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Increasing the value of the corn kernel through fiber conversion

October 4, 2022
Fuel Ethanol Lab Conference

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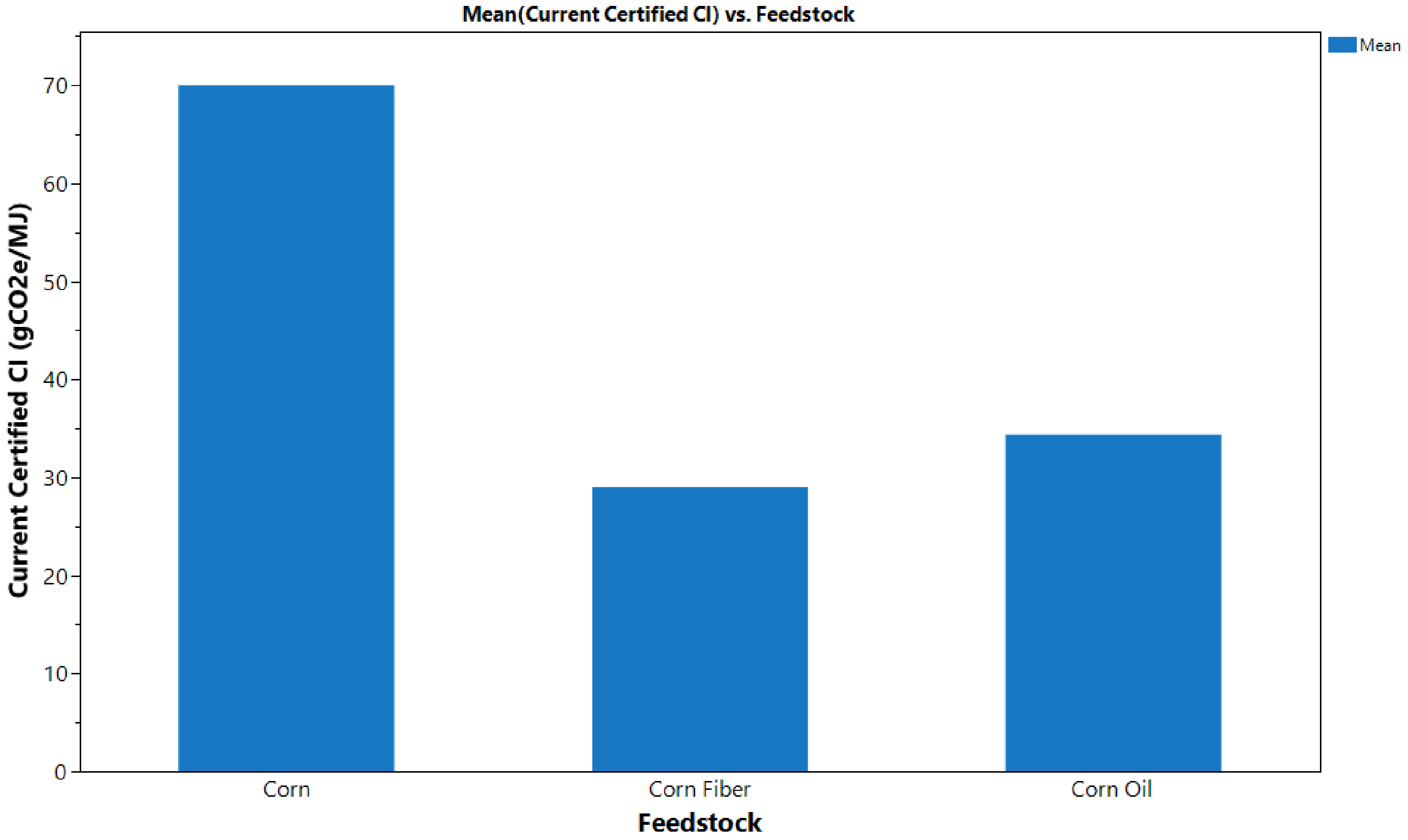
Low carbon fuels



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[LCFS Pathway Certified Carbon Intensities | California Air Resources Board]

Average Corn Composition

Moisture[1]	12-15 %w/w
Starch[2]	65-72 %w/w
Sugar[2]	2.2 %w/w
Protein[2]	9-12 %w/w
Fat[2]	4.4 %w/w
Cell wall material[2]	9.6 %w/w ✓
Ash[2]	1.5 %w/w

Fiber degrading enzymes → Cell wall material

[1] % w/w as is; [2] % w/w dry weight
Ingledew, W.M. *The Alcohol Textbook, Fifth Edition.*

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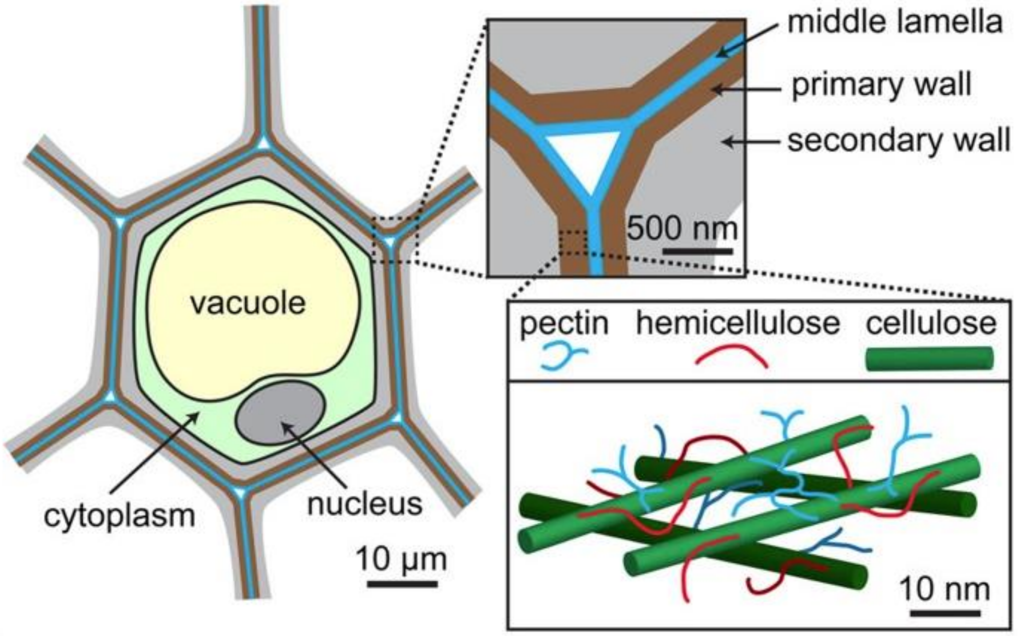
OPTIMIZATION OPPORTUNITIES

Advanced cellulases and hemicellulases to convert fiber

- Maximize potential for Low Carbon ethanol production through corn kernel fiber conversion to fermentable sugar
- Improve potential for higher corn oil yield by breaking open the fiber matrix
- Reduce residual starch to further improve ethanol yield



Xiao, C., Anderson, C. (2013). Roles of pectin in biomass yield and processing for biofuels. *Frontiers in plant science.* 4:67

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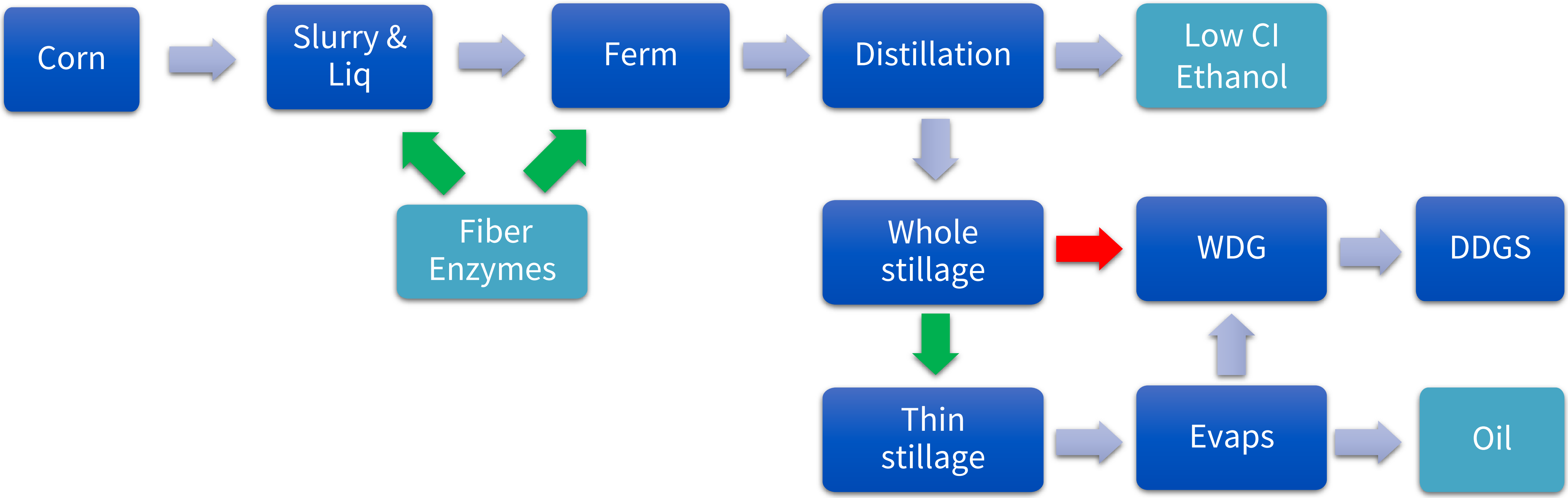
Fiber Conversion:
Increase the value from the corn kernel



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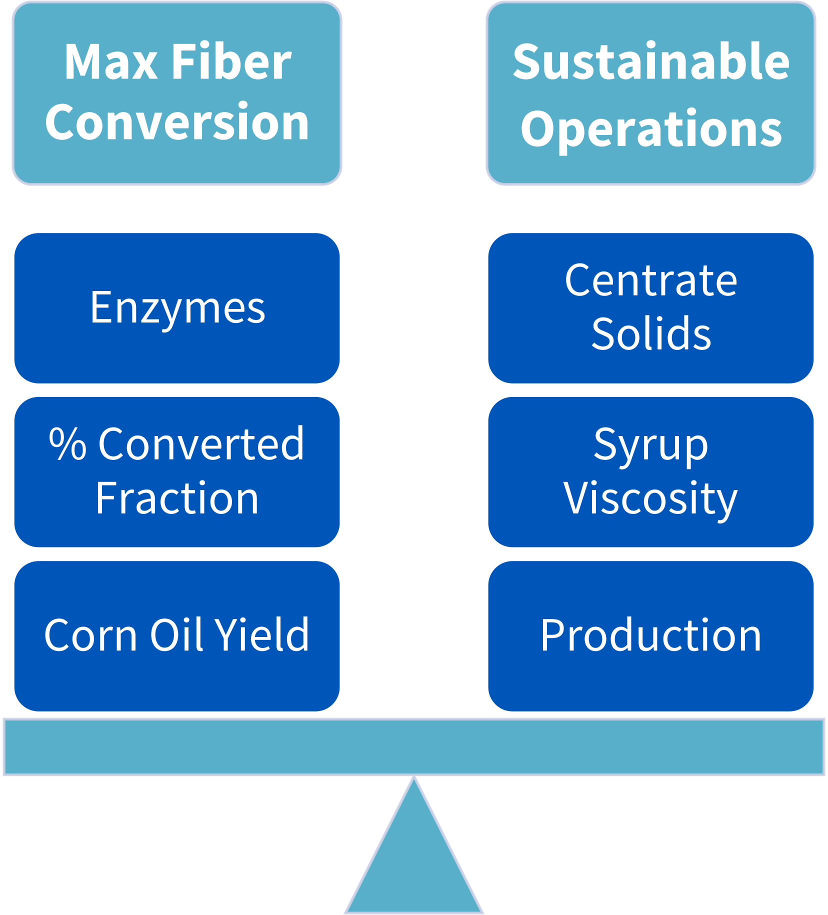
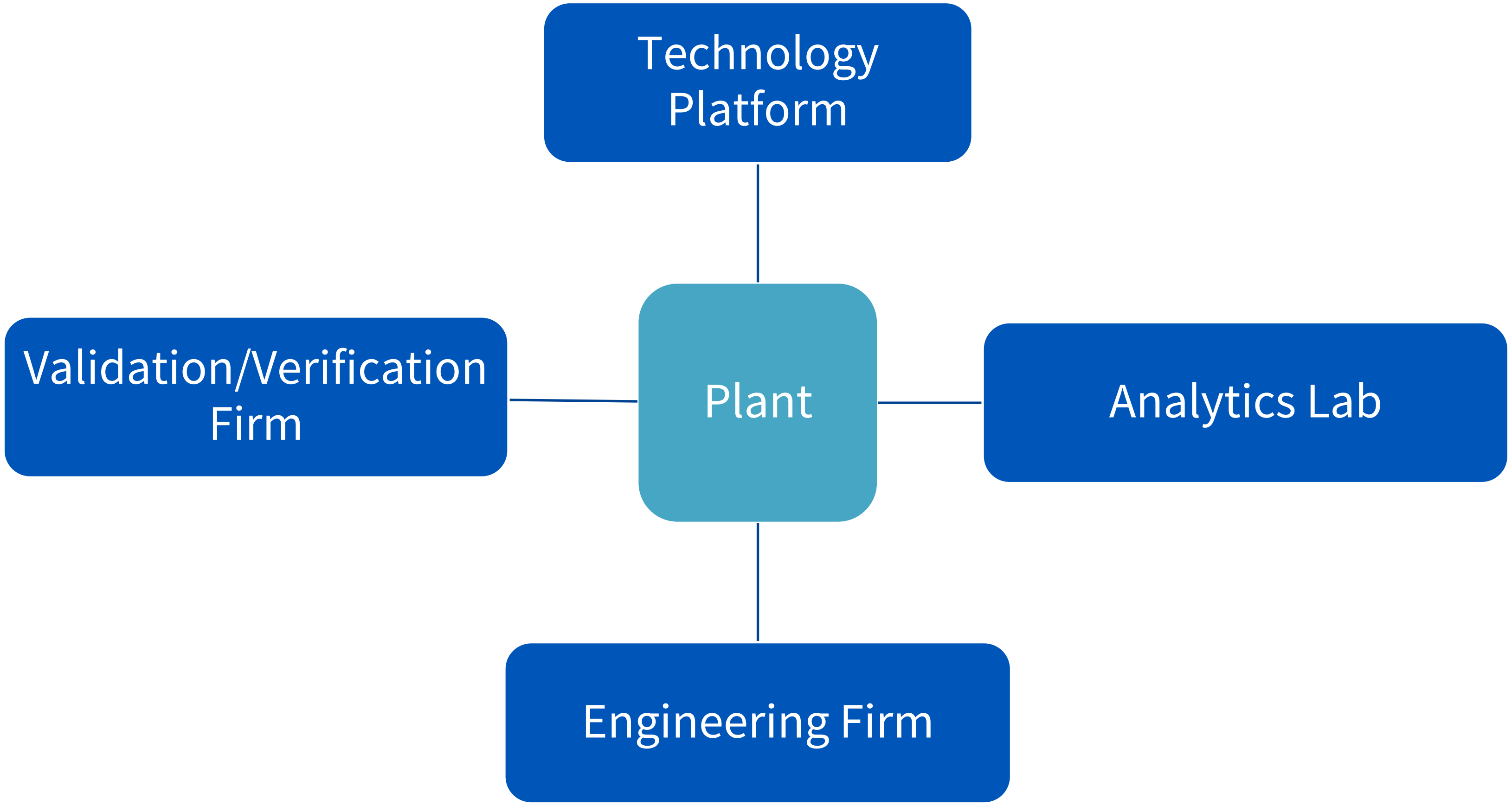
Maximizing results and optimizing operations



Low Carbon Fuels Pathway: Teamwork and Communication



ASTM GUIDANCE: E3181

Standard Practice for Determination of the Converted Fraction of Starch and Cellulosic Content From a Fuel Ethanol Production Facility

THIS PRACTICE IS UNDER THE JURISDICTION OF ASTM COMMITTEE E48 ON BIOENERGY AND INDUSTRIAL CHEMICALS FROM BIOMASS AND IS THE DIRECT RESPONSIBILITY OF SUBCOMMITTEE E48.05 ON BIOMASS CONVERSION.

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Getting your converted fraction: Sampling logistics

Sampling

- Fill/Drop
- Every 500,000 gals

Fiber Analysis

- 3rd Party Analysis
- Mass Balance

Converted Fraction

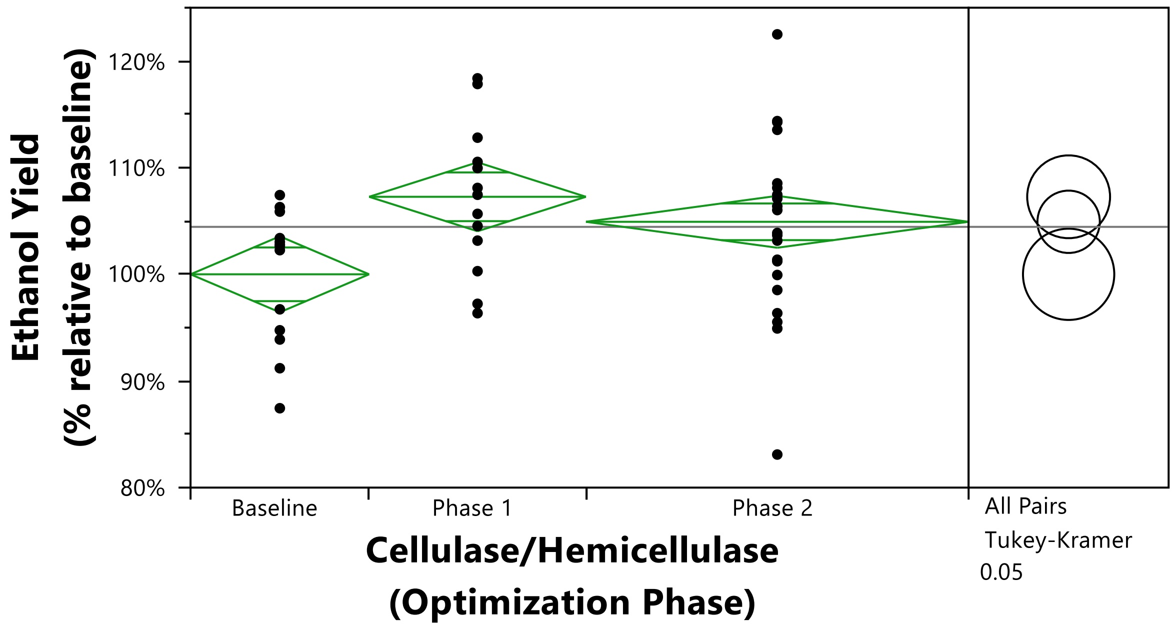
- Carbon Intensity
- % of total gals

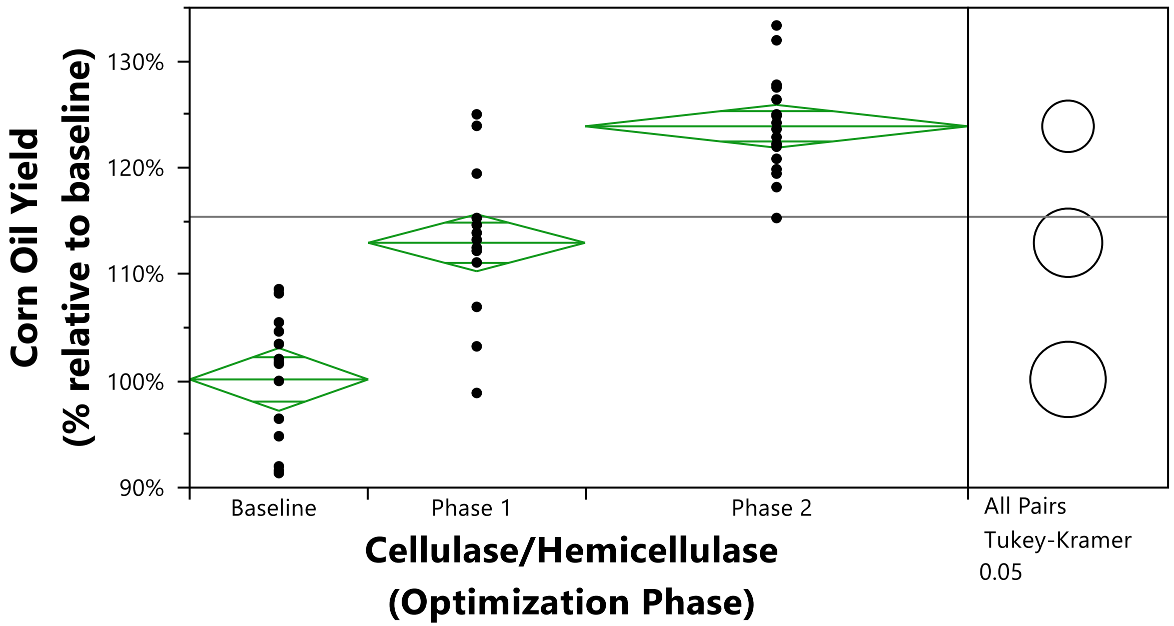
Getting your converted fraction: Calculation in a nutshell

$$Converted\ Fraction = \frac{cellulose_{in} - celluloseou_{t}}{cellulose_{in}}$$

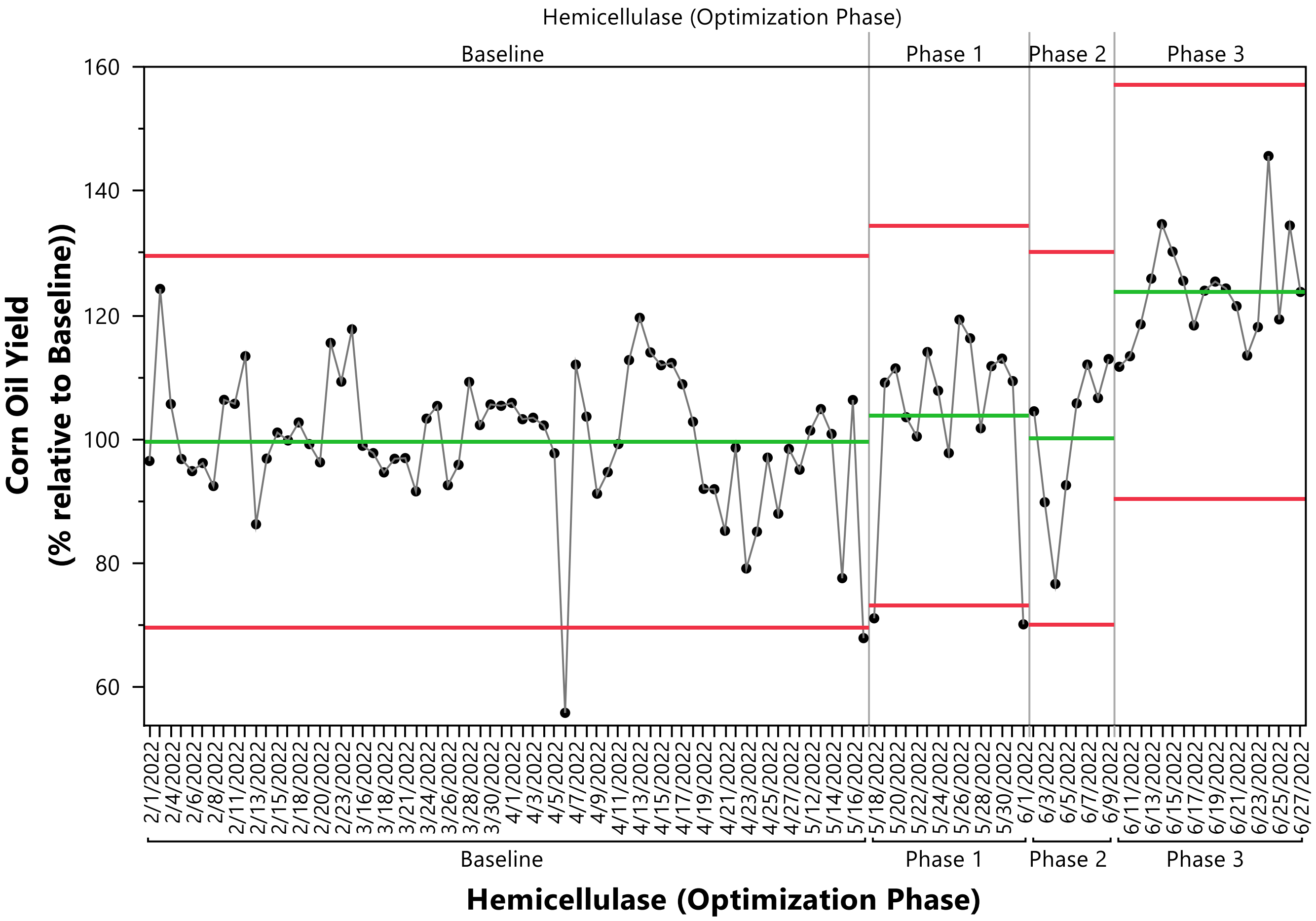
- $Cellulose_{in}$: cellulose content in composite of samples before conversion (ferm fill)
- $Cellulose_{out}$: cellulose content in composite of samples after conversion (ferm drop)

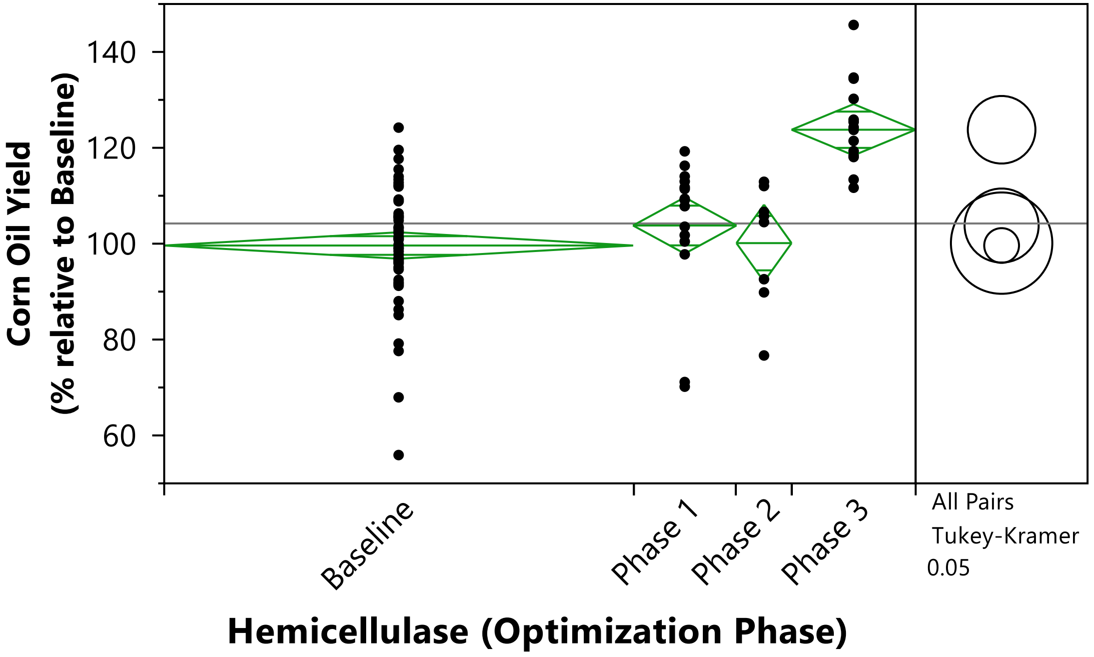
Case Study:
Advanced cellulase/hemicellulase blend improves yields



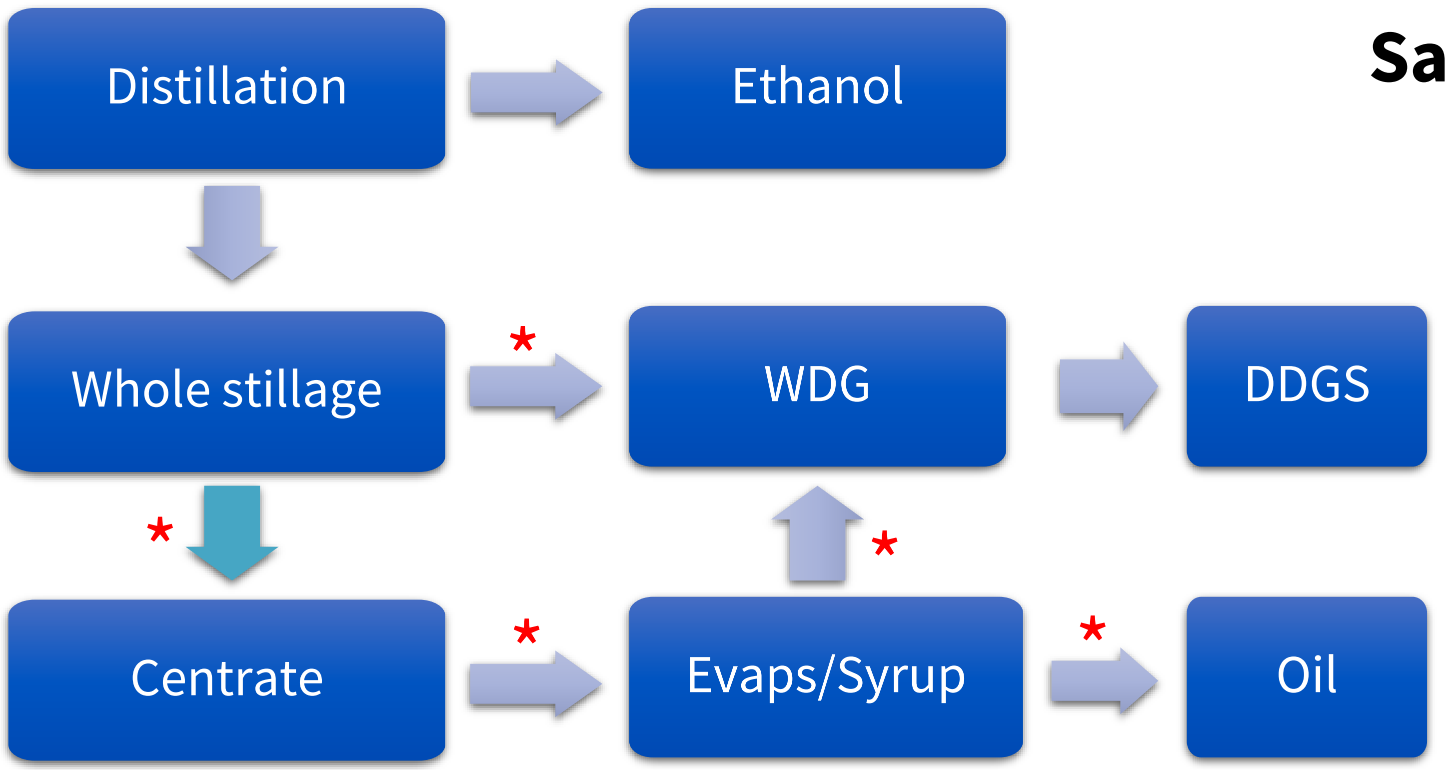


Case Study:
Advanced hemicellulase in liq improves corn oil yield





Corn Oil Optimization:
Optimize oil yield through quantitative analysis



Sampling protocol:

- Corn flour
- Whole Stillage
- Centrate
- Wet cake
- Corn oil centrifuge feed
- De-oiled syrup (heavy phase)
- Syrup (last evap)
- DDGS

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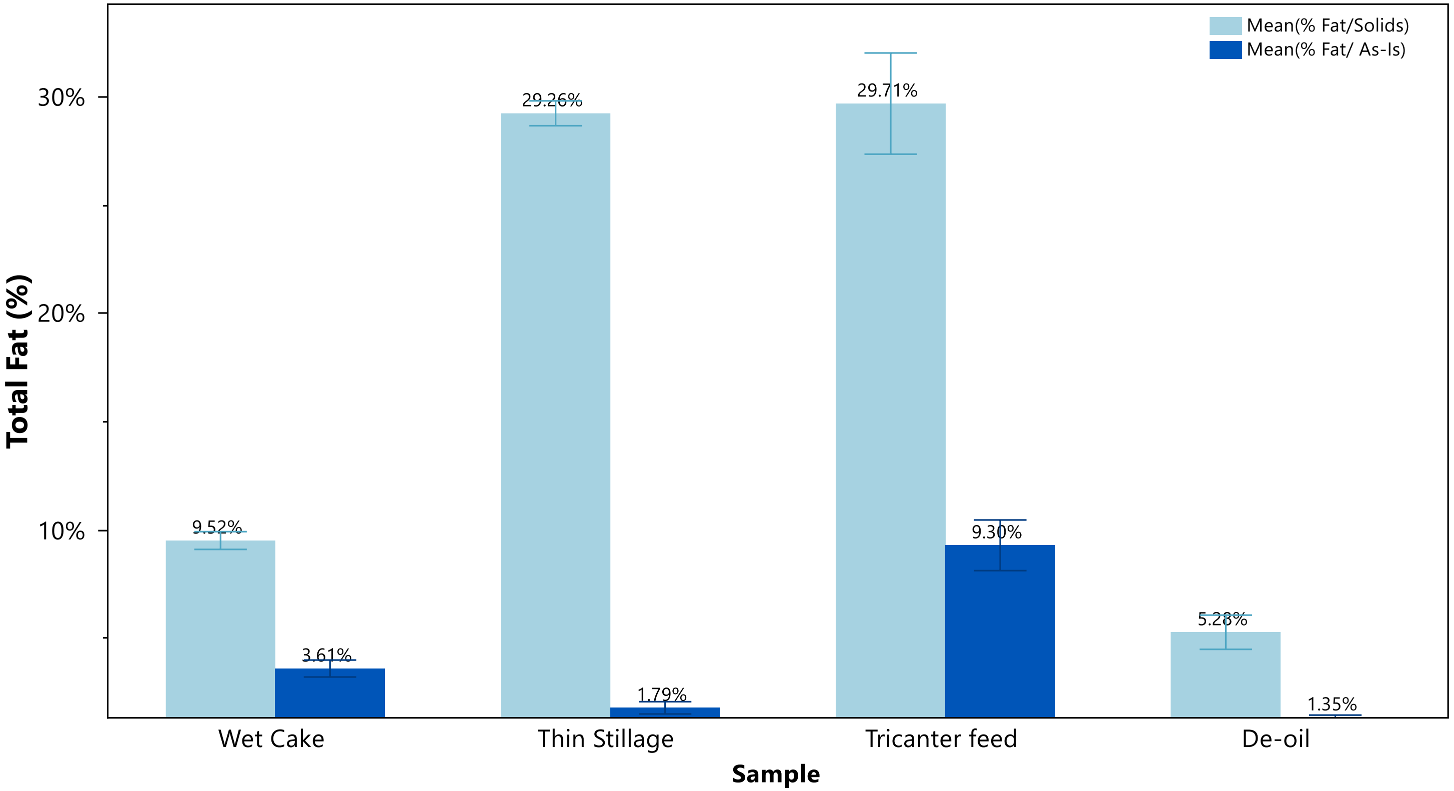
Tracing oil through backend operations



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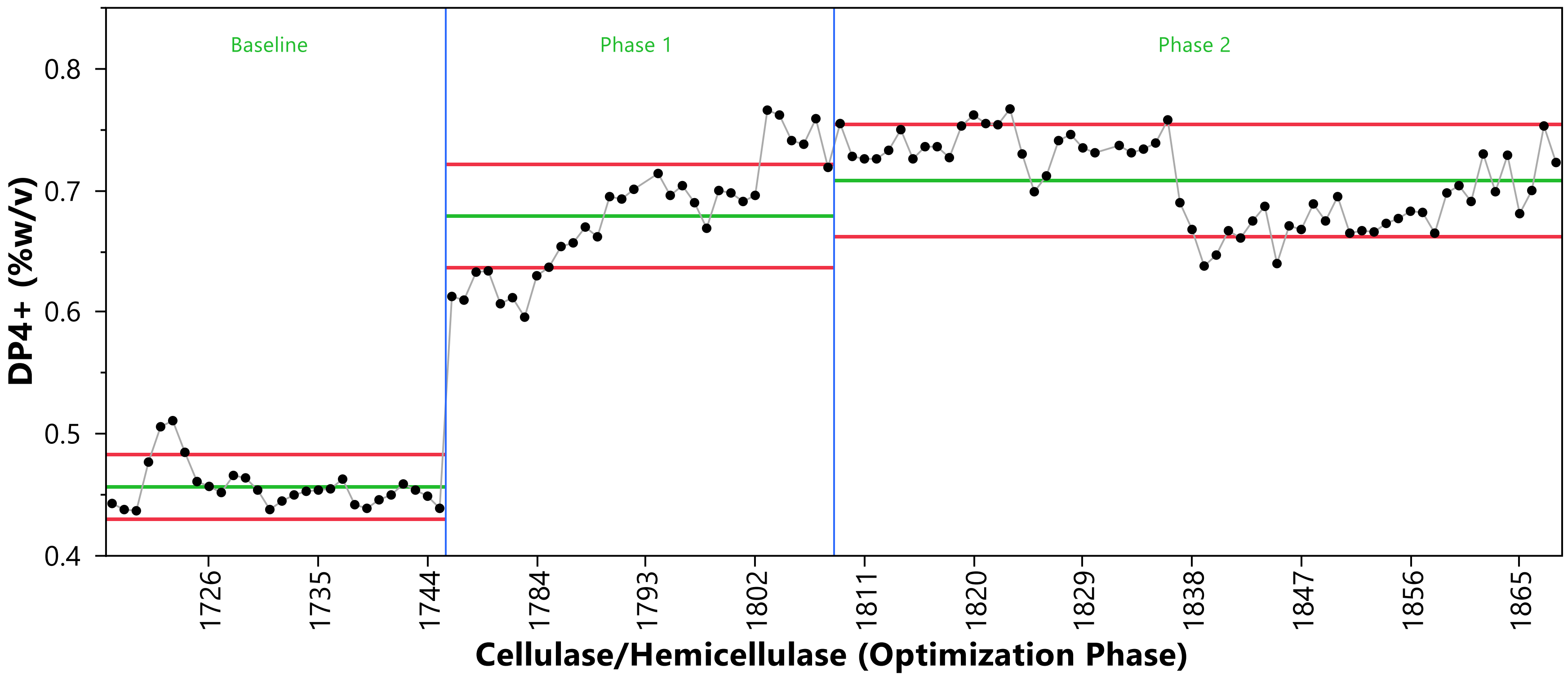
Operations Optimization Support

Opportunity	Category	Objective
Decanter	Mechanical	❑ Optimize torques ❑ Evaluate oil in stillage stream vs wet cake ❑ Evaluate centrate total solids/suspended solids
Feed Solids content	Process	❑ Optimize solids for oil centrifuge feed ❑ Adjust flow rates, energy input, and draw location
Oil Centrifuge	Mechanical	❑ Internal: gravity disk, beach or weir setting, hydraulic pressures ❑ External: Backpressure on oil or de-oiled stream
Evaps	Process	❑ Optimize thin stillage flow to evaps ❑ Evaluate evap pump capacity ❑ Adjust syrup draw if necessary

Cellulase/Hemicellulase solubilize fiber oligomers increasing DP4+



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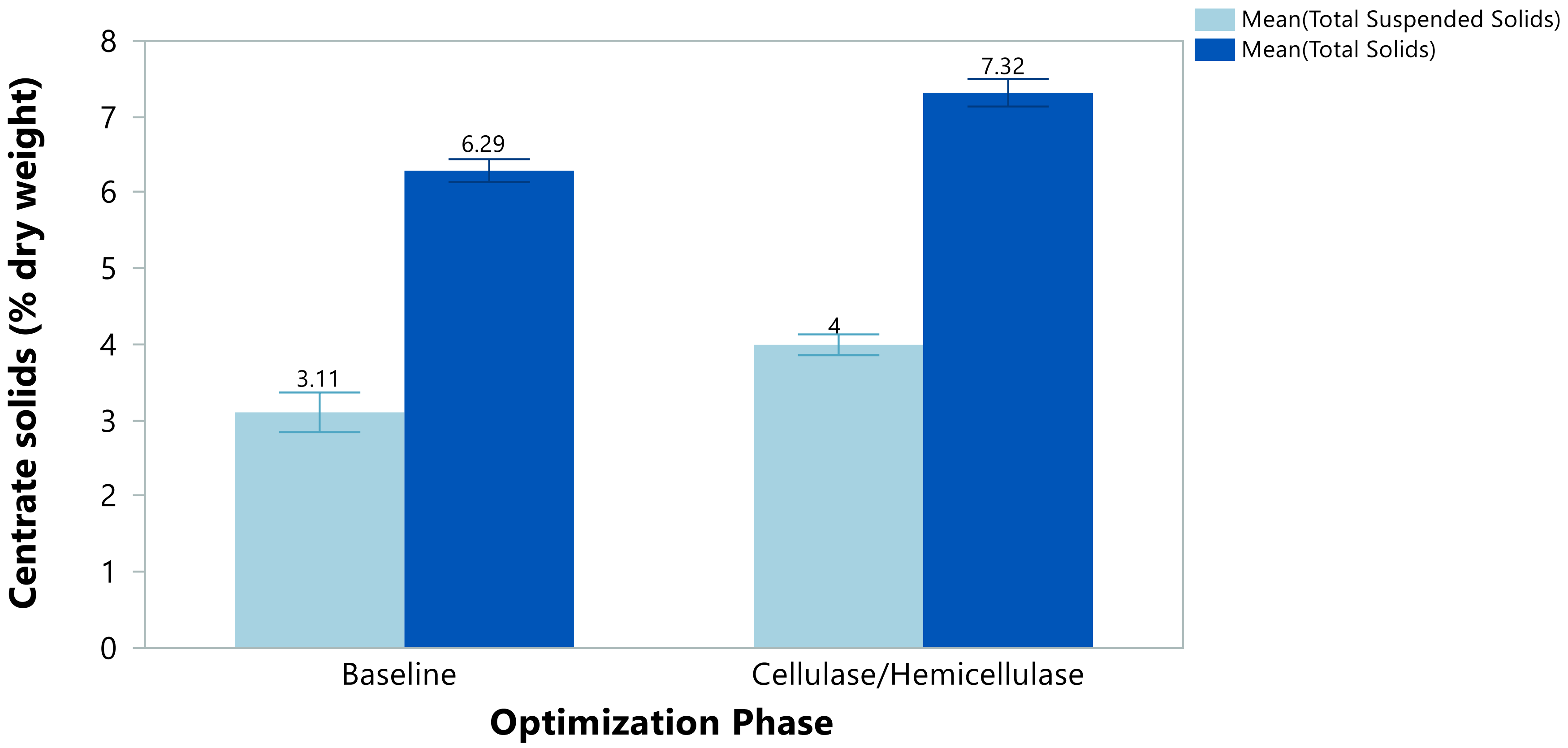
Measuring centrate solids: Filter or spin down method



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PERFORMANCE OPTIMIZATION

Funnel flow: Syrup flowability

Quick measurement to evaluate syrup flowability/viscosity

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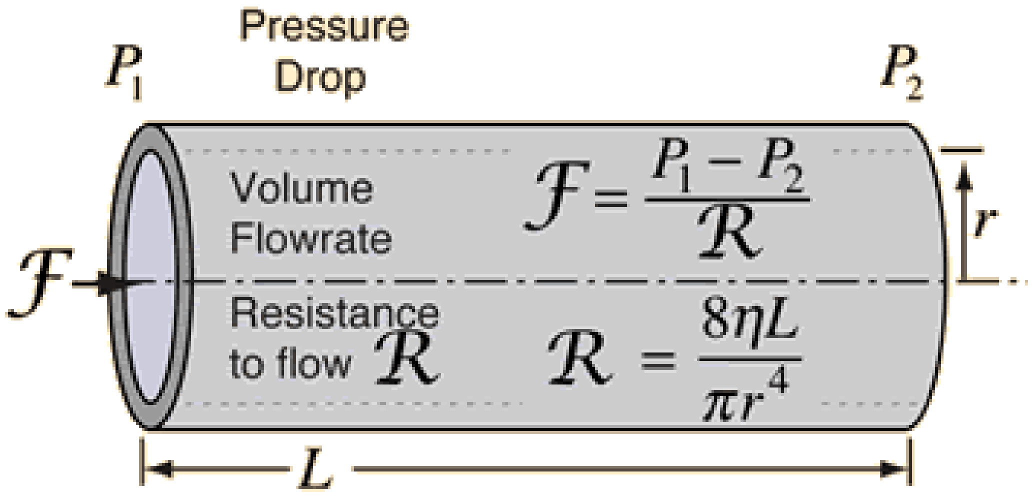
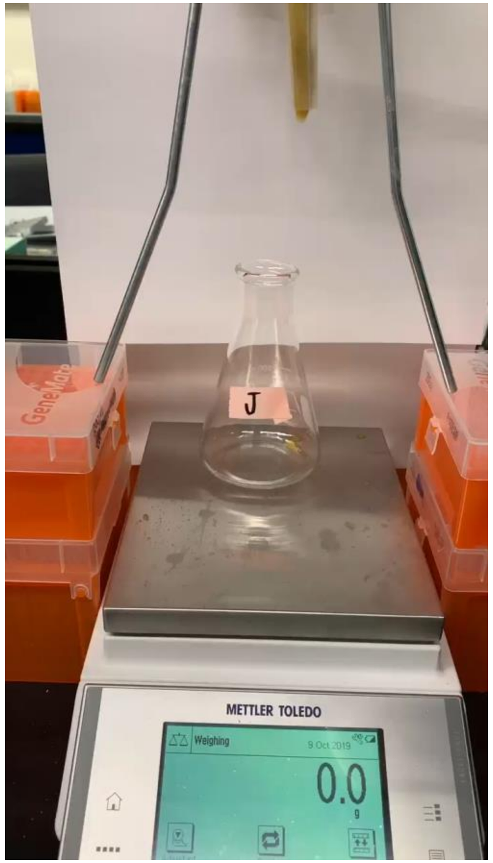
Poiseuille's law:
Flow rate is inversely proportional to viscosity

- Flow rate is inversely proportional to viscosity
  - Flow rate is proportional to the pressure drop divided by resistance to flow
  - Resistance to flow is directly proportional to viscosity η

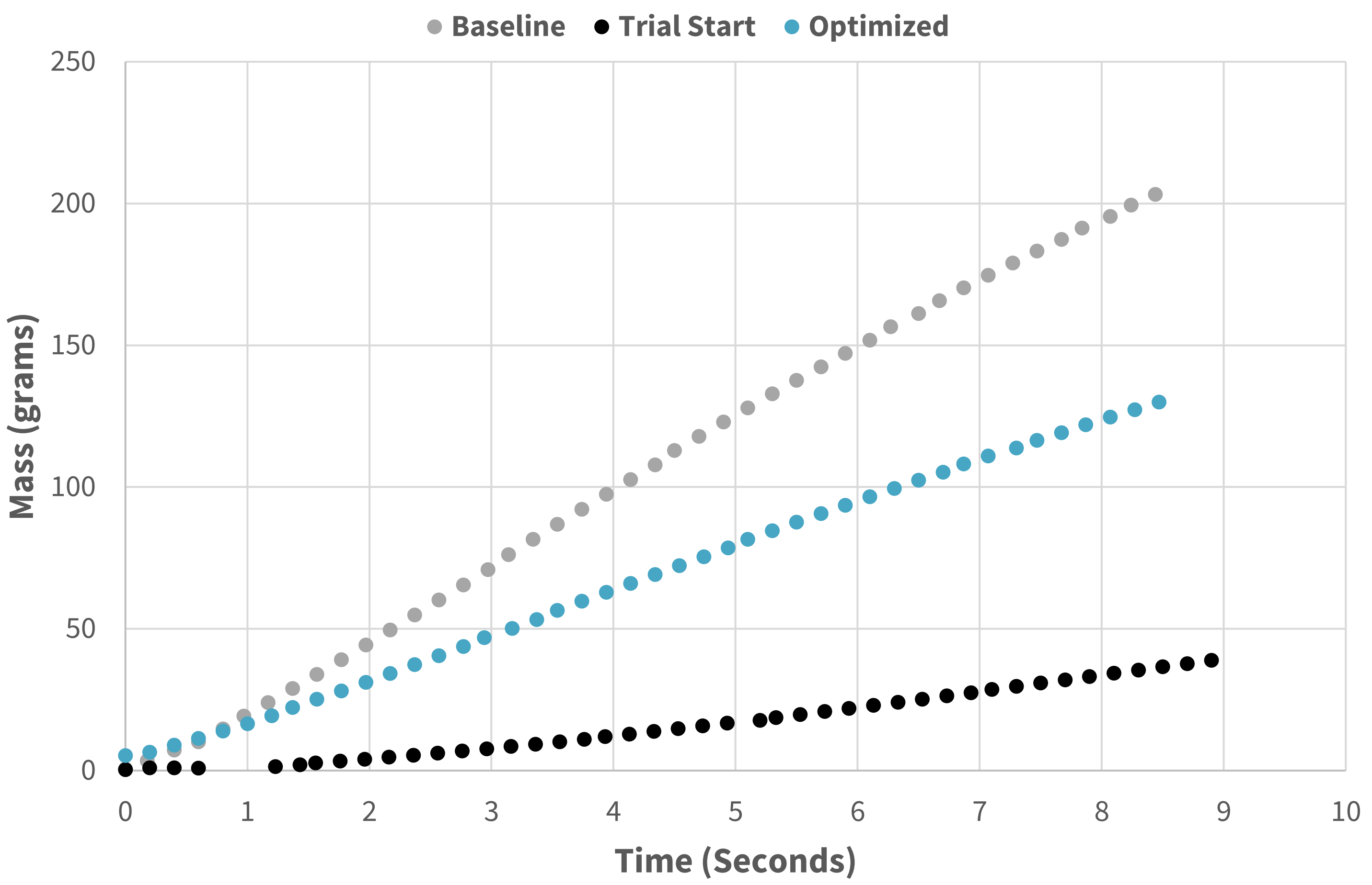


How is flow rate related to viscosity. Socratic.org

Flowability: Video Example



Funnel flow:
Syrup viscosity optimization



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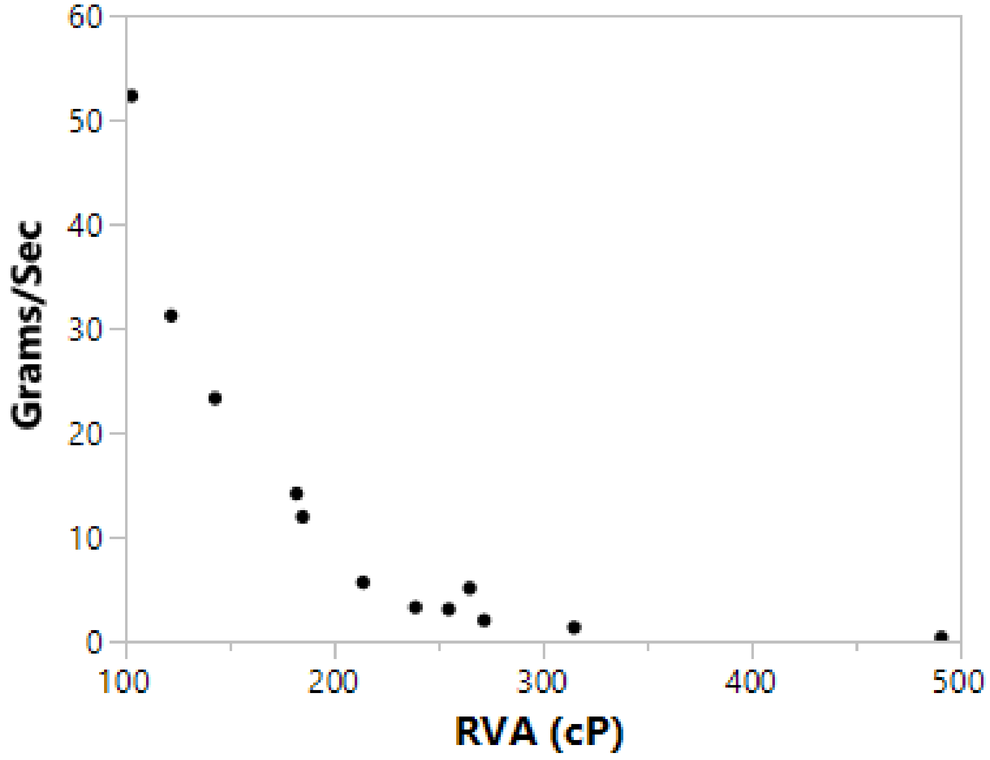
Relationship between funnel flow and Viscometer



Summary

- Fiber conversion opens new opportunities for more value
- Lab support is crucial for success
- Know what to expect in the process and use data to guide optimization
- Operational adjustments are likely necessary
- Understand the market and regulations
- Leverage your plants efficiency investments for lower carbon intensity

Thank you!

Questions? Email us
followup@cte-usa.com

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We can help—contact us today.

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