein Content and Increase Starch with Adjuncts =

Desirable final product

[Library of Congress]

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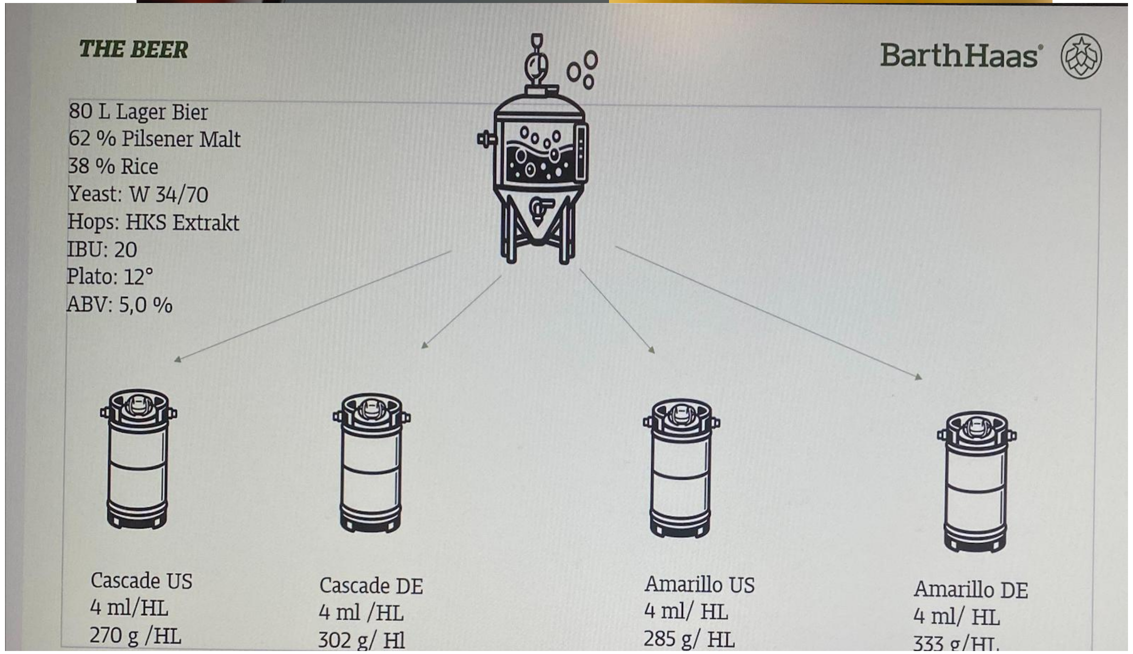
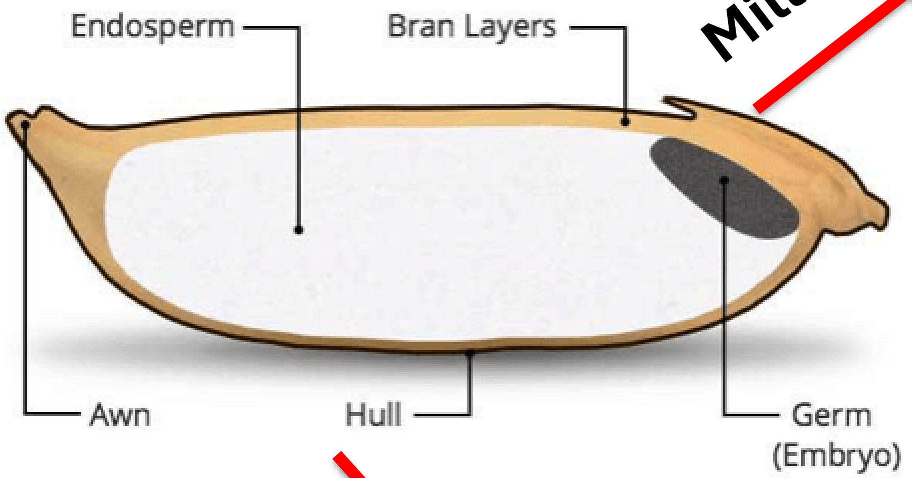
Brewing Industry & Rice

- Fastest-growing and top-selling beer uses rice
- Top-selling non-alcoholic brew uses rice
- Consumer habits show rice has positive attributes in the final product
- Being used by R&D to highlight flavors



Rice Processing

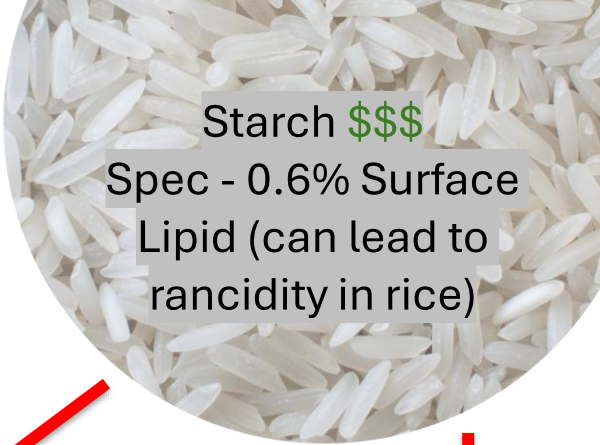


Milling

Milling removes the hull. ~20% of the weight of a rice kernel. Hulls can be used in mash filtration

Polishing

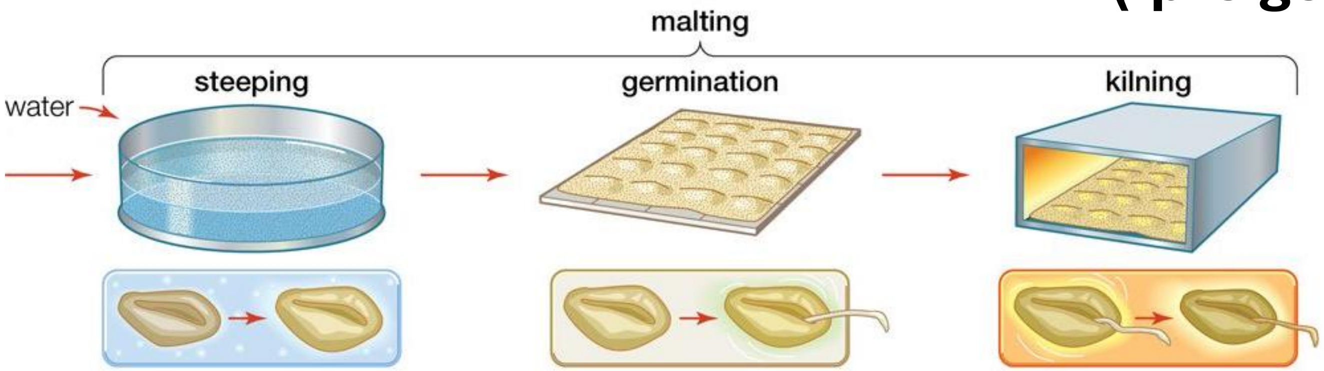
Removal of bran layer. ~8% weight of the kernel which contains lipids and proteins



Post Processing (‘pre gel’)

Rice syrup

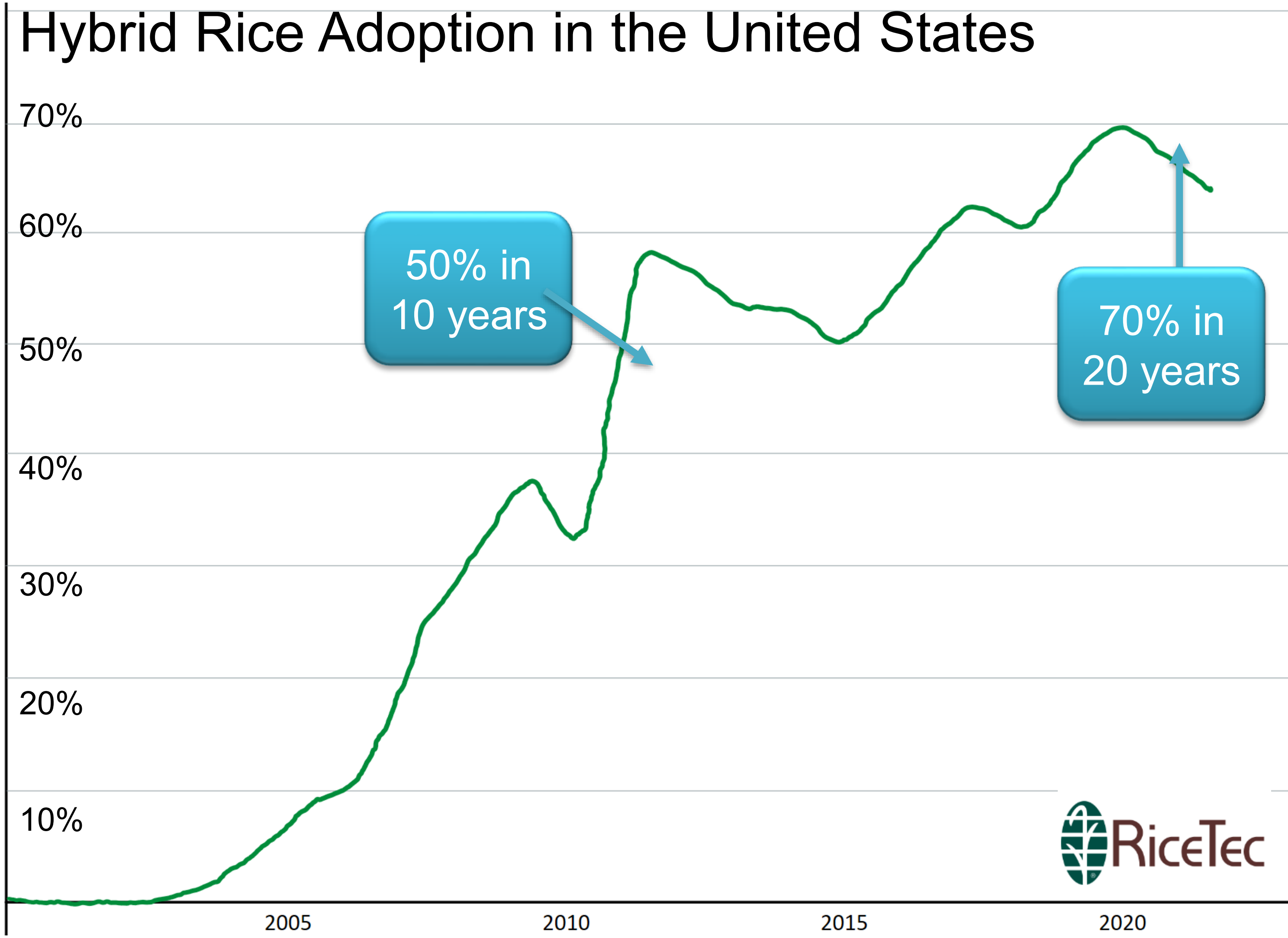
Malting



Cultivar development – primary goal is field yield!

- Hybrid varieties –
  - Breeding of 2 different rice cultivars to increase yield.
- Increase in yield allows lower acreage usage.
- Sustainability increases with lower land usage
- Fast adaptation to this new technology

Hybrid
rice



What opportunities for rice industry in brewing - traditional approach

Main forms of addition
Whole cereal
Malted cereal
Malted pseudo-cereal
Flaked
Grits
Syrup/ extract

Paddy rice

Milling

Whole/ broken milled rice/ brewer's rice

- Adjunct or **neutral-flavored** starch source
- Gel temp 67-91 C (152.6-195.8 F)

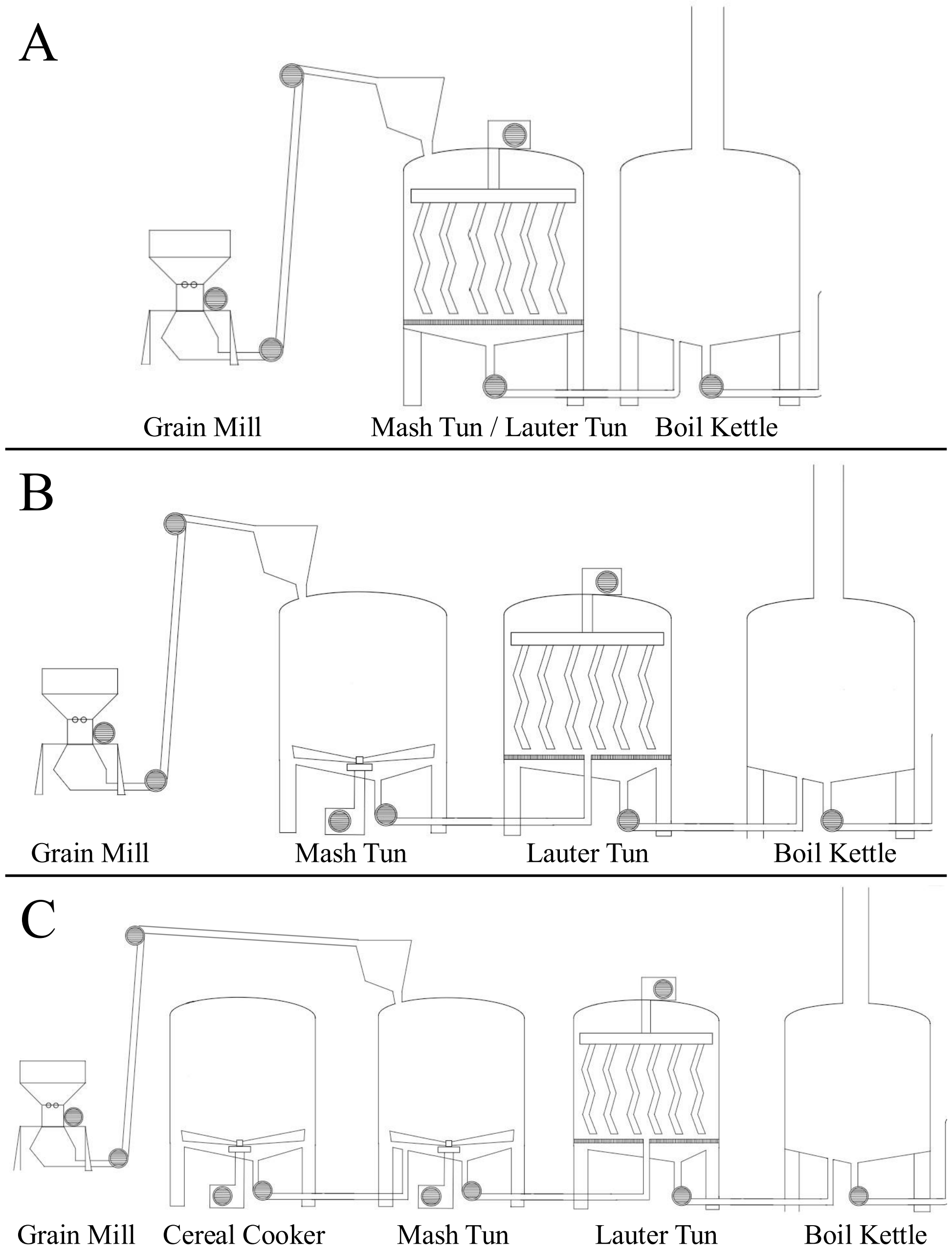
Polishing

- **0.4-0.6% lipid**
- **80-90% extract**
- **Shelf life ~ 1 month**

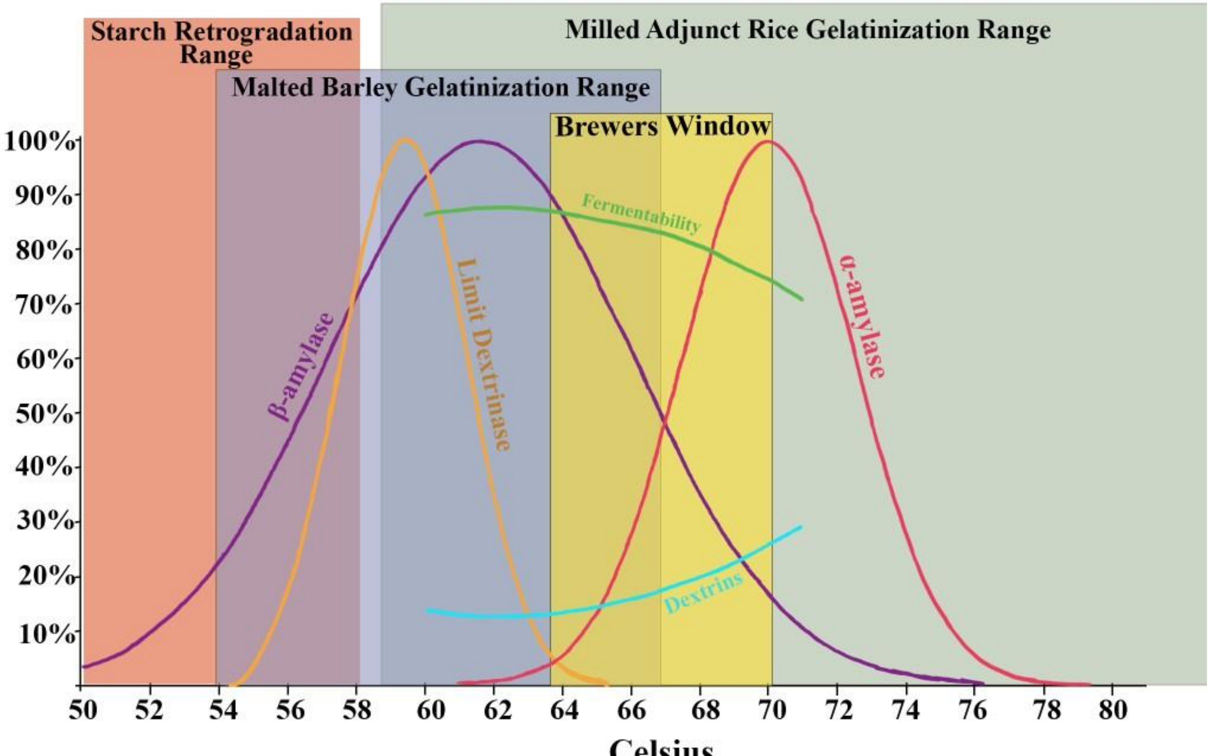
Pain points -

- Currently limited COAs exist for rice cultivars for brewing
- Varieties get binned together without cultivar differences taken into consideration

Considerations when working with milled rice

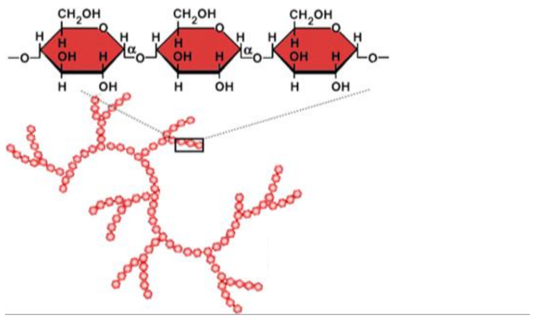


- ✓ **Processing & handling** – high starch gelatinization temperature requires cooking/liquefaction prior to enzymatic conversion.
- ✓ **Starch hydrolysis** – limited endogenous enzymes require sufficient malt or exogenous enzymes for effective starch breakdown.



Brewing 101 – Chemistry

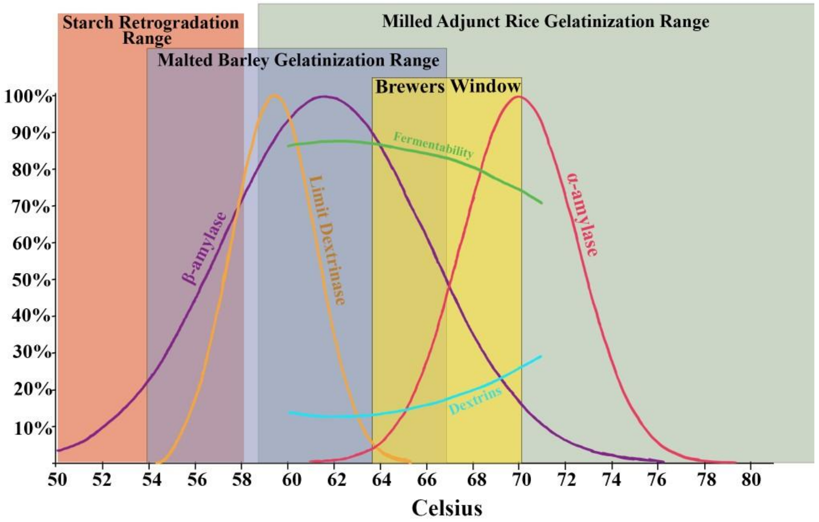
1. Starch gelatinization

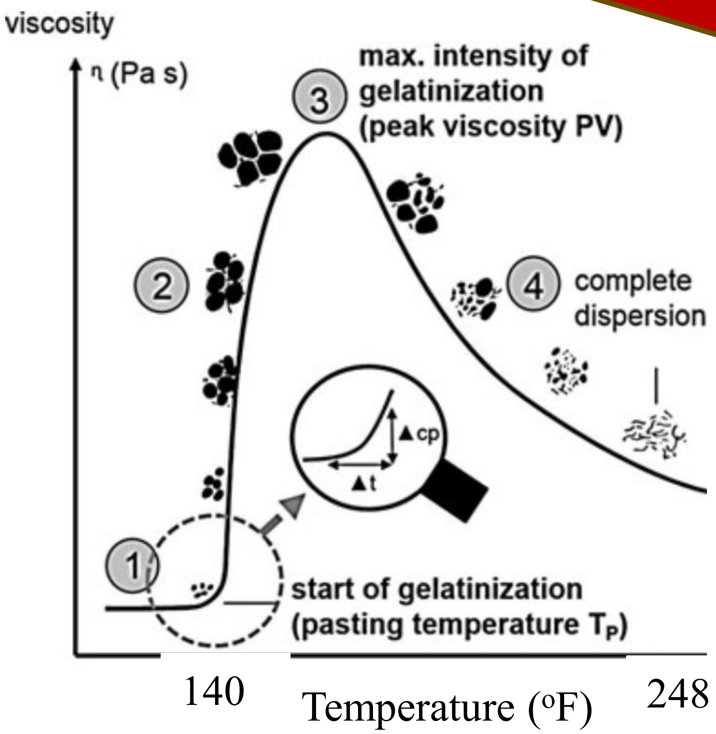


Starch source	Gel. Temp. °C (°F)
Barley	52-66 (125.6-150.8)
Adjuncts	
Wheat	58-66 (136.4-150.8)
Corn	62-80 (143.6-176)
Rice	58-91 (136-195.8)
Sorghum	69-80 (156.2-176)
Oat	52-62 (125.6-143.6)
Rye	50-62 (122-143.6)
Millet	54-80 (129.2-176)

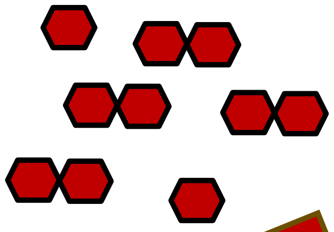
2. Fermentable Extract Production (dextrin < 4 subunits)

Mashing Enzymes (malted grains or exogenous)





Schirmer, M., et al. (2015). "Starch gelatinization and its complexity for analysis." Starch - Stärke **67**(1-2): 30-41.



Fermentation- Yeast

Ethanol

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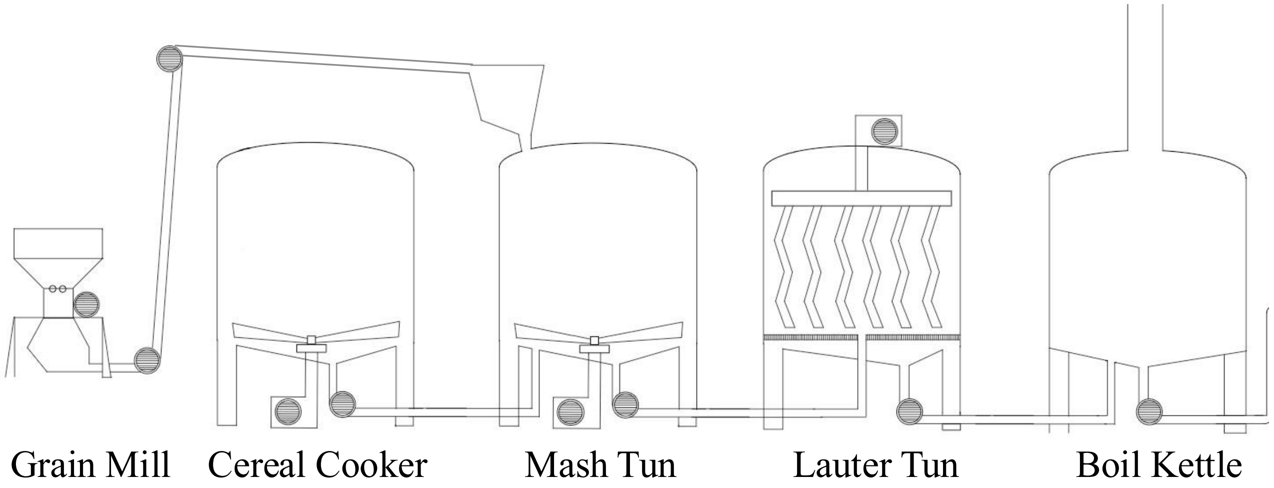
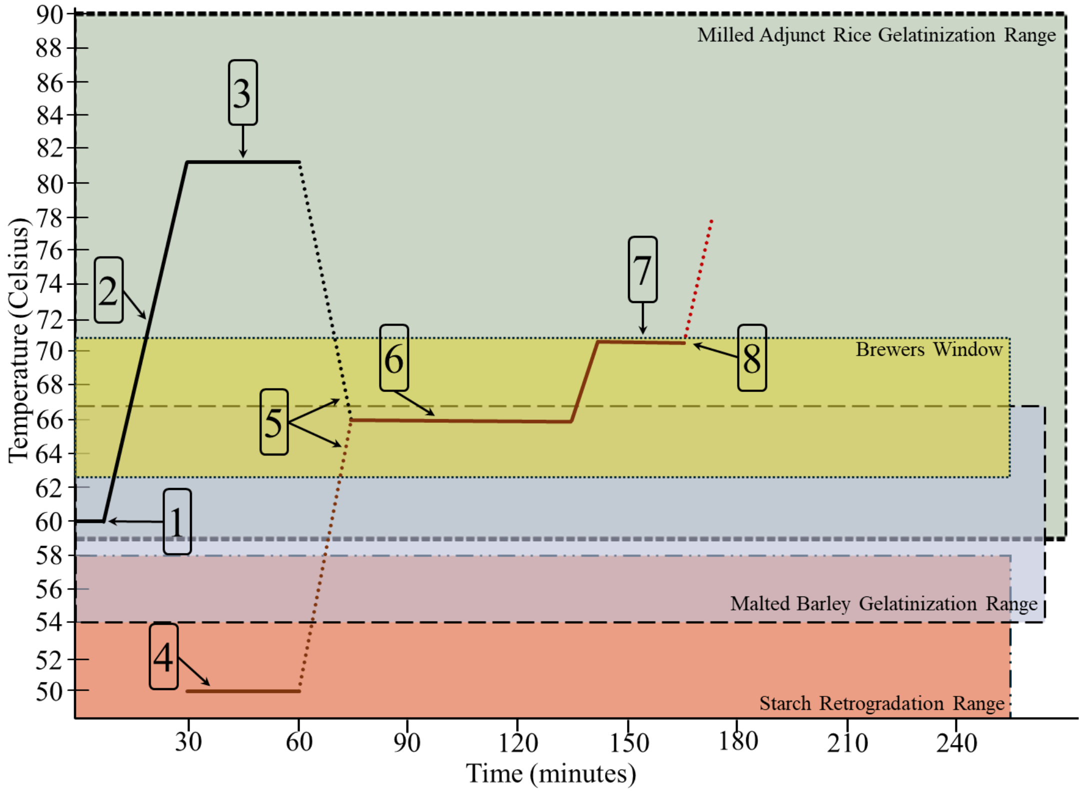
Traditional American Double Mash

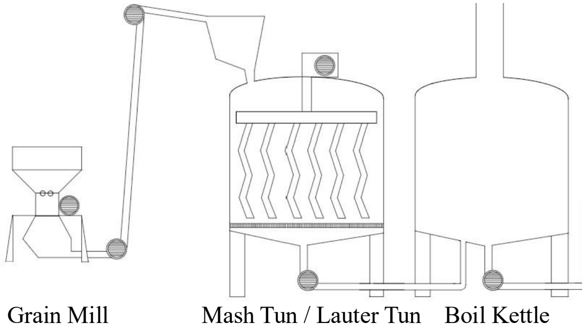


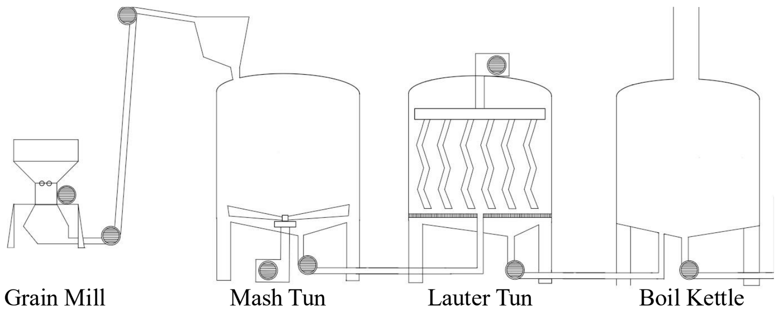


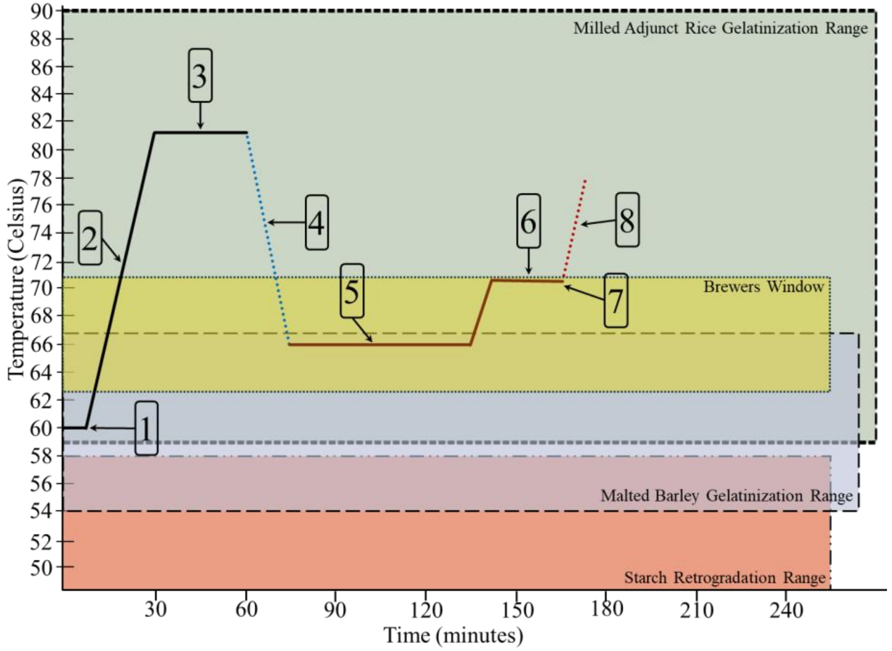
- Rice is cooked in a cereal cooker to gelatinize starch.
- Malt enzymes or malt slurry added for partial liquefaction.
- The boiled adjunct mash is transferred to the main mash for enzymatic starch hydrolysis and conversion.
- $$ more capital expense

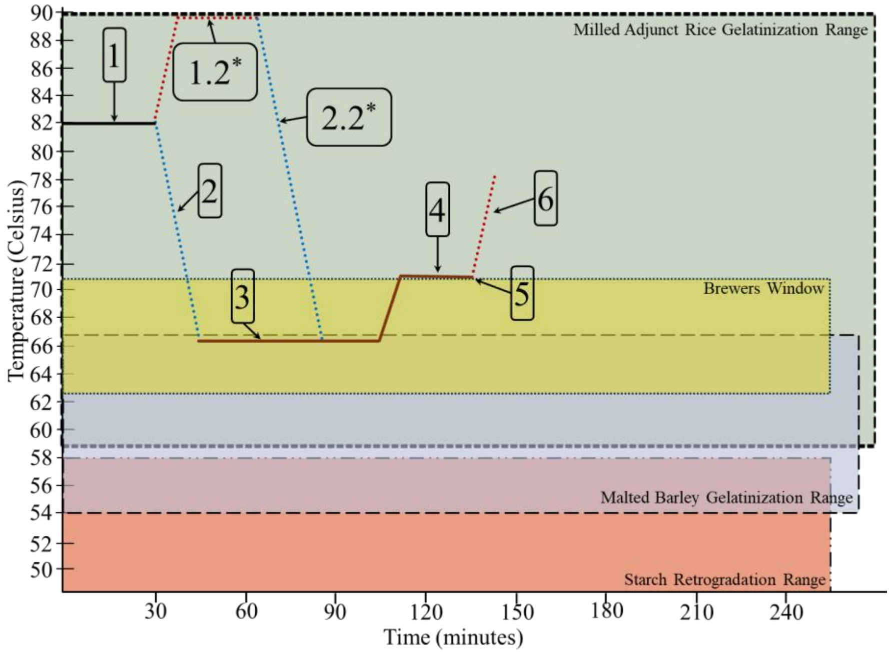
https://biologyreader.com/starch-gelatinization.html

Traditional 2 OR 3 vessel systems









Scenario 1 – No Exogenous Enzymes

Key idea: Malt enzymes control viscosity and drive saccharification after gelatinization.

- **Mash in rice + 10–20% malt at ~60 °C** to reduce viscosity.
- **Heat above rice gelatinization temperature** and hold (~30 min).
- **Cool with water to saccharification temperature (~65–67 °C)**.
- **Add remaining malt** for starch conversion.
- **Transfer to lauter tun** for runoff and sparging.

Scenario 2 – With Heat-Stable α-Amylase

Key idea: Exogenous enzyme **liquefies starch during gelatinization**, reducing viscosity constraints.

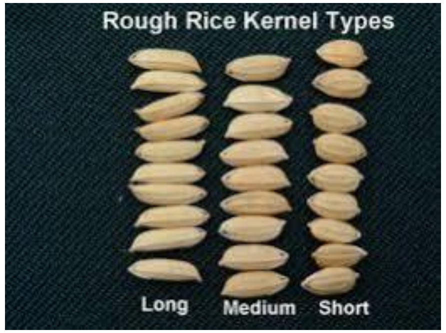
- **Add rice at gelatinization temperature with heat-stable enzyme**.
- **Hold (~30 min)** for gelatinization and starch liquefaction.
- Two options:
  - **Cool directly** (enzyme remains active), or
  - **Heat to denature enzyme → then cool** to saccharification temperature.
- **Add remaining malt** for conversion.
- **Transfer to lauter tun** for runoff and sparging.

Does rice cultivar impact extract yield?

Matthew Aitkens (MS Student)

98 samples - 74 different cultivars

- 18 Hybrid lines
- 56 Pure lines



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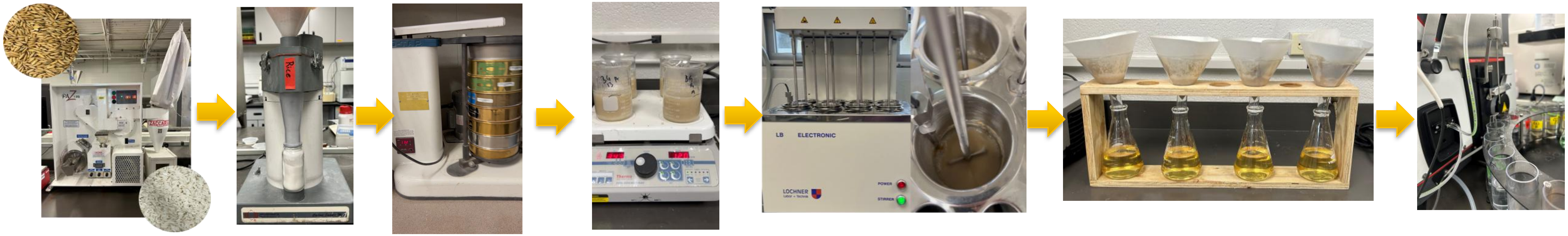
USDA
RiceTec
ARKANSAS RICE PROCESSING PROGRAM

Small scale brewing (120g paddy rice, duplicate 5 g moisture, ~350 mL wort, MEBAK R-100.03.005)

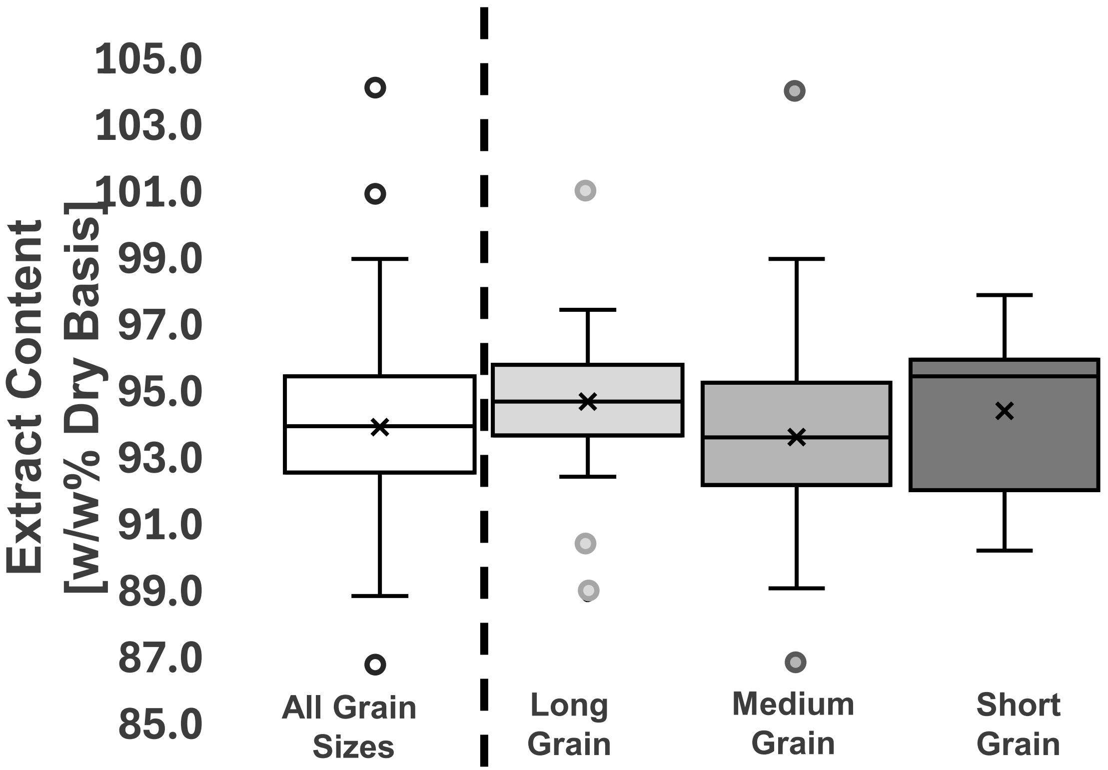


https://www.tandfonline.com/doi/full/10.1080/03610470.2025.2499768

Does rice cultivar impact extract yield?

- First public data on this since 1983
  - Teng, J. ***The Importance of Rice Variety Selection for Optimum Brewhouse Operation***
  - 8 cultivars and ***showed that medium and short were highest in extract***
- **Extract dry basis** ranged ~20%
  - from 87-104%, with 94% as the mean
  - ~$1.6/hL difference between high and low to make a 40% adjunct
- Kernel size seems to have no impact on extract!

Based on 74 cultivars



JOURNAL OF THE AMERICAN SOCIETY OF BREWING CHEMISTS
https://doi.org/10.1080/03610470.2025.2499768

ASBC Taylor & Francis Taylor & Francis Group

Check for updates

Unveiling Cultivar and Agricultural Factors Influencing Extract Yield from Milled Rice

Matthew S. Aitkens[a], Christian Schubert[a,d], Kaushik Luthra[a], Griffiths G. Atungulu[a], Christian de Guzman[b], Xueyan Sha[b], Shannon R. M. Pinson[c], and Scott Lafontaine[a]

https://www.tandfonline.com/doi/full/10.1080/03610470.2025.2499768

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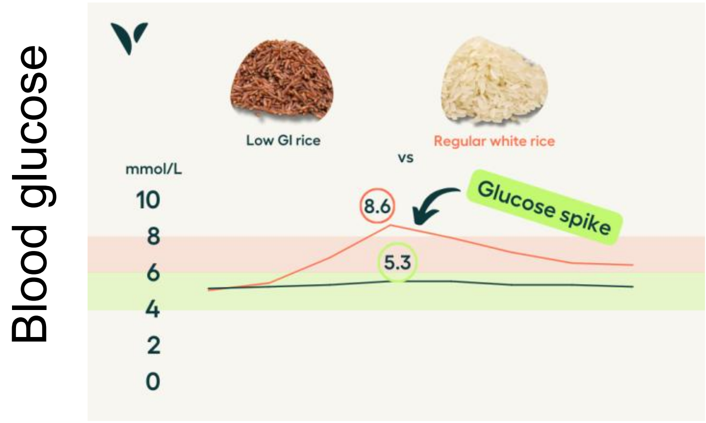
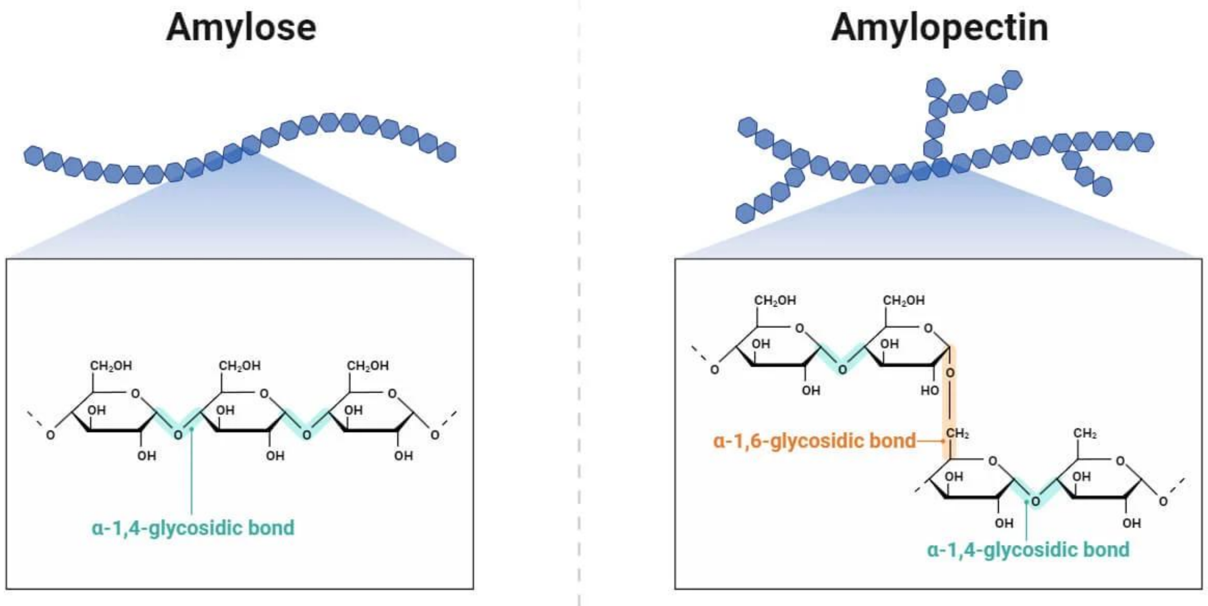
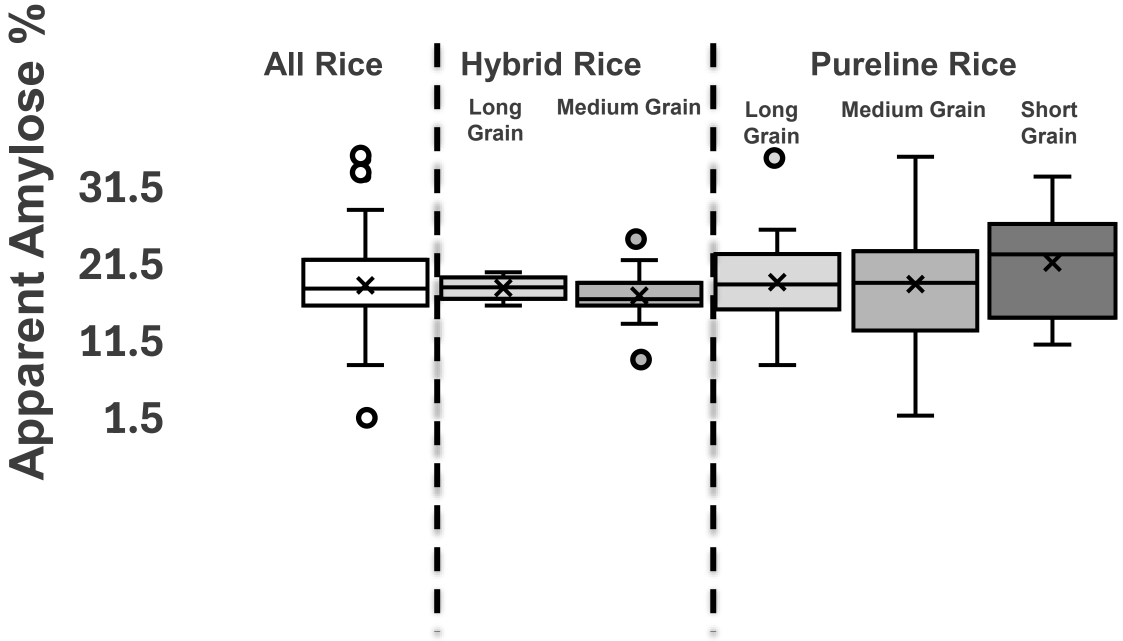
Understanding rice cultivar - % amylose

- IRRI breeding high-amylose rice for low-GI diets
- **High amylose → slower starch digestion**
- Brewing challenge: reduced enzymatic conversion and extract potential and higher gelatinization







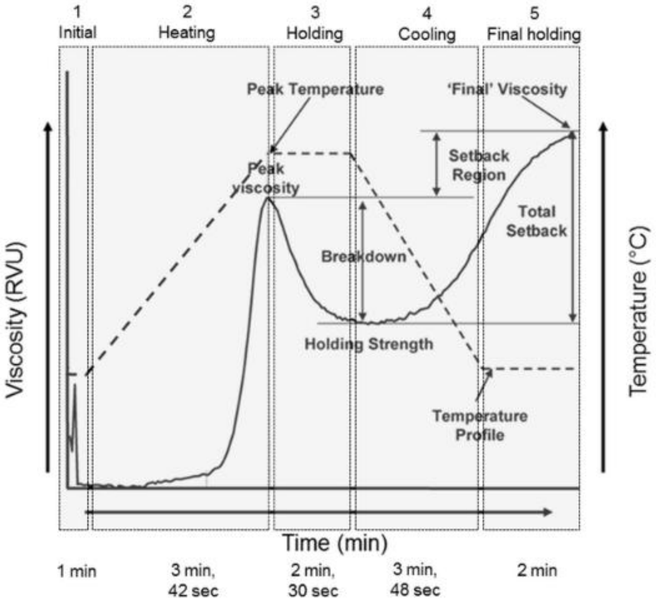
Range = 1.54-35.40%. Average = 18.6%

https://www.irri.org/news-and-events/news/irri-reveals-scientific-breakthrough-low-and-ultra-low-glycemic-index-rice

Picture source - https://microbenotes.com/starch/

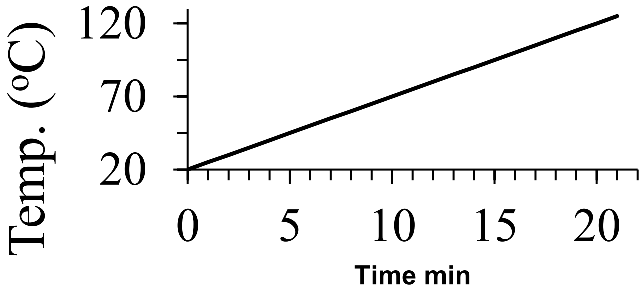
Raw material characterization DSC vs RVA

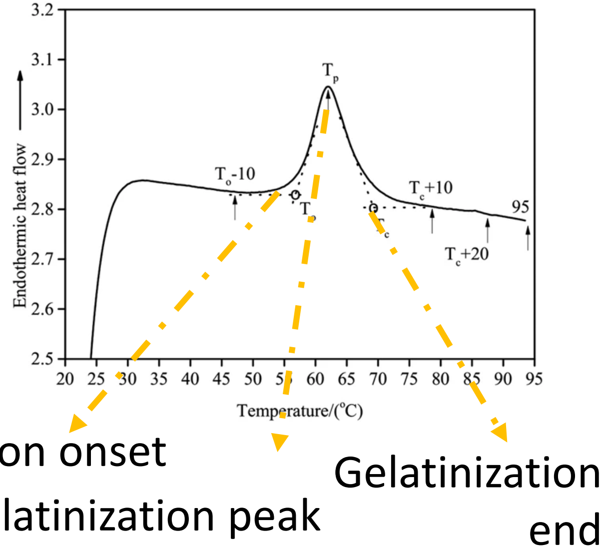
Rapid Visco Analyser (RVA)



- **Measurement** - viscosity of a starch suspension as it's heated and cooled
- **Outputs** - starch pasting properties
    - Peak viscosity, holding strength, final viscosity, breakdown viscosity, setback viscosity
- **Recipe dependent!** – grist/ water ratio, particle size, etc.

Differential scanning calorimeter (DSC)





- **Measurement -** heat flow to detect phase transitions (e.g., melting of starch crystallites)
- **Outputs** - Onset, peak, and end temperatures, enthalpy of transitions
- Better for characterizing raw material quality

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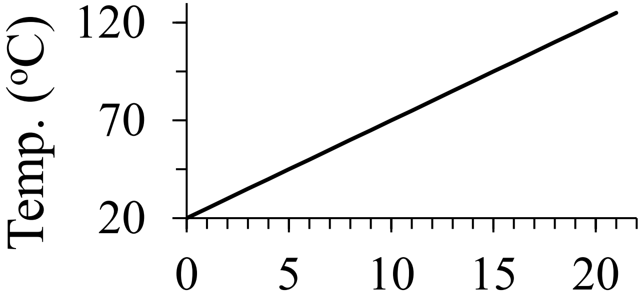
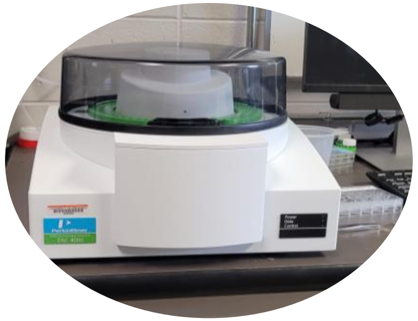
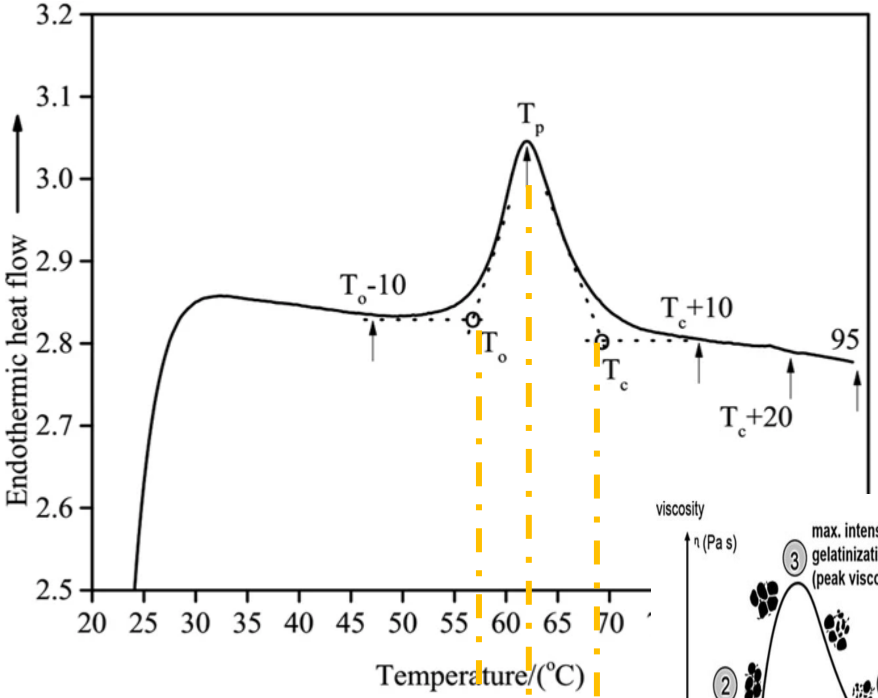
https://escholarship.org/content/qt0cf6r30w/qt0cf6r30w_noSplash_2886155dd512462b6b923db0bc223784.pdf

Understanding rice cultivar - Gelatinization temperature - DSC



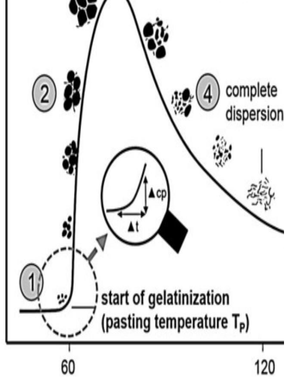




Gelatinization onset

Gelatinization peak

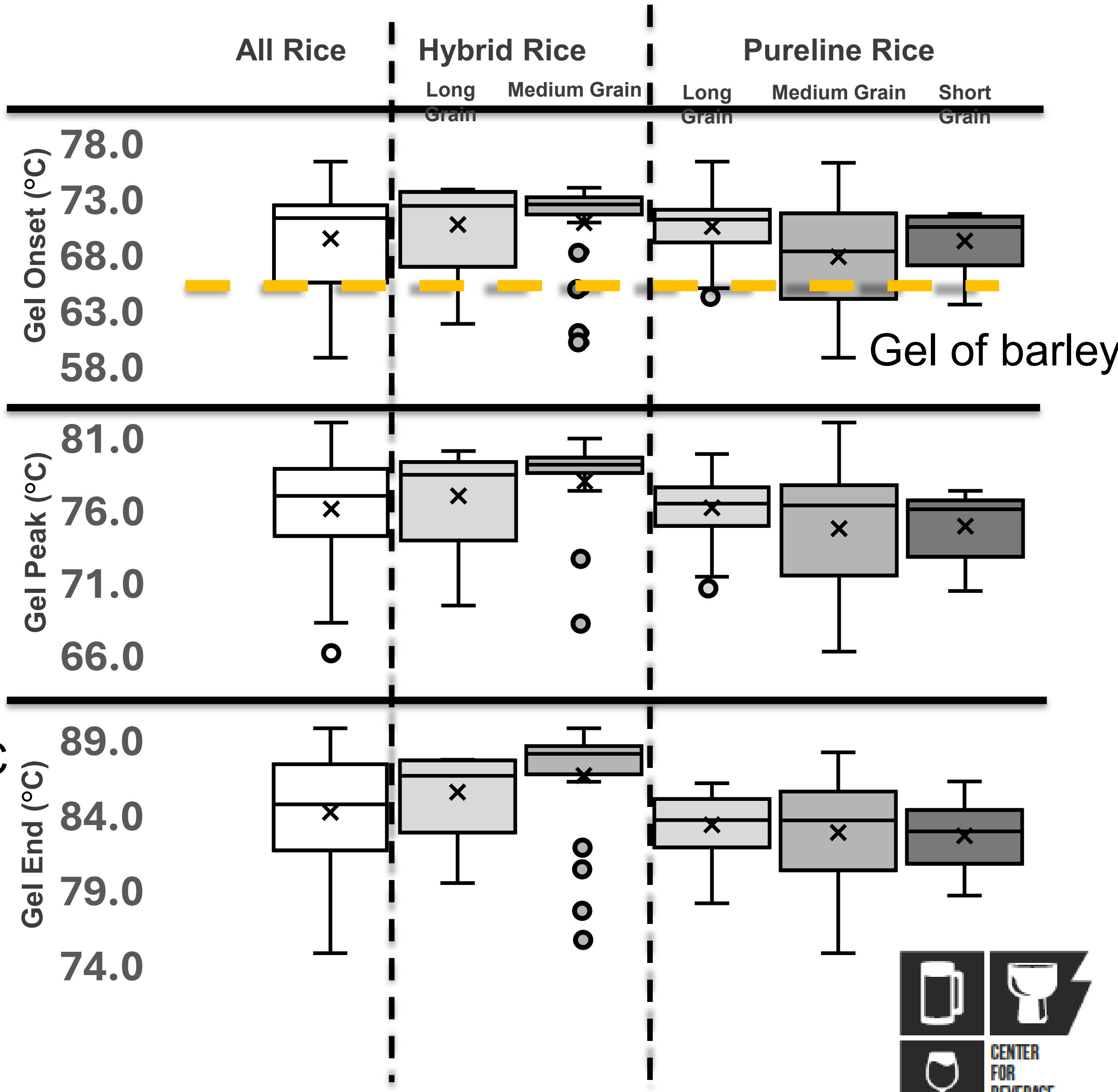
Gelatinization end



58.83°C – 76.40°C

66.29°C – 82.09°C

74.84°C – 89.83°C



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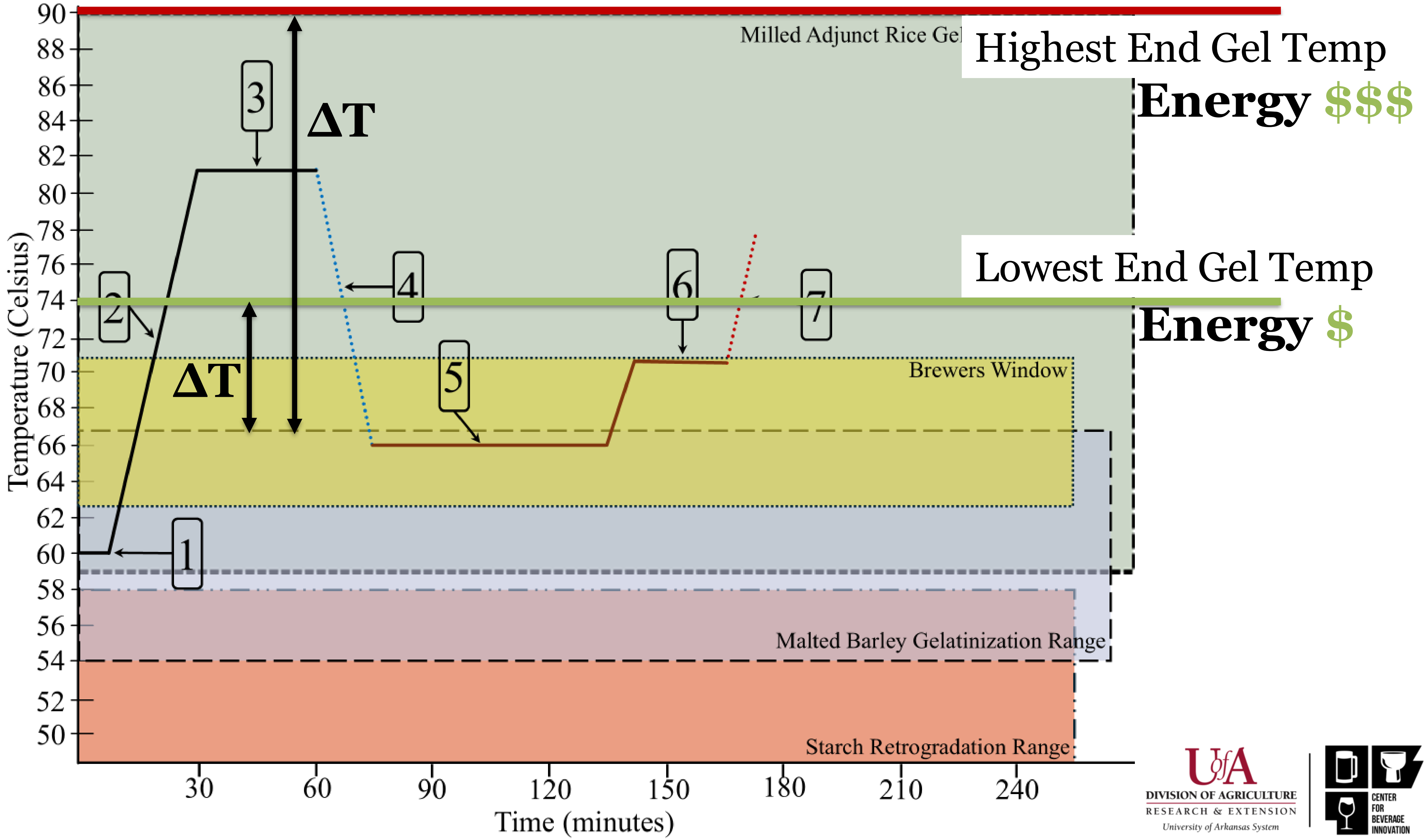
Mashing Strategies – Traditional Craft Setups



DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

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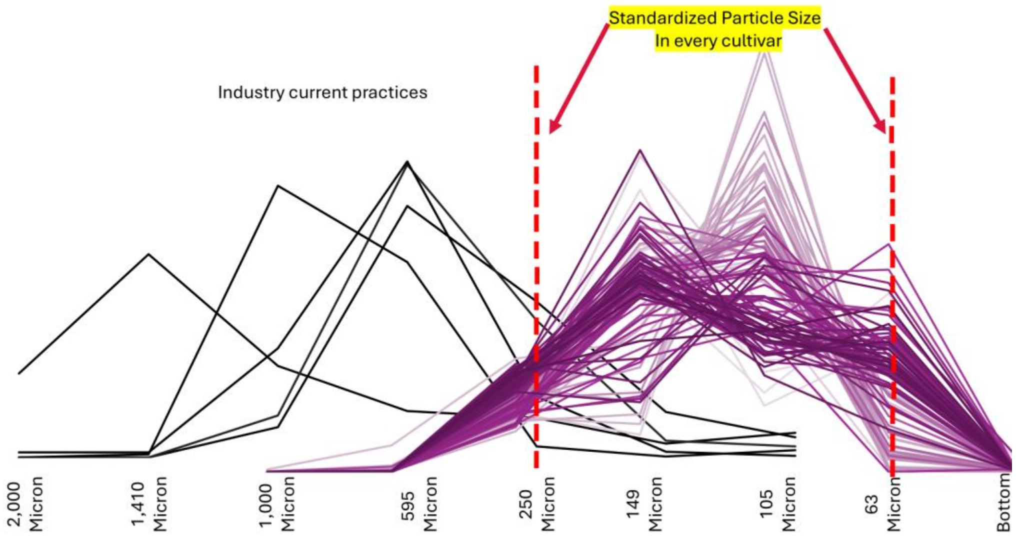
Rice millability is important!

- Rice fractionating into smaller rice particle sizes = higher extract %
- Rice fractionating into larger rice particle sizes = lower extract %



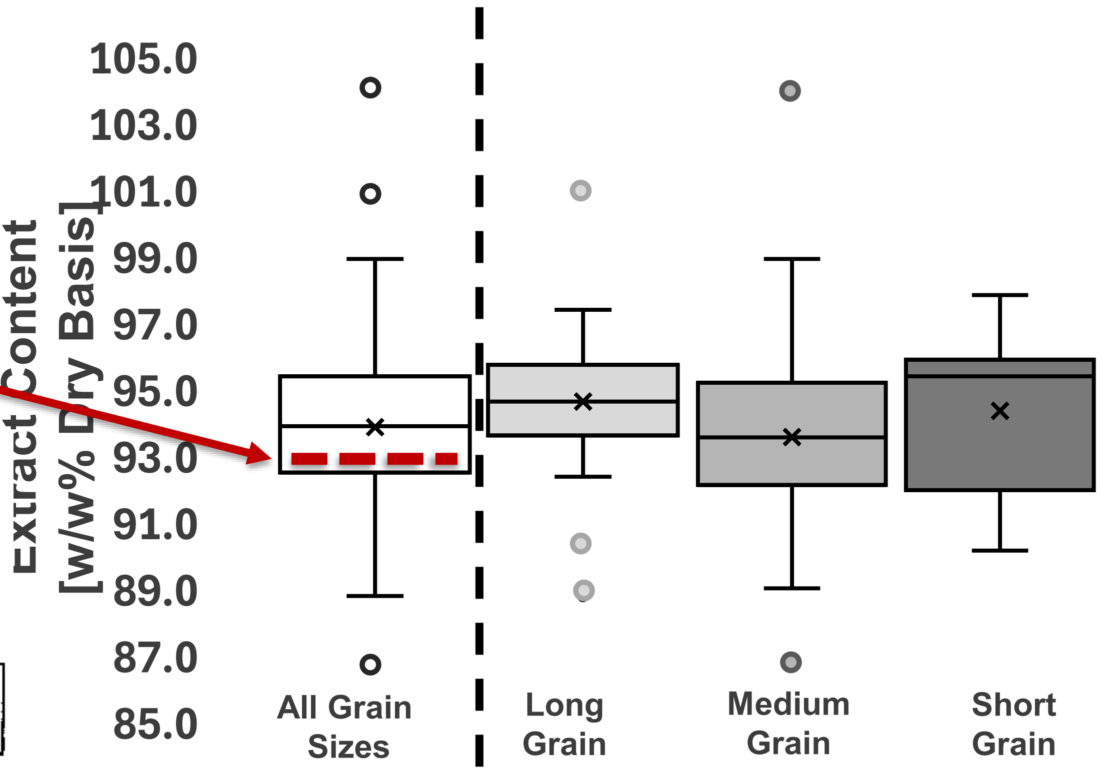
Variables	Extract yield % d.b.
Extract yield (d.b.)	**1**
Sieve 18 (1.00)	-0.035
Sieve 30 (.600)	0.008
Sieve 60 (.250)	**-0.459**
Sieve 100 (.150)	-0.085
Sieve 140 (.106)	**0.340**
Sieve 230 (.063)	-0.227
Bottom	-0.053
Whole Kernel %	0.043
Broken Kernel %	-0.032
Chalky Kernel %	0.123
Long Grain %	0.020
Medium Grain %c	0.028
Short Grain %	-0.036
Kenrnel Length	0.013
Kernel Width	-0.081
Kernel Length/Width Ratio	0.054
Gelatinization Peak	-0.025
Amylose %	**-0.239**

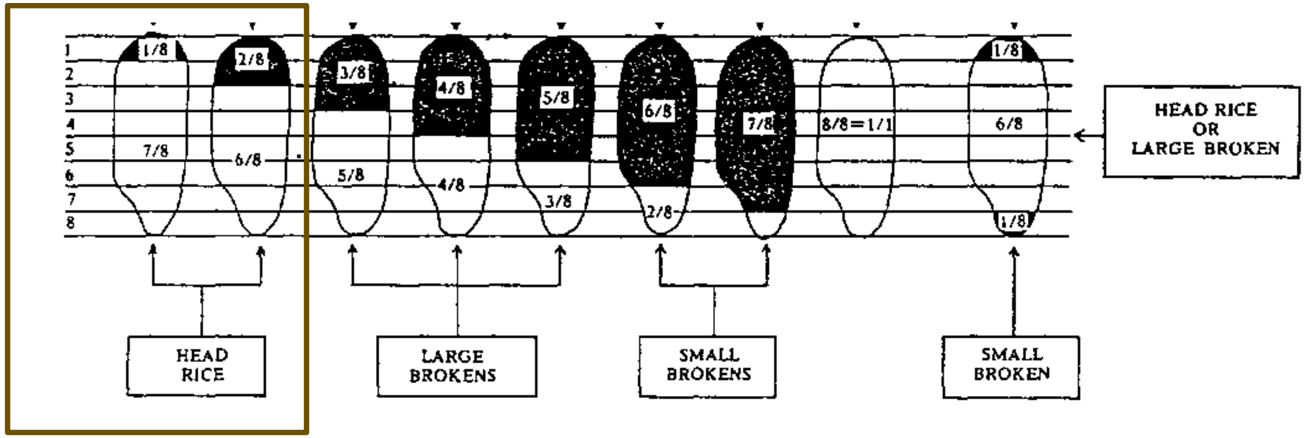
CENTER FOR BEVERAGE INNOVATION

Fissure resistance on extract yield?

- USDA prioritizing increasing head rice yields
- Cypress – fissure resistance not likely great for brewing extract – **bad for brewers!**

Based on 74 cultivars





What is related to extract ($)?

- Smaller rice particle sizes = higher extract %
- Larger rice particle sizes = lower extract %
- No relationship between kernel length and extract
- Lower amylose = more extract

CENTER FOR BEVERAGE INNOVATION

Variables	Extract yield % d.b.
Extract yield (d.b.)	**1**
Sieve 18 (1.00)	-0.035
Sieve 30 (.600)	0.008
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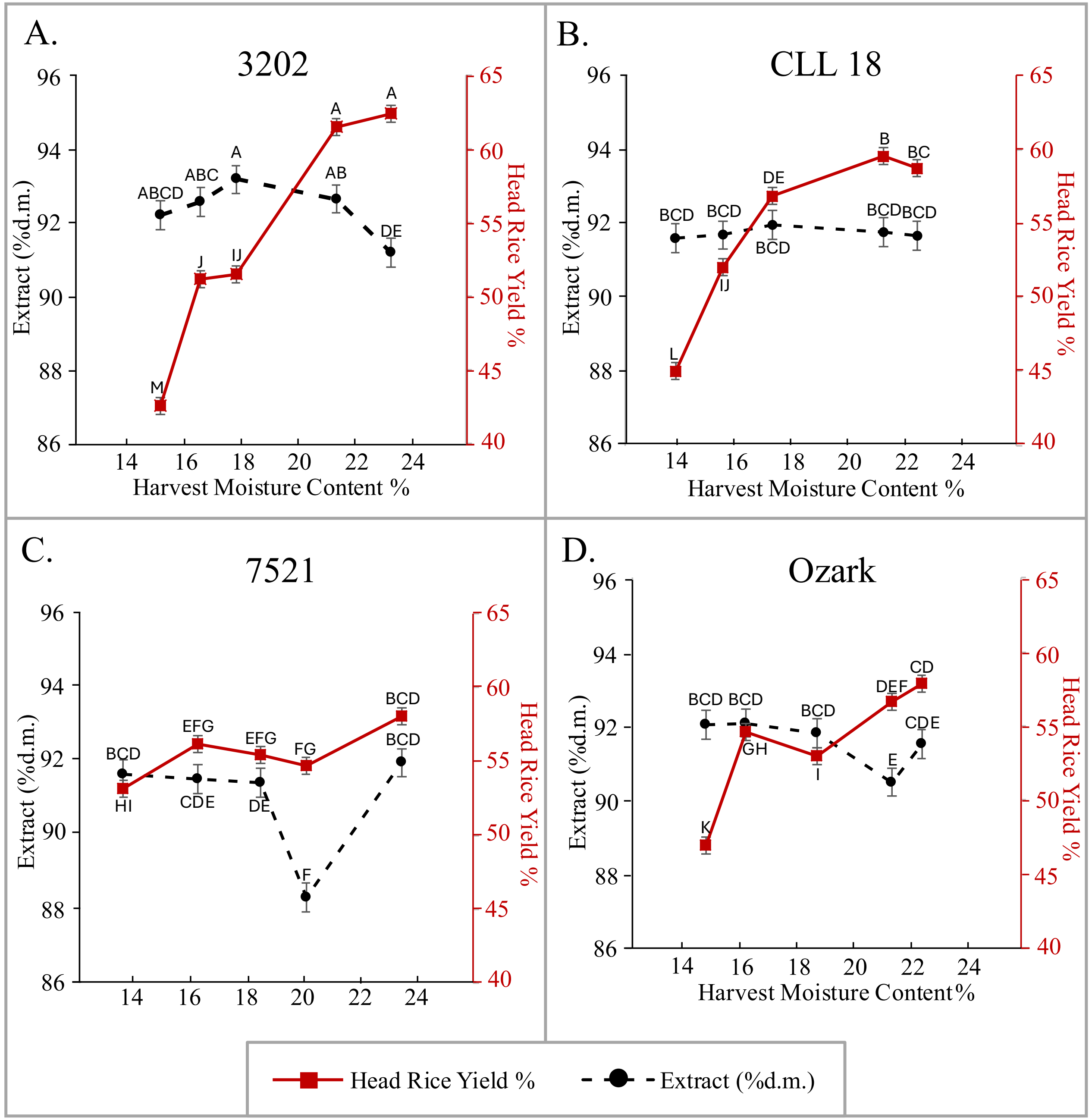
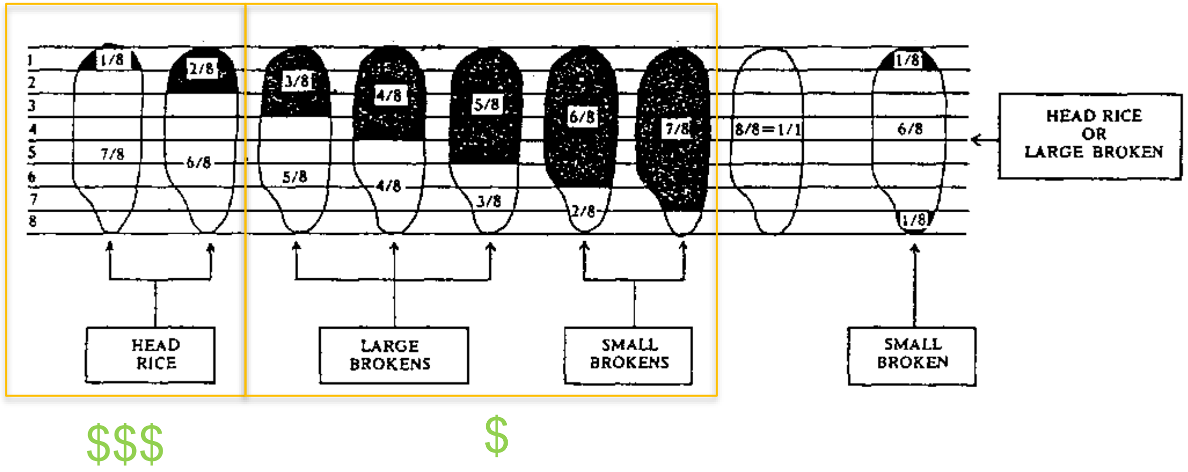
Kernel Width	-0.081
Kernel Length/Width Ratio	0.054
Gelatinization Peak	-0.025
Amylose %	**-0.239**

Farmer decisions - Harvest moisture vs extract and head rice yield





- Agricultural practices also influence quality
- Higher HMC = Higher HRY
  - Rice fractures less in general
- Higher HMC = lower extract?

Farmer decisions – how does fertilizer rate impact extract?

TABLE 1 | Effects of nitrogen on rice nutrient composition (protein, amylose, and lipid).

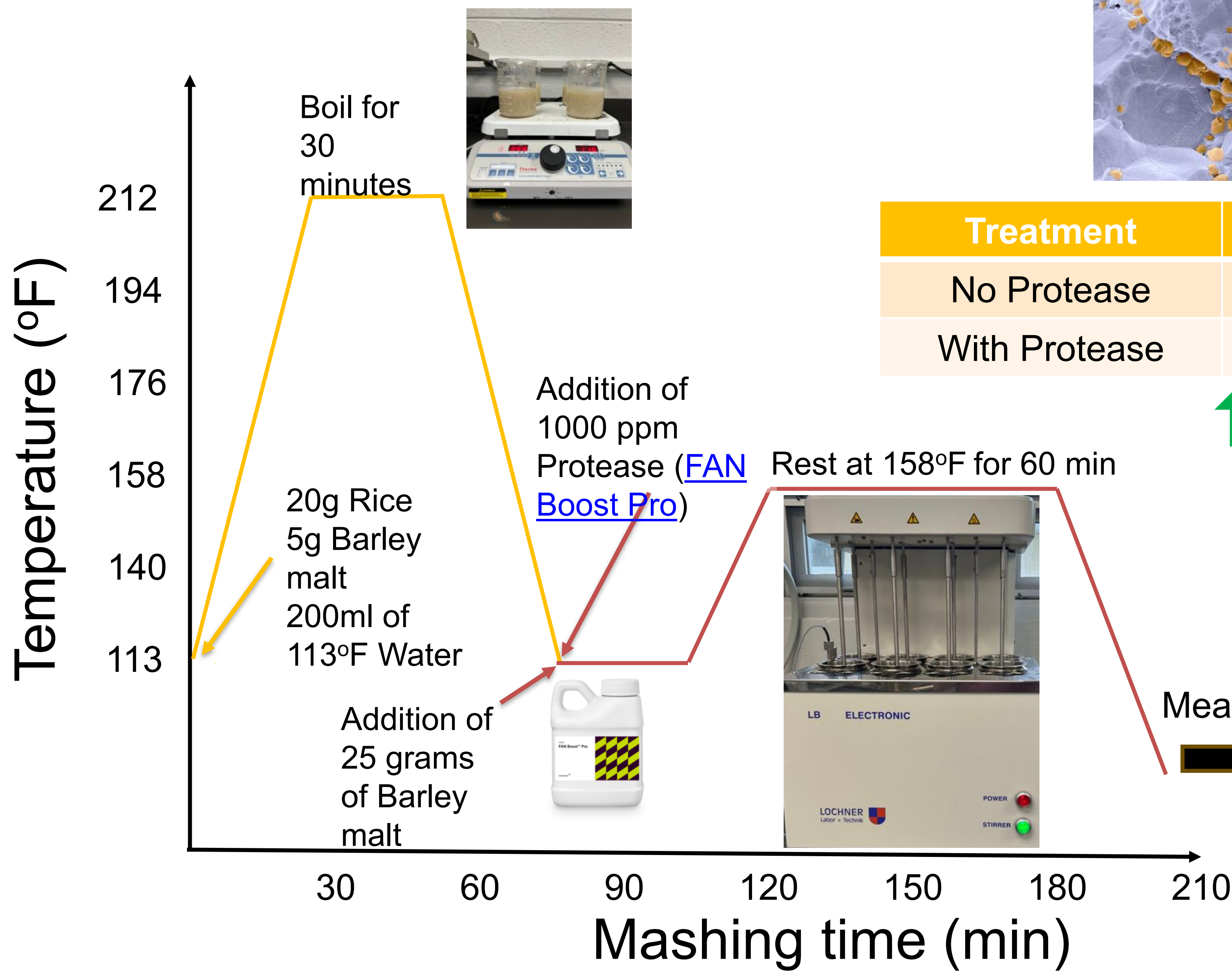
Cultivar	Treatment (kg/ha)	Amylose (%)	Lipid (%)	Protein (%)
RT 3202	0	13.5 ± 1.12a	2.4 ± 0.02de	7.1 ± 0.01j
	90	12.4 ± 0.69a	2.5 ± 0.05bc	8.0 ± 0.14 h
	120	11.6 ± 0.38a	2.6 ± 0.04a	8.4 ± 0.03 g
	150	12.0 ± 0.19a	2.6 ± 0.03ab	8.8 ± 0.03 f
	180	13.6 ± 0.04a	2.5 ± 0.00ab	10.0 ± 0.02c

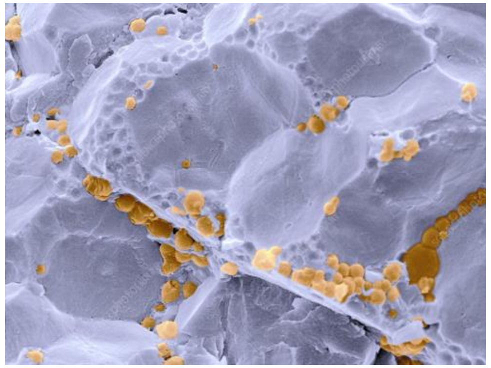
Cultivar	Treatment (kg/ha)	Peak viscosity (cP)	Breakdown viscosity (cP)	Final viscosity (cP)	Setback (cP)	Pasting temperature (°C)
RT 3202	0	3935.5 ± 88.4a	1687.5 ± 94.3a	3338.0 ± 0.0c	−597.5 ± 88.4 g	76.8 ± 0.7bc
	90	3357.0 ± 96.5bc	1379.0 ± 90.5b	3040.5 ± 157.9cd	−316.5 ± 61.5fg	76.5 ± 0.0c
	120	3141.5 ± 143.84cde	1241.5 ± 33.2bcd	2942.5 ± 105.06d	−199.0 ± 38.2ef	86.0 ± 0.0a
	150	3275.0 ± 26.8bcd	1208.5 ± 11.7cd	3073.0 ± 21.2cd	−202.0 ± 5.6ef	82.4 ± 6.3abc
	180	3017.5 ± 64.35cde	1130.5 ± 38.9d	2881.5 ± 95.5d	−136.0 ± 31.1ef	87.6 ± 0.0a

- How fertilizer rates impact quality and extract?
- Farmers chasing yield apply higher N = higher protein grains/ higher pasting temperatures
- Current USDA and barley priorities to **breed** new varieties with lower protein

https://doi.org/10.1002/cche.70013

Protein affecting extract?





Picture source: https://www.sciencephoto.com/media/148076/view/sem-of-protein-in-rice-grain

Treatment	Extract (as is)	Extract (d.b.)
No Protease	76. 41%	85.83%
With Protease	82.00%	91.61%

5.18% increase 5.79% increase

Is this cost effective ?

Measure density

Thoughts about targets for milled rice in the brewing industry

Brewers need to communicate needs to farmers

Chemical Traits

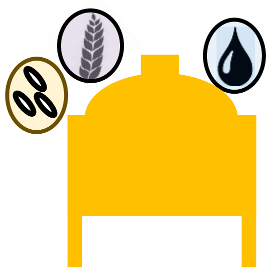
- Low protein
- Low gel < 65
- Low amylose/ low DP37-65

Physical

- Needs to have some Fracturability
- Need plump kernels

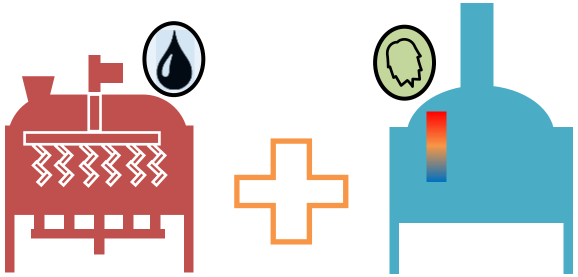
How does rice impact beer flavor?

[Dr. –Ing. Christian Schubert (guest researcher)]



Pregelatinize rice (Aroma 22):
Mash in 72 °C + α-amylase (heat stable) 0.1 ml/kg grist
heat to 90 °C – rest 20 min

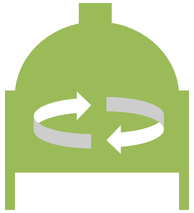
Main mash:
Mashing in 72 – rest 60 min
(saccharification → iodine normal)
gel. rice + pale 2-row malt + 10 % total grist rice husks + 0.05 ml/kg enzyme mix
(cellulase / arabinoxylanase)



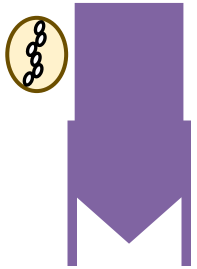
Sparging:
72 °C water until kettle full wort at 6.5 °P (~35L)

Start boil:
hop addition CTZ
(14.2 % α-acids - target 20 BU)
1 g/L yeast nutrient
(diammonium phosphate + urea)
60 min boil

End boil:
pH adjust - 4.6 (lactic acid)
Gravity adjust - 7.0 °P



Whirlpool:
Adding 1 tbl. Whirfloc
Whirlpool rest 15 minutes



Pitching:
2 g/hl brewers clarex + 2 g/hl α-acetolactate decarboxylase
5 mio. cell/l *Saccharomycodes ludwigii*

Fermentation:
16 °C / ABV 0.35 – 0.45 % vol.

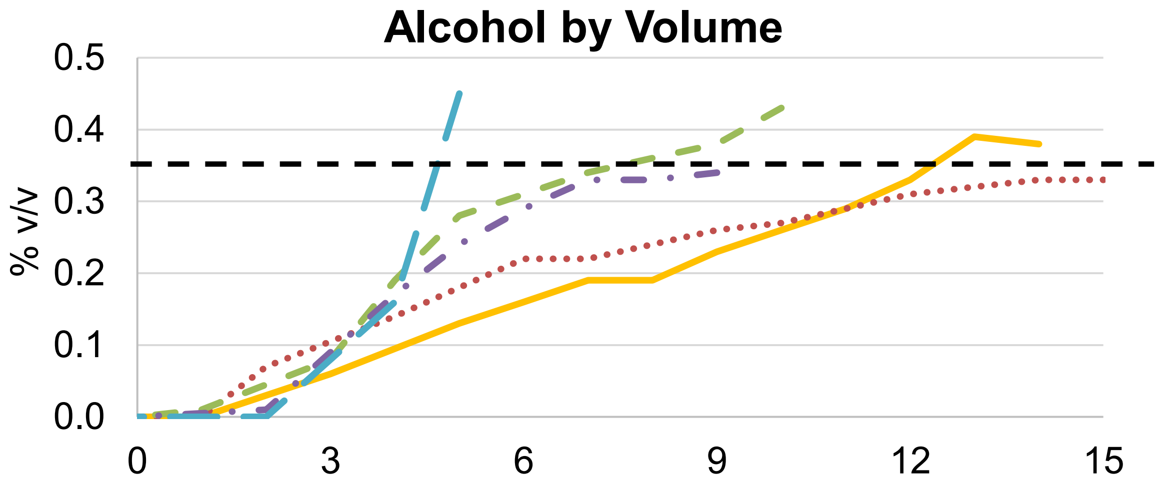
Barley Malt [%]	Aromatic Rice [%]
100	0
70	30
50	50
30	70
0	100

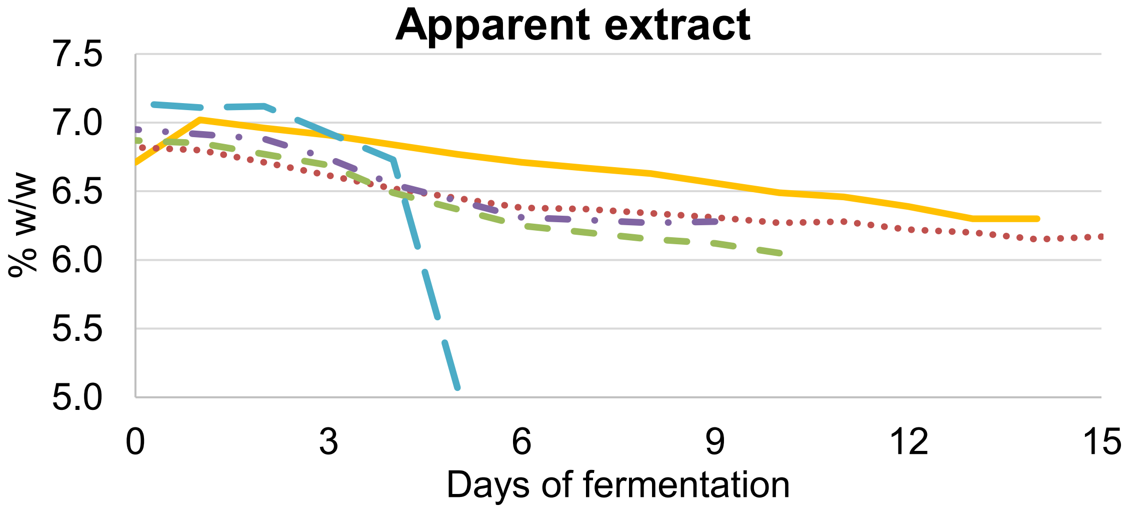
https://www.tandfonline.com/doi/full/10.1080/10942912.2025.2520907

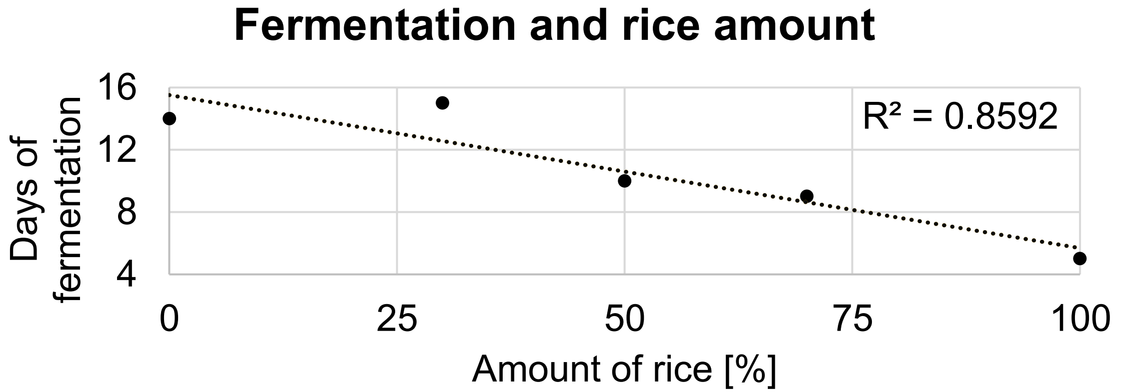
Impact of rice on fermentation characteristics

Increasing rice %

100 Barley Malt · 70 Barley Malt / 30 Rice · 50 Barley Malt / 50 Rice · 30 Barley Malt / 70 Rice · 100 Rice







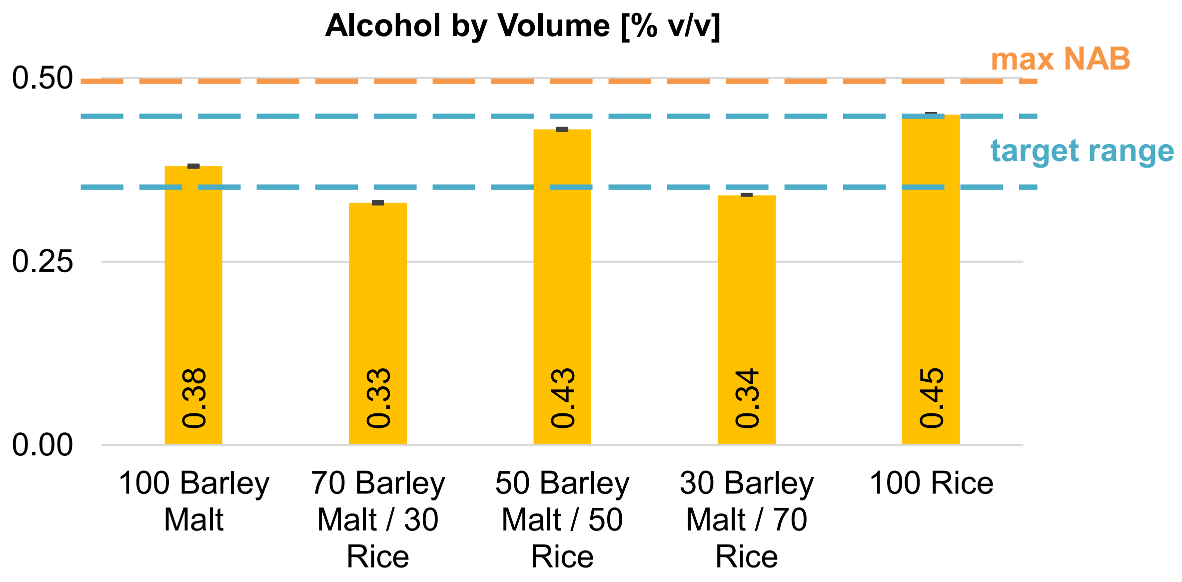
- Fermentation at 16 °C is no problem
  - takes longer – can be (time) problematic in industrial size

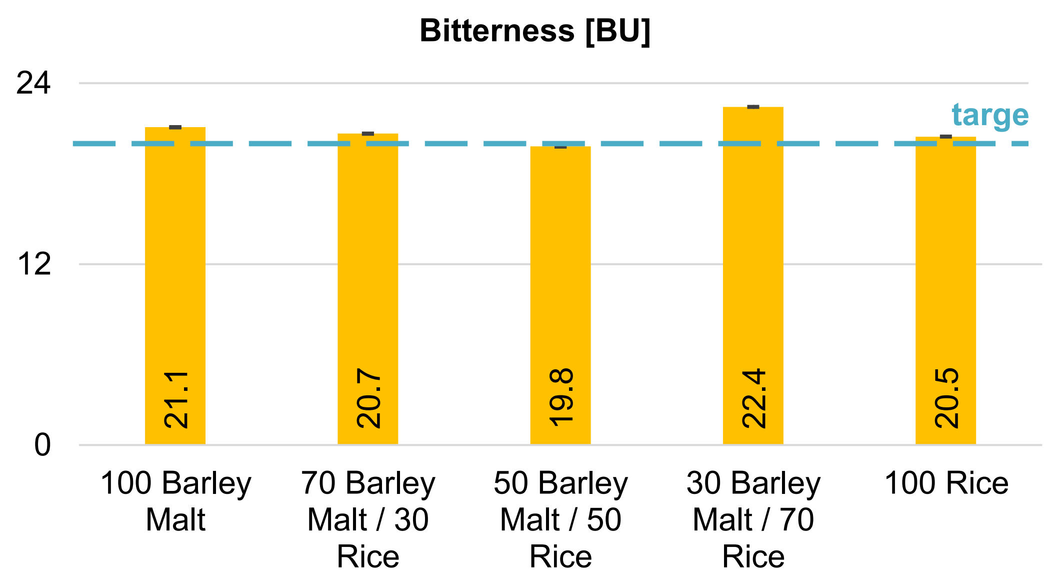
- Increase of rice seem to reduce fermentation to final ABV
  - **adding simple sugar only → faster fermentation**
  - drastically when using 100 % rice
    - different enzyme addition → sugar profile – **sensory effect?**

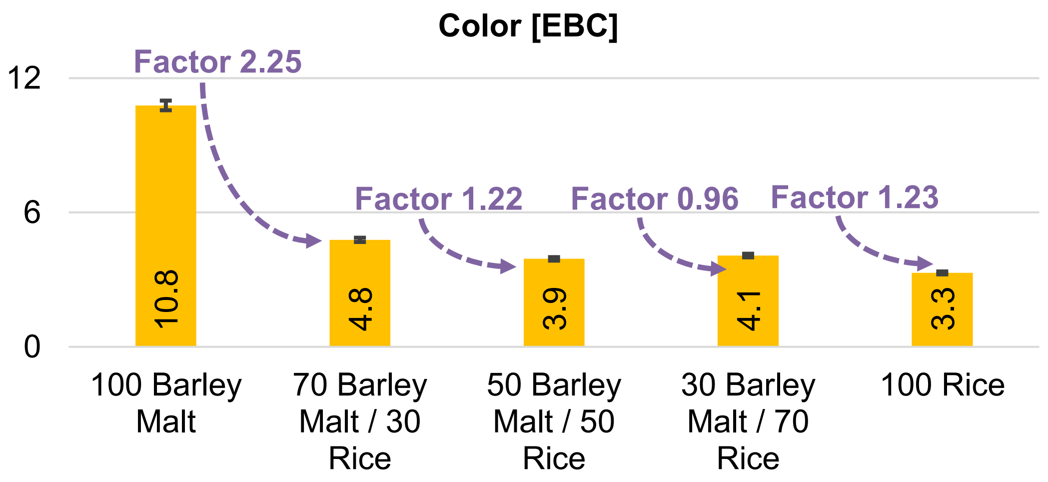
- ABV goal of 0.35 – 0.45 was achieved

Overall positive fermentation properties with increasing rice %

Impact of rice on basic beer characteristics







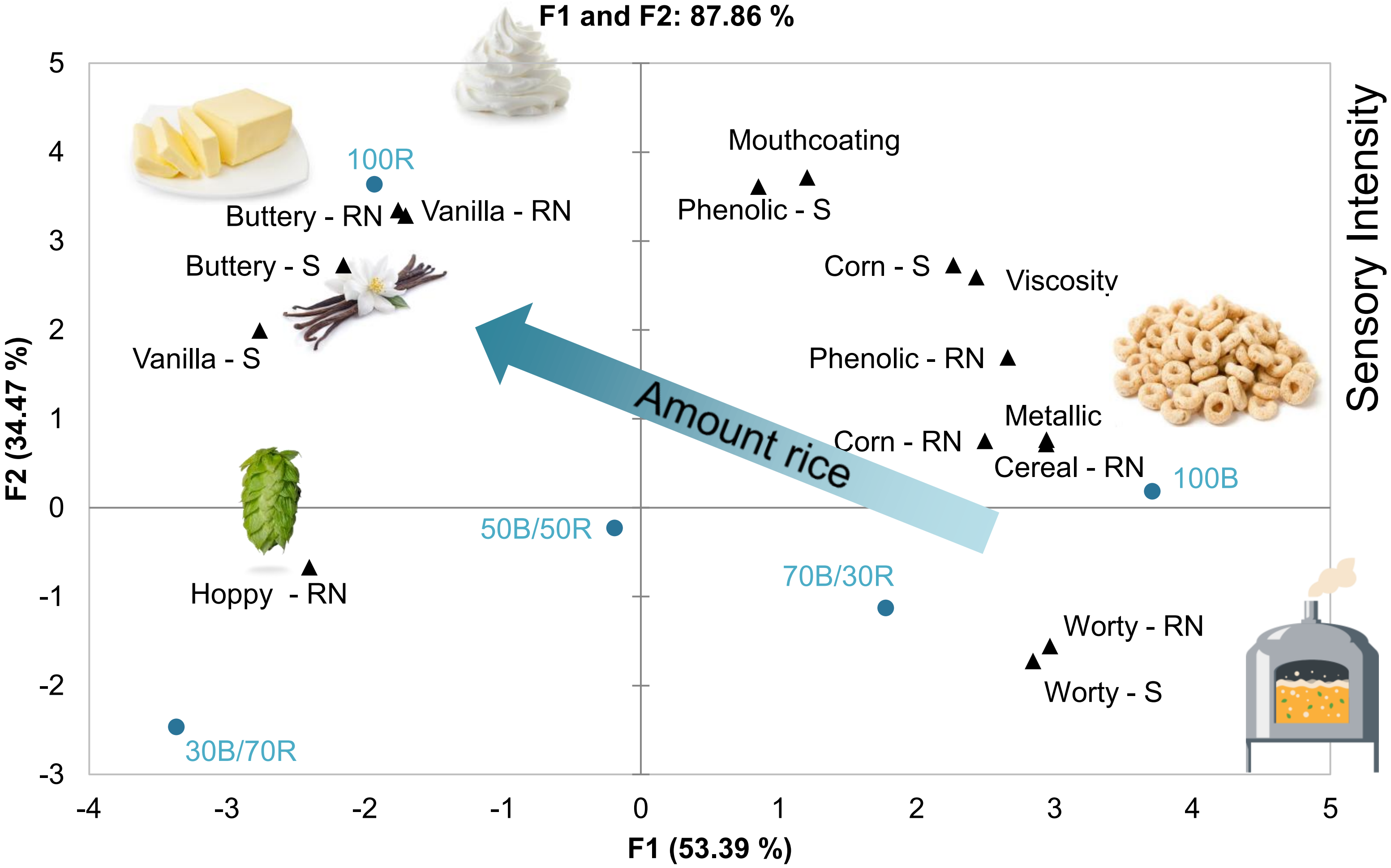
Error bars defined as standard error

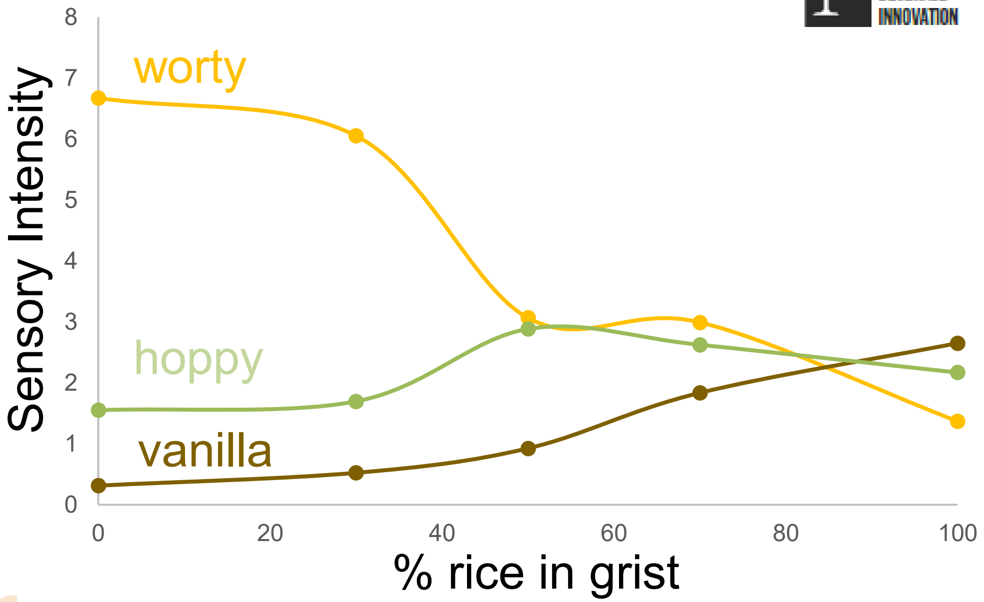
All NABs brewed showed comparable basic data

- all brews can be classified as NAB (<0.5 % vol.)
  - 100 % rice presents highest ABV
    - ➢ sugar composition → fermentation harder to control / check in the small scale (~ 35L)
- equal bitterness – target 20 BU
- color is clearly influenced by barley amount

https://www.tandfonline.com/doi/full/10.1080/10942912.2025.2520907

Impact of aromatic rice on beer flavor





Increase % rice:

↓ wort/cereal

↓ metallic

↑ buttery

↑ vanilla

↑ hoppy

https://www.tandfonline.com/doi/full/10.1080/10942912.2025.2520907

Consumer studies on NAB made with alternative grains

NAB production

- Yeast – Berkely NA strain
- 50% American pale 2-row barley malt
- 50% other (global) starch source:

  1. Barley malt (100 % reference)
  2. Barley (dehusked)
  3. Rice (**non-aromatic**)
  4. Yellow corn (flakes)
  5. Wheat
  6. Sorghum
  7. Millet

- Panel **n=116** (56 male, 60 female; ≥21 years)

  ➢ *Gen Z = 32; Millennials = 37; Gen X = 41; Boomer = 6*

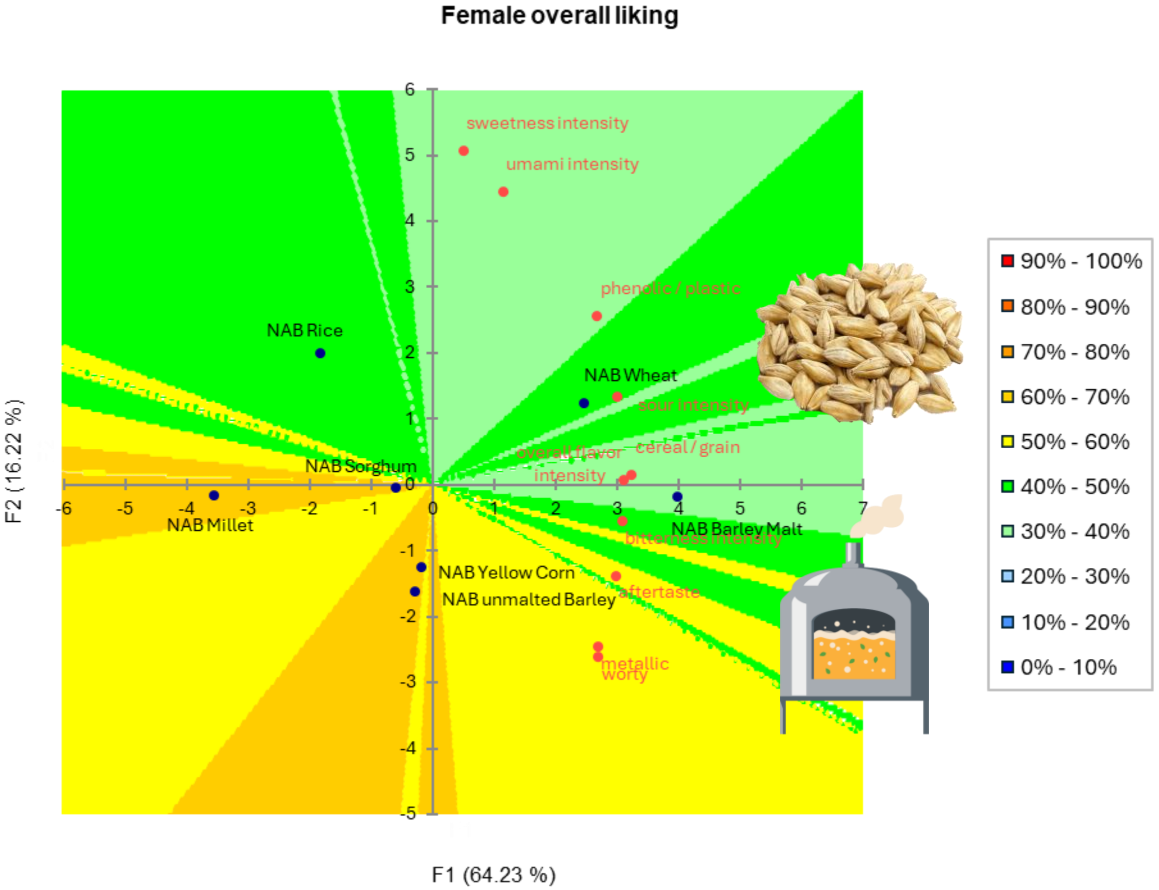
- 9-point hedonic scale: **aroma, taste, overall**

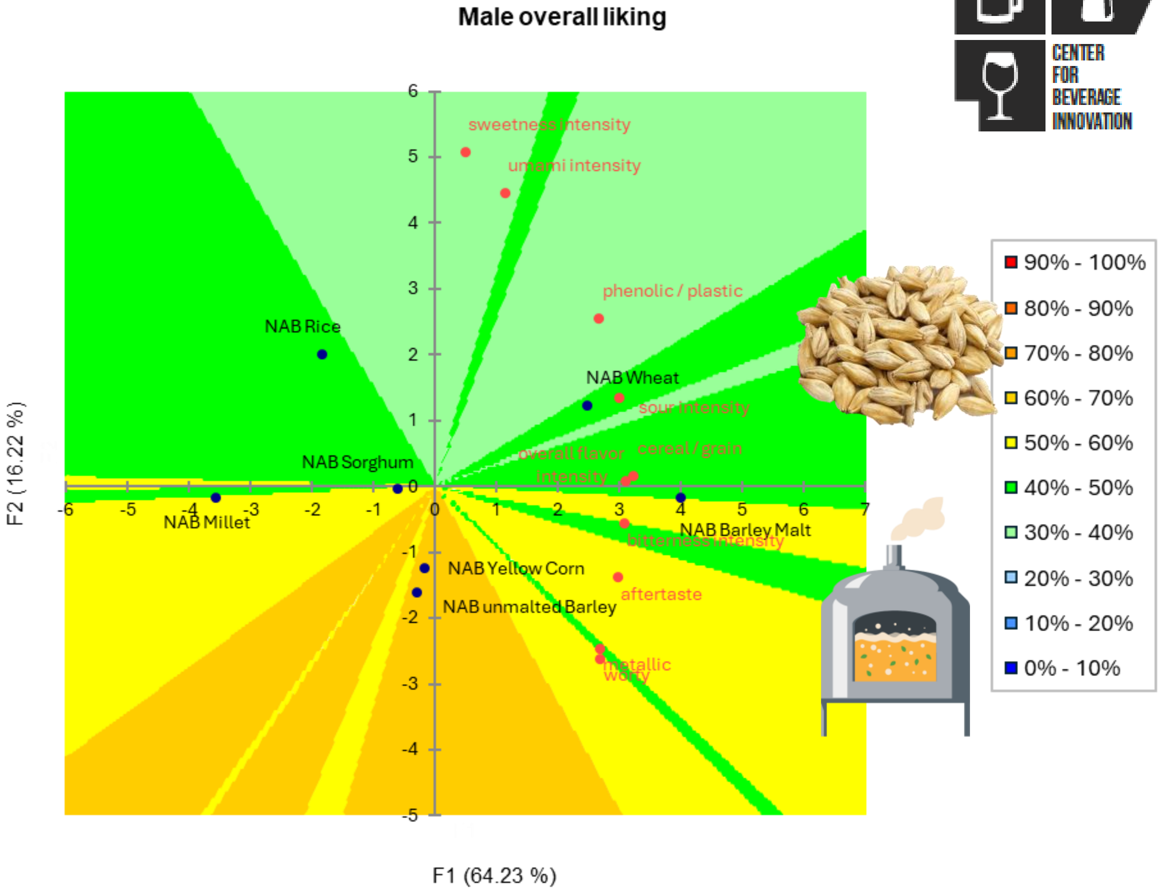
- Additional 0 – 100 line scale (not at all – extremely)

  ➢ *Attributes:* ***overall flavor intensity, cereal/grain, phenolic / plastic, sweetness, bitterness, umami, sour, aftertaste, metallic, worty***

Designing better NABs

(consumer overall liking; 60 female, 56 male)





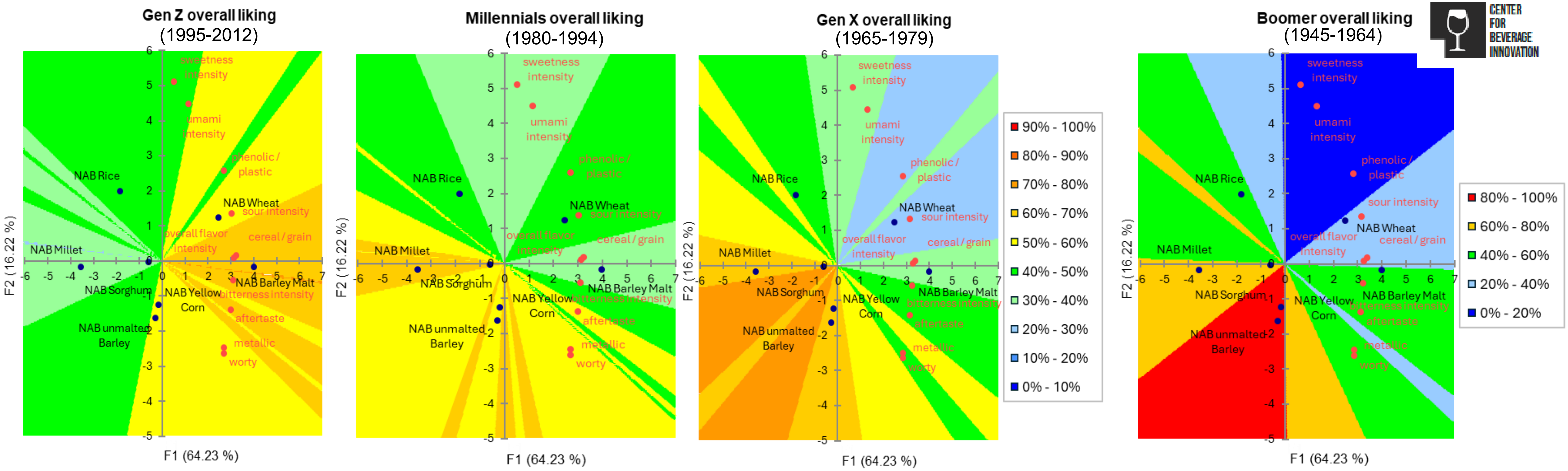
No clear overall product preference

All-malt, wheat, and rice products least preferred

Neutral, alternative-grain products preferred

Designing better NABs

(consumer overall liking; Gen Z = 32; Millennials = 37; Gen X = 41; Boomer = 6)



preferences are shifting slowly

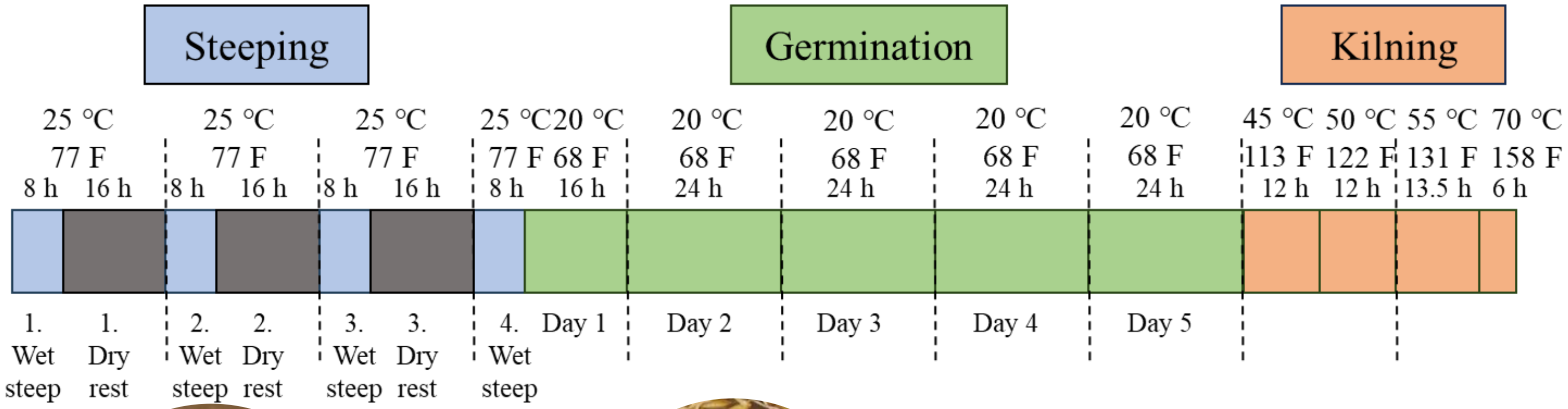
Thoughts about flavor that can be achieved with rice

- Flavor outcome depends heavily on **variety selection and processing conditions**
- Rice can contribute a **clean, neutral, and highly fermentable base**, allowing other ingredients to stand out.
- Different rice varieties can provide **subtle floral, sweet, popcorn-like, nutty, or pandan-like aromatics**.
- Rice can support a **lighter body and cleaner finish**, which may enhance drinkability depending on target age group

Malting

- Main objectives of malting:
  - ✓ Production of enzymes
  - ✓ Breakdown of protein
  - ✓ Improved stability

Mayer, H., et al. (2014). "Production of a Saccharifying Rice Malt for Brewing Using Different Rice Varieties and Malting Parameters." Journal of Agricultural and Food Chemistry **62**(23): 5369-5377.



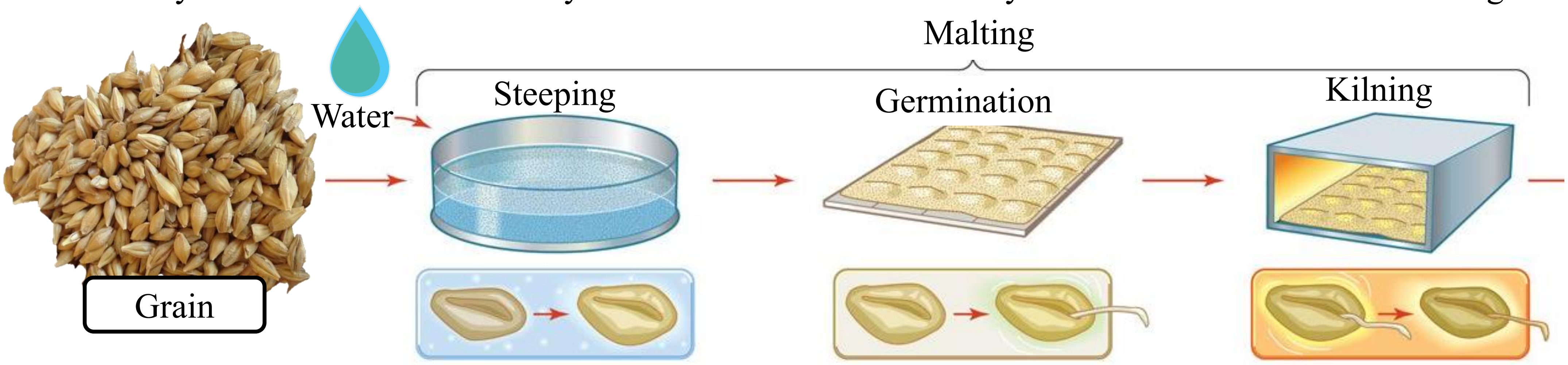

Day 0


Day 1



Day 5

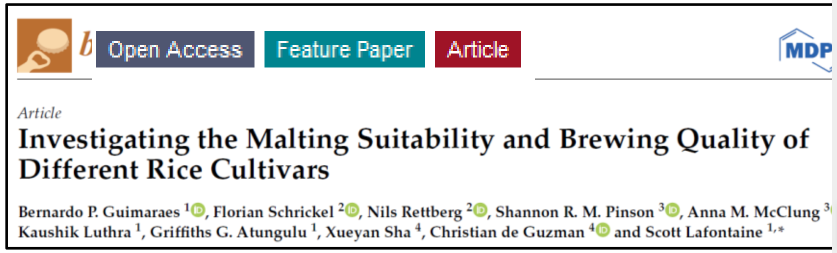

Kilning



Britannica, E. (2012). "The brewing process." Retrieved Nov. 22, 2023.

Our approach

Cultivar	L/W	USDA classification	Characteristics and country of origin
14	1.74	Short grain	Non-aromatic, Japan
13	1.98	Short grain	Non-aromatic, USA
18	2.15	Medium grain	Non-aromatic, USA
17	2.51	Medium grain	Non-aromatic, USA
3	2.53	Medium grain	Purple bran, aromatic, Brazil
4	2.72	Medium grain	High resistant starch, non-aromatic, the Philippines
6	2.96	Medium grain	Purple bran, aromatic, USA
10	2.99	Medium grain	Purple bran, non-aromatic, the Philippines
11	3.04	Long grain	Non-aromatic, USA
9	3.13	Long grain	Non-aromatic, USA
2	3.13	Long grain	Aromatic, USA
8	3.15	Long grain	Hybrid, non-aromatic, USA
12	3.16	Long grain	Red bran, non-aromatic, USA
1	3.19	Long grain	Non-aromatic, USA
19_2	3.22	Long grain	Aromatic, USA
7	3.25	Long grain	Aromatic, the Philippines
19_1	3.39	Long grain	Aromatic, USA
16	3.41	Long grain	Non-aromatic, USA
5	3.48	Long grain	Aromatic, USA
15	3.52	Long grain	Non-aromatic, USA


Open Access Feature Paper Article

Article

Investigating the Malting Suitability and Brewing Quality of Different Rice Cultivars

Bernardo P. Guimaraes [1], Florian Schrickel [2], Nils Rettberg [2], Shannon R. M. Pinson [3], Anna M. McClung [3], Kaushik Luthra [1], Griffiths G. Atungulu [1], Xueyan Sha [4], Christian de Guzman [4] and Scott Lafontaine [1,*]

Malting

Malt

malted rice

Wort/beer

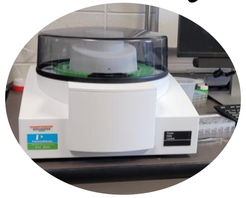
https://www.mdpi.com/2306-5710/10/1/16

Published Feb 1: 3000 unique downloads!

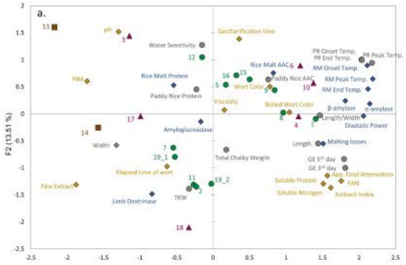
Bernardo Guimaraes (PhD Student)

paddy rice

Chemical analysis



Data analysis

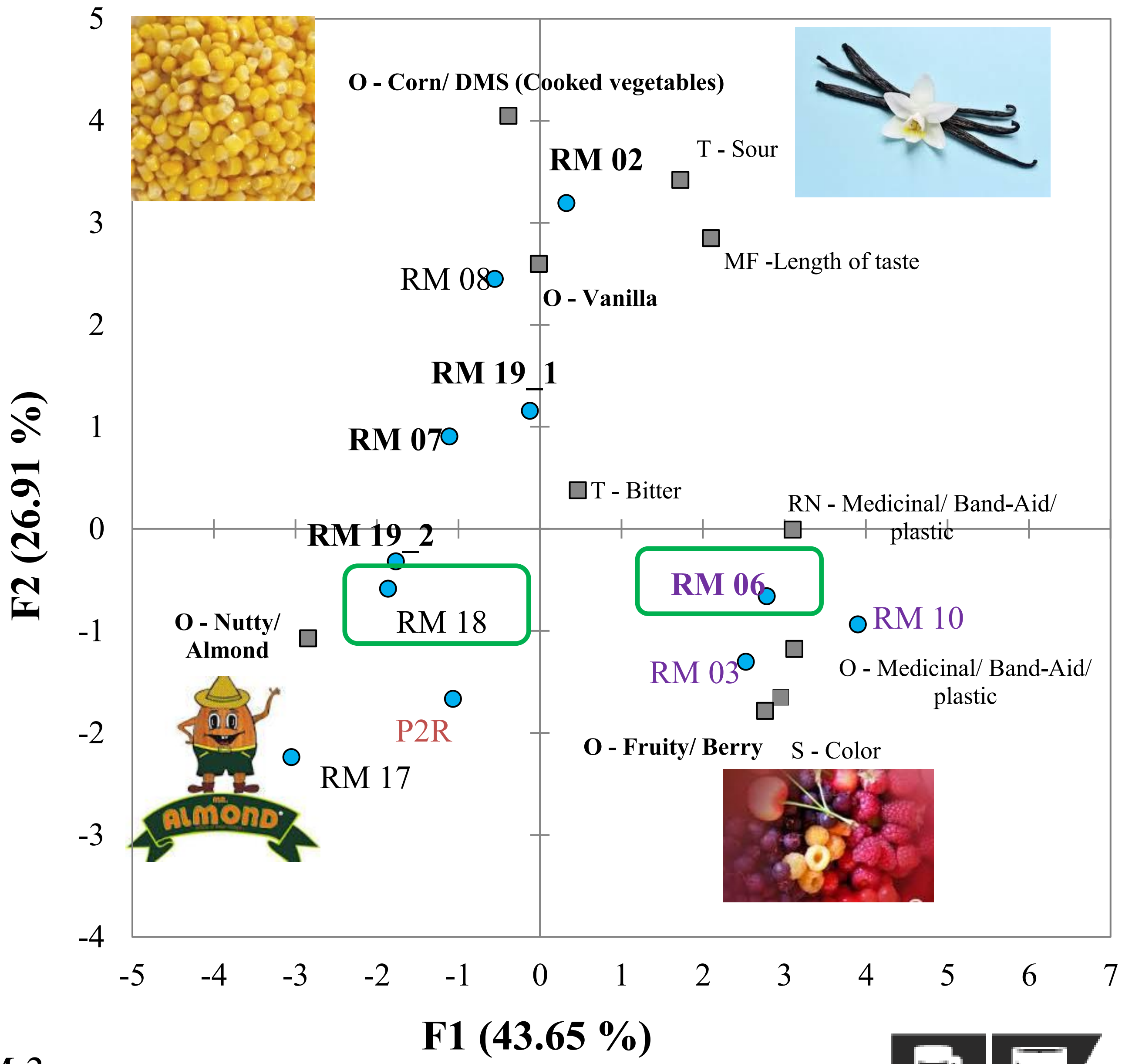


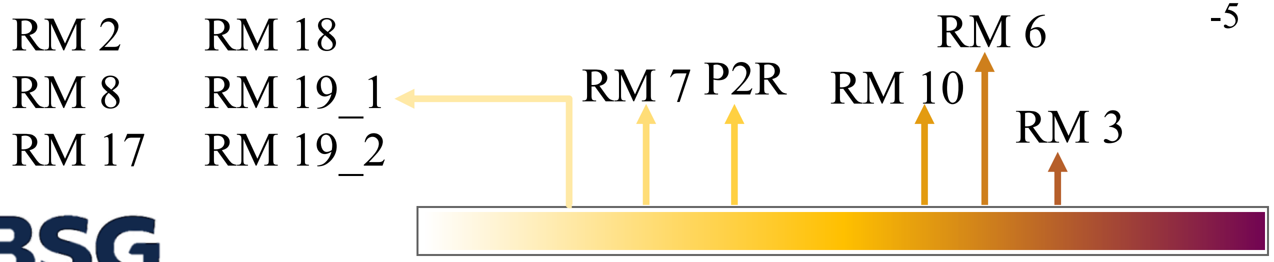
Want to learn more podcasts:

- Brülosophy Bru Lab Podcast Episode 156 | Brewing With Rice Malt w/ Bernardo Pontes Guimaraes and Dr. Scott Lafontaine
- Basic Brewing Radio Podcast May 16, 2024

Sensory

- Malted rice flavor
  - Can overlap with barley flavor
  - Can yield novel flavors
    - Aromatic – buttery/vanilla
    - Pigmented – fruity/ medicinal





https://www.tandfonline.com/doi/abs/10.1080/03610470.2025.2566485

BSG

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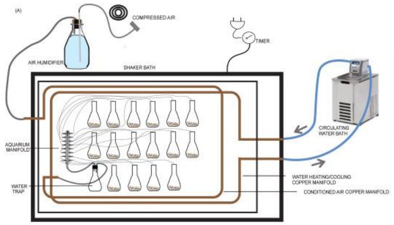
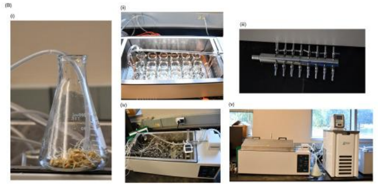
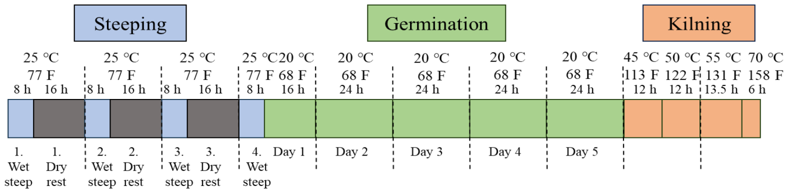
Rice Malting Using Benchtop Malting System

[Heena Rani (Post Doc.)](#)





https://www.sciencedirect.com/science/article/pii/S0733521025000360?via%3Dihub#fig1



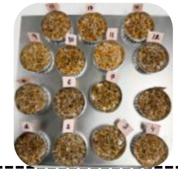
[Guimaraes, B. P., et al. (2024)](https://www.mdpi.com/2306-5710/10/1/16)
https://www.mdpi.com/2306-5710/10/1/16

Paddy rice
- Whole kernel length
- Whole kernel width
- Color
- Gelatinization onset, peak and end temp
- Amylose

Steeping
- Removal of impurities
- Moisture increases (12% → 47%)
- Chitting

Wet steep (4 times)
Dry rest (3 times)
at 25°C (80 h)

Germination
- Breakdown of cell walls and proteins
- Activation of hydrolytic enzymes
- Formation of antioxidants
- Acrospire growth



20°C (120 h)

Kilning
- Heat treatment (45-70 ℃)
- Moisture reduction (47% → 5%)
- Halt germination
- Enzyme inactivation and preservation

45°C (12 h)
50°C (12 h)
55°C (13.5 h)
70°C (6 h)
With 30 min ramps at each stage

Deculming
- Rootlet removal

Rice Malt Quality Analysis
- Diastatic power
- α- amylase, β-amylase, Limit dextrinase
- Free amino nitrogen
- Extract
- Soluble protein
- Kolbach index

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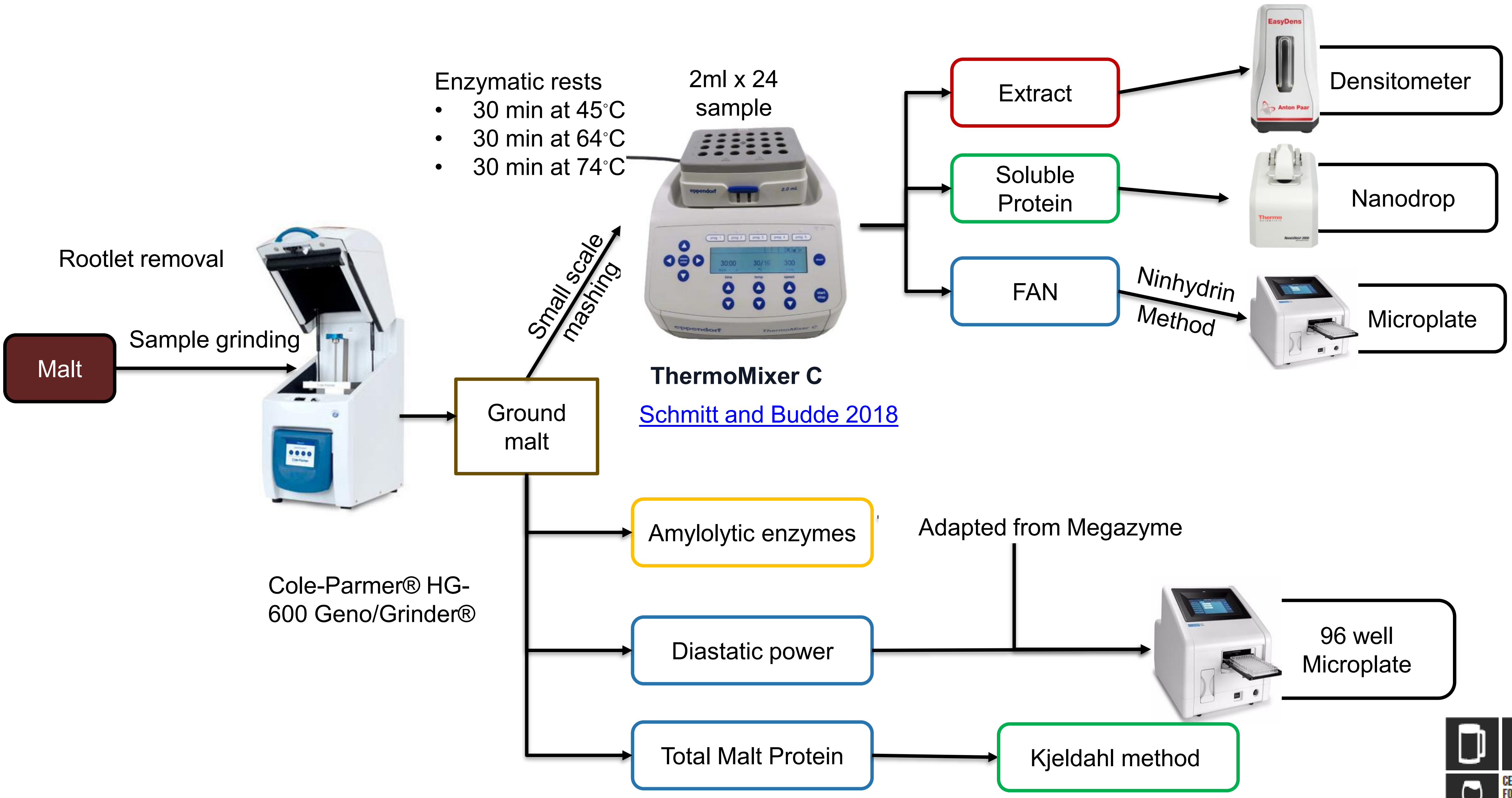
Rice Malt Quality Analysis Workflow



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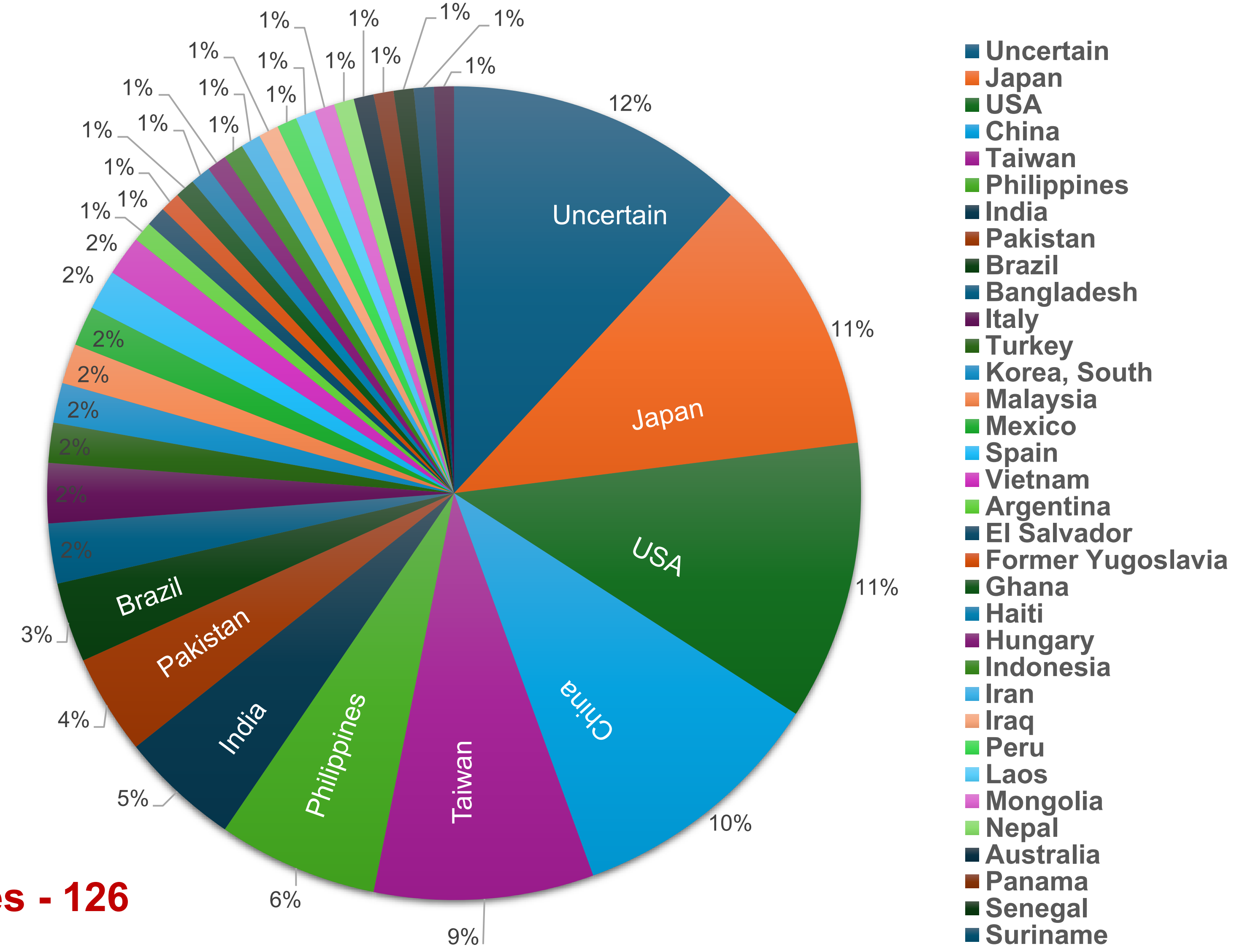
Screening Diverse Rice Genotypes from Across the Globe



Total genotypes - 126

Variation in Grain Morphology Across Genotypes

Whole Kernel Length (mm) **Whole Kernel Width (mm)** **Whole Kernel Length/Width (mm)**

Min Length | Max Length | Min Width | Max Width | Short | Medium | Long

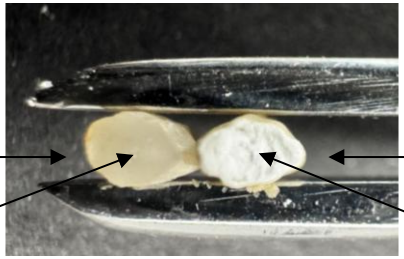
There are rice cultivars that might be able to be processed with existing barley malt equipment and systems

Cross-Sectional Views and Images of Rice Malt During Germination

DOG3

DOG5

DOG0



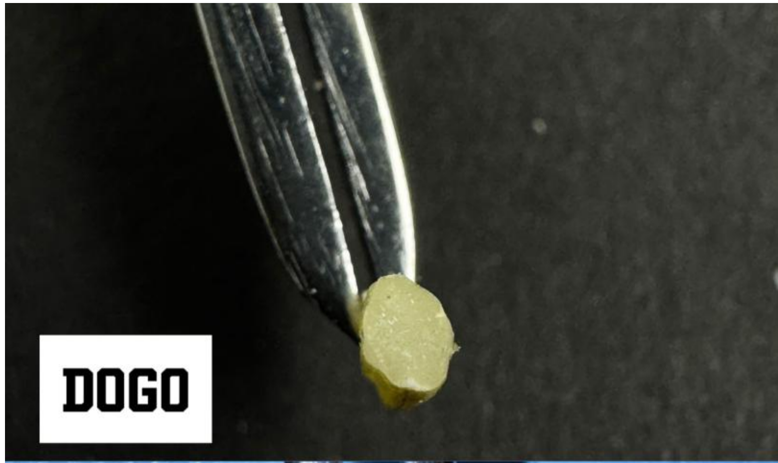
DOG5

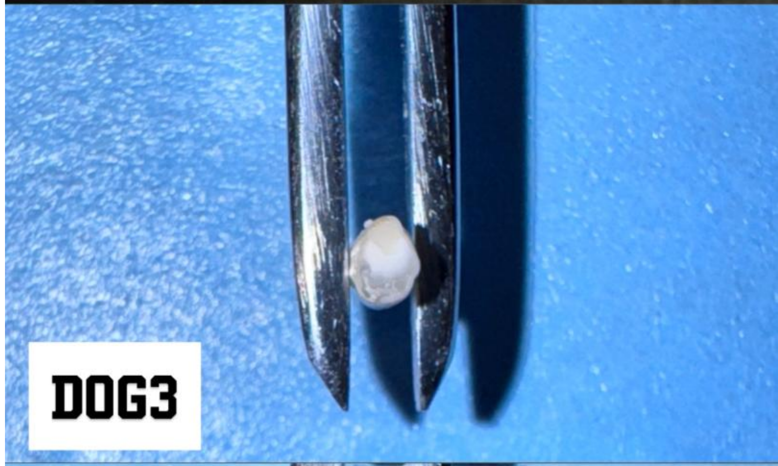
Crystalline

Friable

DOG: Day of germination

Proper modification is crucial for enhancing friability and reducing crystallinity, both of which are key to improving malt processability in the brewhouse





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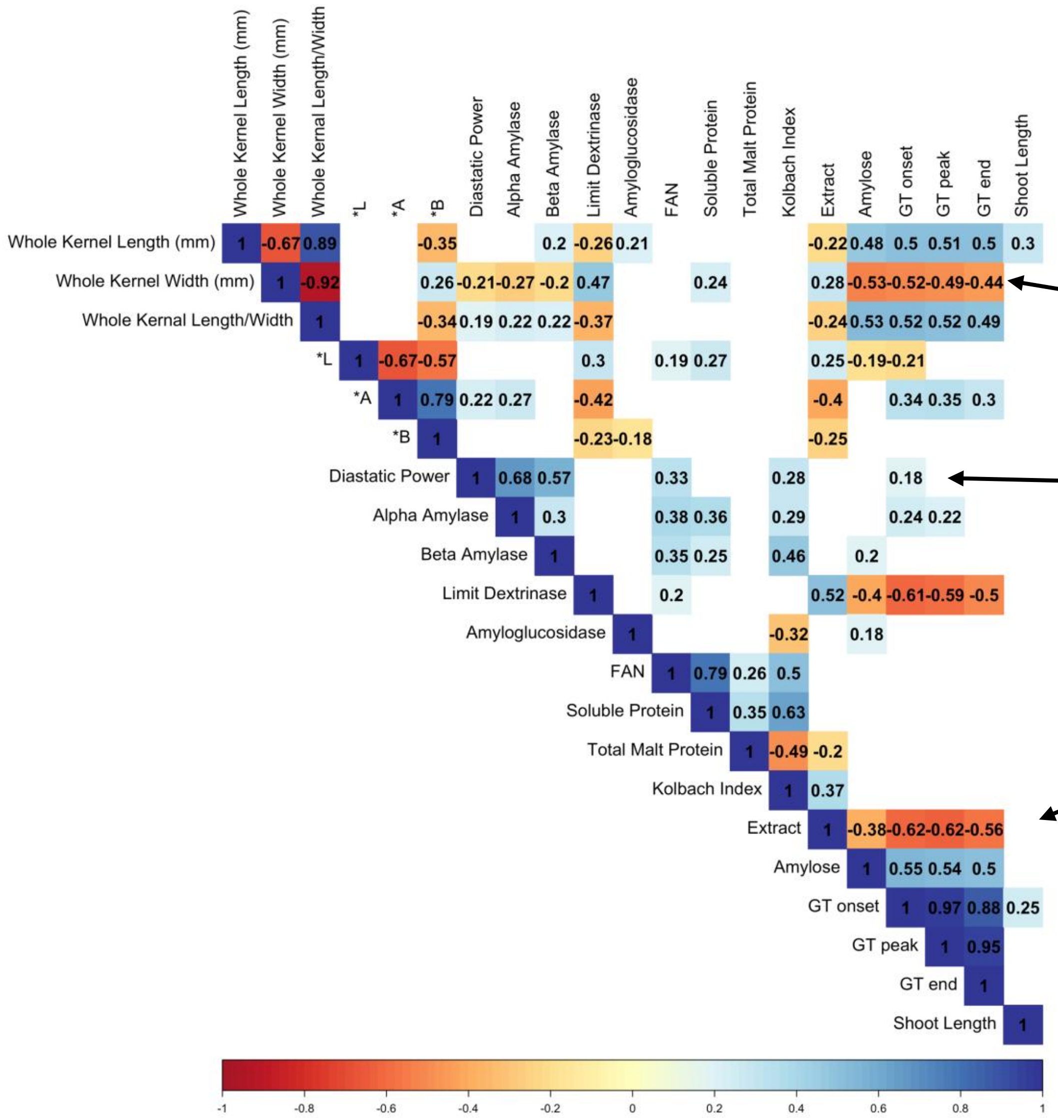
Correlation Between Malt Quality Parameters



Blue box = positive correlation

Orange box = negative correlation

$p < 0.05$

- Width **negatively correlated** with diastatic power (DP), amylose, and gelatinization temperature but **positively correlated** with limit dextrinase.
- DP, alpha amylase, beta amylase, FAN, and are **positively correlated**.
- Limit dextrinase and extract show a **positive correlation**.
- Extract is **negatively correlated** with amylose content and gelatinization temperature.
- In agreement with past research –
  - https://www.mdpi.com/2306-5710/10/1/16
  - https://www.tandfonline.com/doi/full/10.1080/03610470.2025.2499768

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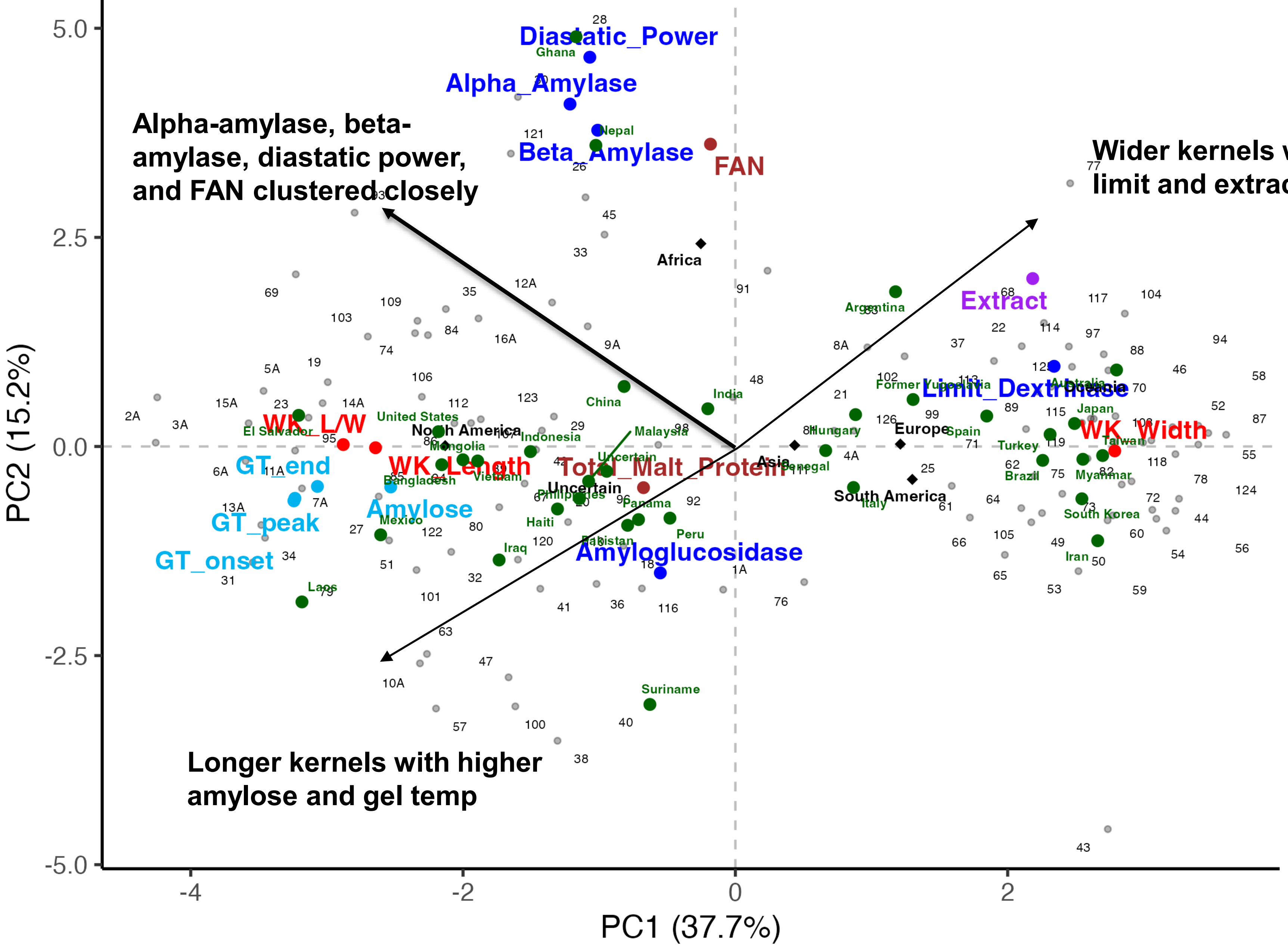
Considering all the rice malt quality analysis – What do we move forward with?



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Conclusions on rice and ‘expanding the multiverse’

- **Rice malt can impart traditional and novel flavors**
- **Rice cultivars showed malting capabilities with good results**
  - Malting rice could be a new breeding target
  - Lots of interest in this topic from the brewing industry
- **Rice can be a locally sourced starch**
- **Rice is cost effective**
- **Gluten-free**
- Rice yield less susceptible than barley to climate change ([Zhao et. al. 2017]())

Partnership Opportunities

- **Contract Analytical Testing**
  - Malt quality analysis testing, product innovation/ development, rapid screening for off flavors or flavor stability. Brewing and Beverage Innovation Payment Form - Formstack
- **Co-Develop New Beverages**
  - Engage CBI for pilot trials using alternative grains, novel hop products, or specialty yeasts.
- **Cultivar Commercialization**
  - Joint IP and licensing for malting quality, high-extract, and/or flavor-distinct rice lines tailored to brewing

Guided Tasting - Rice in brewing today – Lets taste what rice can do for you

Traditional rice beverages

100% rice

Light Lagers

~40-60% rice

American/ Japanese/ Chinese Lagers

~20-40% rice

Adjunct IPAs

~5-30% rice

- **Flavor neutrality** – provides fermentable extract without contributing strong malt flavors leading to clean crisp profiles
- **Shelf-life stability** – low lipid and polyphenol content improves flavor stability and reduces staling.
- **Process efficiency** – high starch content supports efficient extract production in brewing.
- **Product innovation** – enables development of lighter beers and novel beverage styles.
- **Traditional beverage production** – foundational ingredient in beverages such as sake and rice beers.

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Q&A

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