

UNIVERSITEIT STELLENBOSCH UNIVERSITY

RENEWABLE & SUSTAINABLE ENERGY STUDIES

Steam pretreatment and fermentation scenarios for a sugarcane biorefinery

8th Renewable Energy Postgraduate Symposium – 12 July 2017

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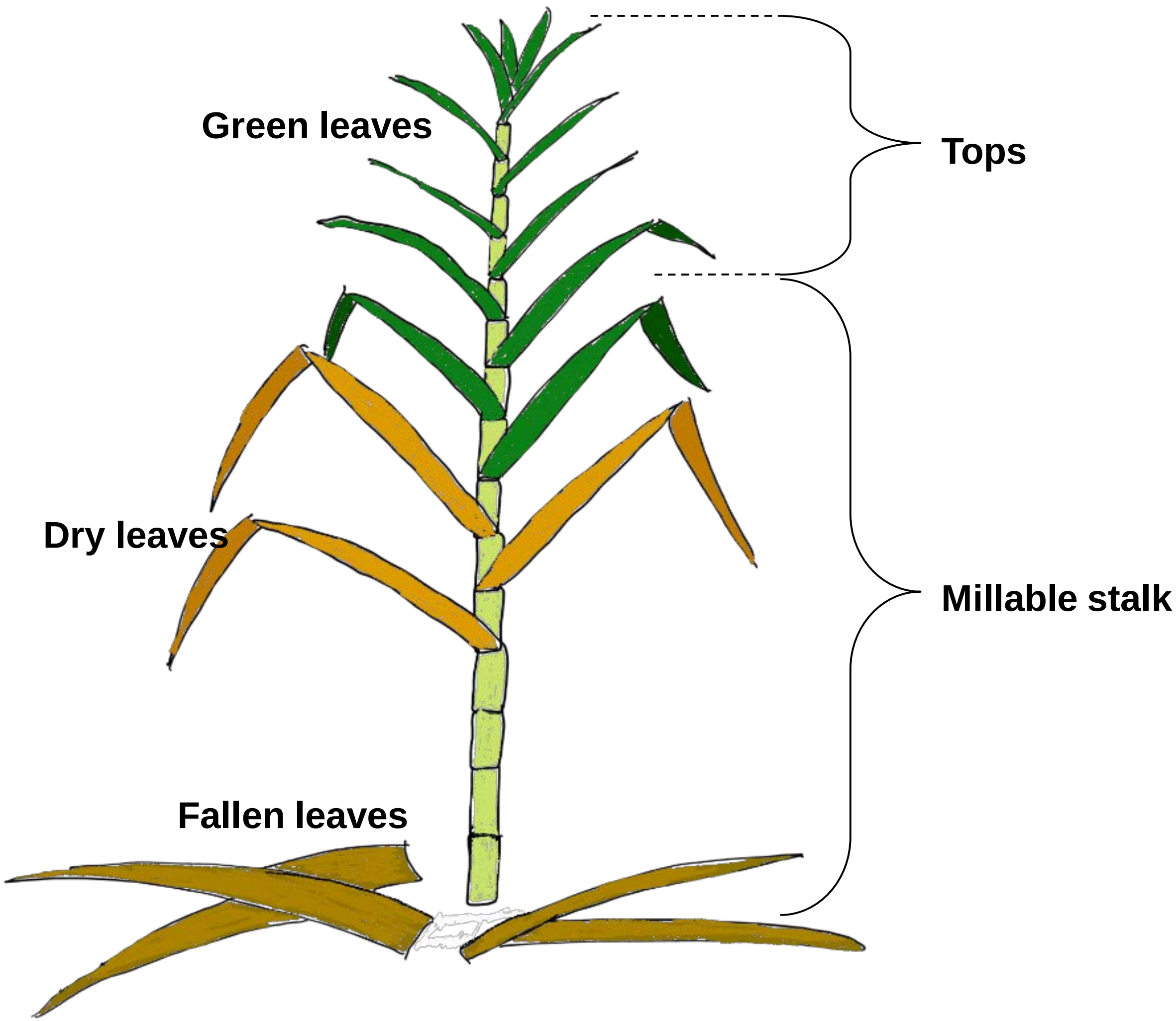
Sugarcane biomass



For every 1 000 kg of millable stalk harvested:

- approx. 300 kg of bagasse produced
- approx. 300 kg of harvest residues discarded

Pre-harvest burning

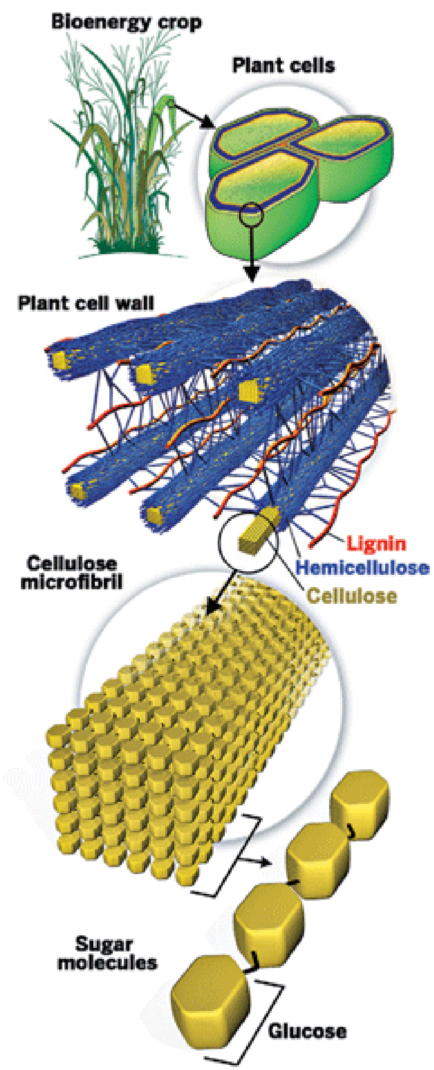
Current sugar mill operation

Bagasse

Sugar

Molasses

Sugarcane biorefinery



Feedstocks

Sugar

Molasses

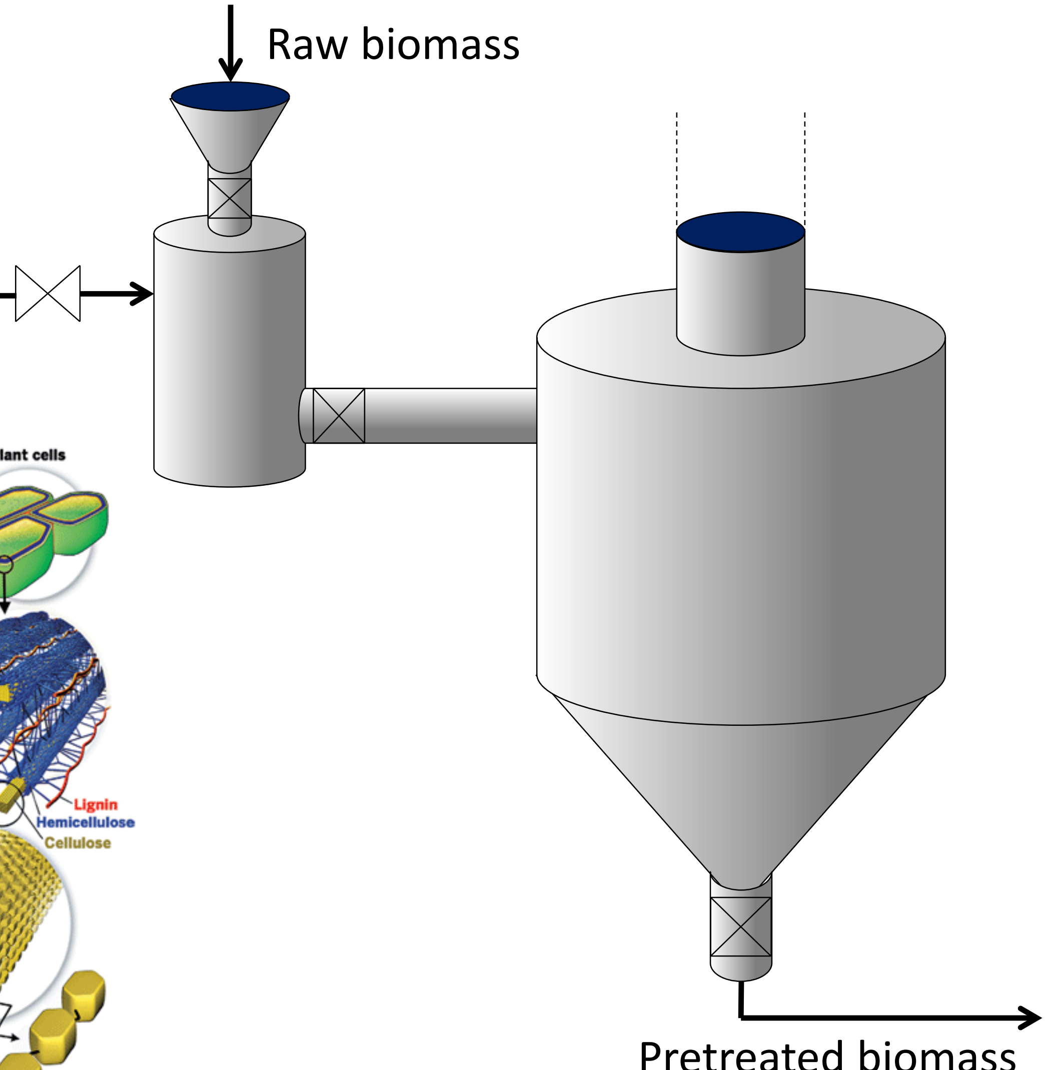
Ethanol from cellulose

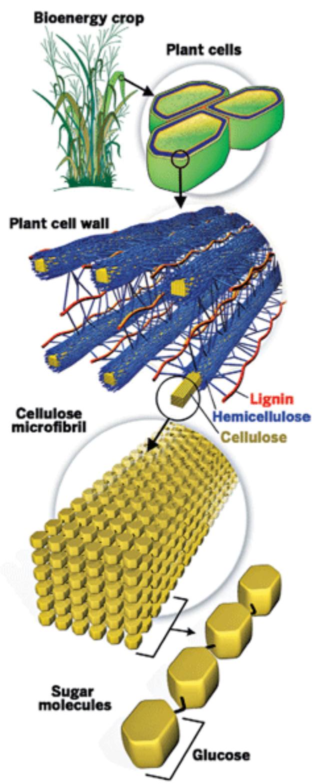
Platform chemicals from hemicellulose

Fuel from lignin rich residues

Fertiliser

Steam pretreatment



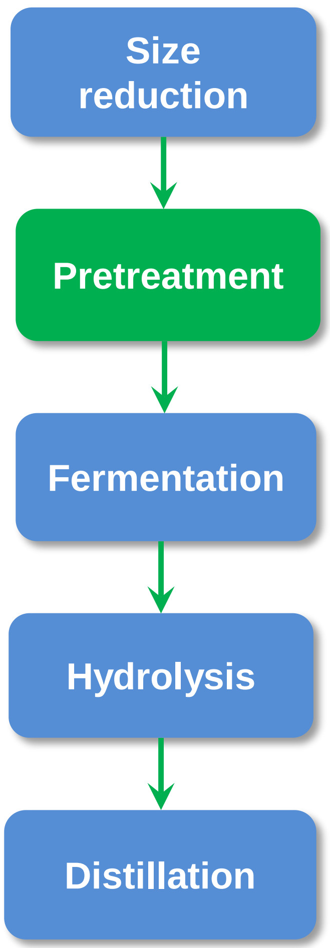


Steam pretreatment

Bagasse

Harvest residues

Biorefinery-based pretreatment and fermentation



Conditions as industrial relevant as possible:

- steam pretreatment at 5 – 15 min, 185 - 215°C
- steam pretreatment without catalyst
- preheating of reactor to minimise condensation
- no washing of pretreated solids – only pressed
- no detoxification
- fed-batch SSF up to 15% solids
- low enzyme concentration (10 FPU / g solids)

Not to change pretreatment effects:

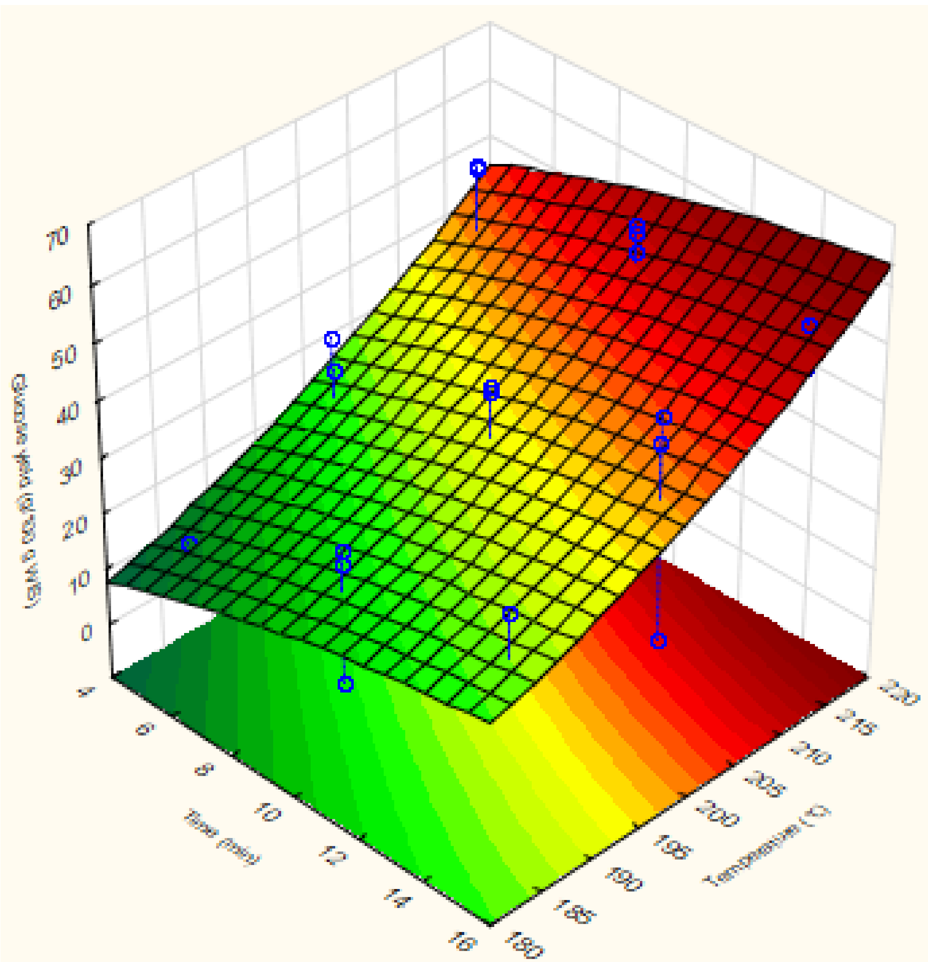
- pretreated solids not frozen, but fermented within 24h
- pretreated solids not sterilized – ampicillin
- relative high inoculum of 10% at OD of 1

Compositional analyses

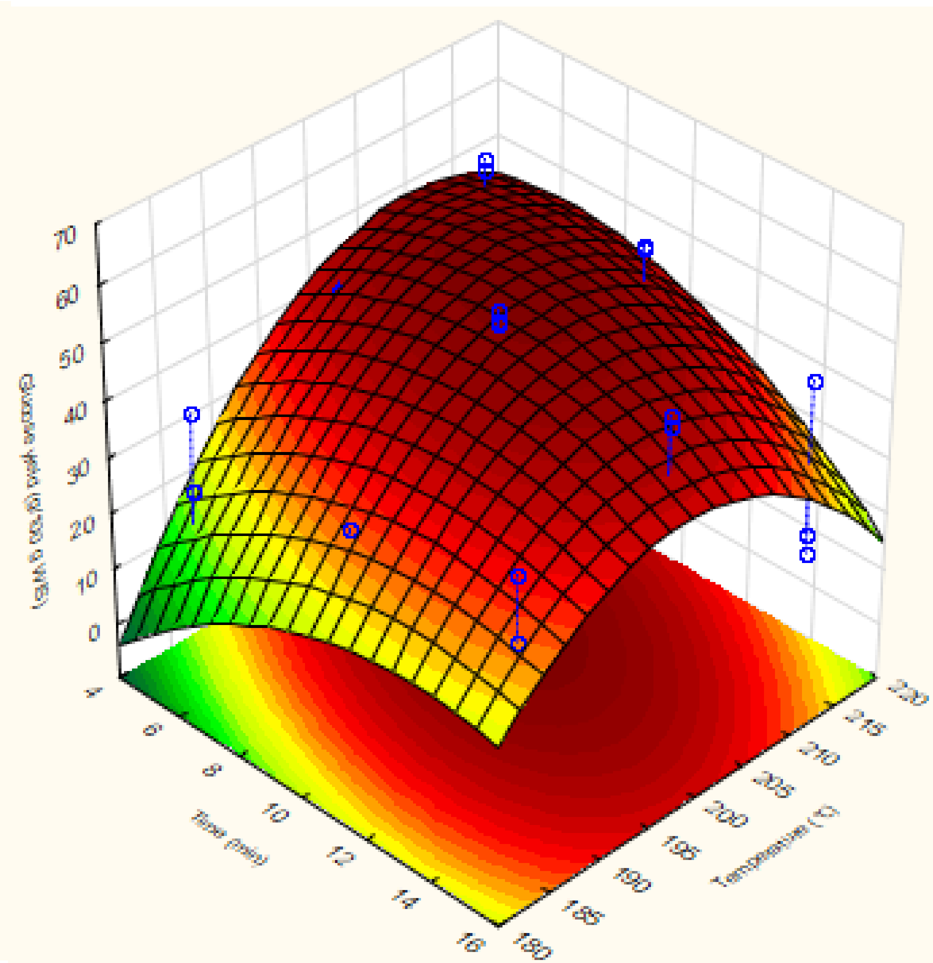
Compound	Sugarcane bagasse g/100 g dry	Sugarcane harvest residues g/100 g dry
Glucan	33.31 (± 0.37)	29.74 (± 0.03)
Xylan	20.43 (± 0.45)	19.52 (± 0.11)
Arabinan	0.49 (± 0.13)	1.73 (± 0.52)
Total extractives	6.77 (± 0.40)	14.79 (±0.47)
Total lignin	20.85 (± 0.65)	17.44 (± 0.25)
Acetyl groups	4.13 (± 0.15)	2.78 (± 0.05)
Ash	2.19 (± 0.15)	7.03 (±0.06)

Digestibility screening

Bagasse digestibility
(g glucose / 100 g WIS)

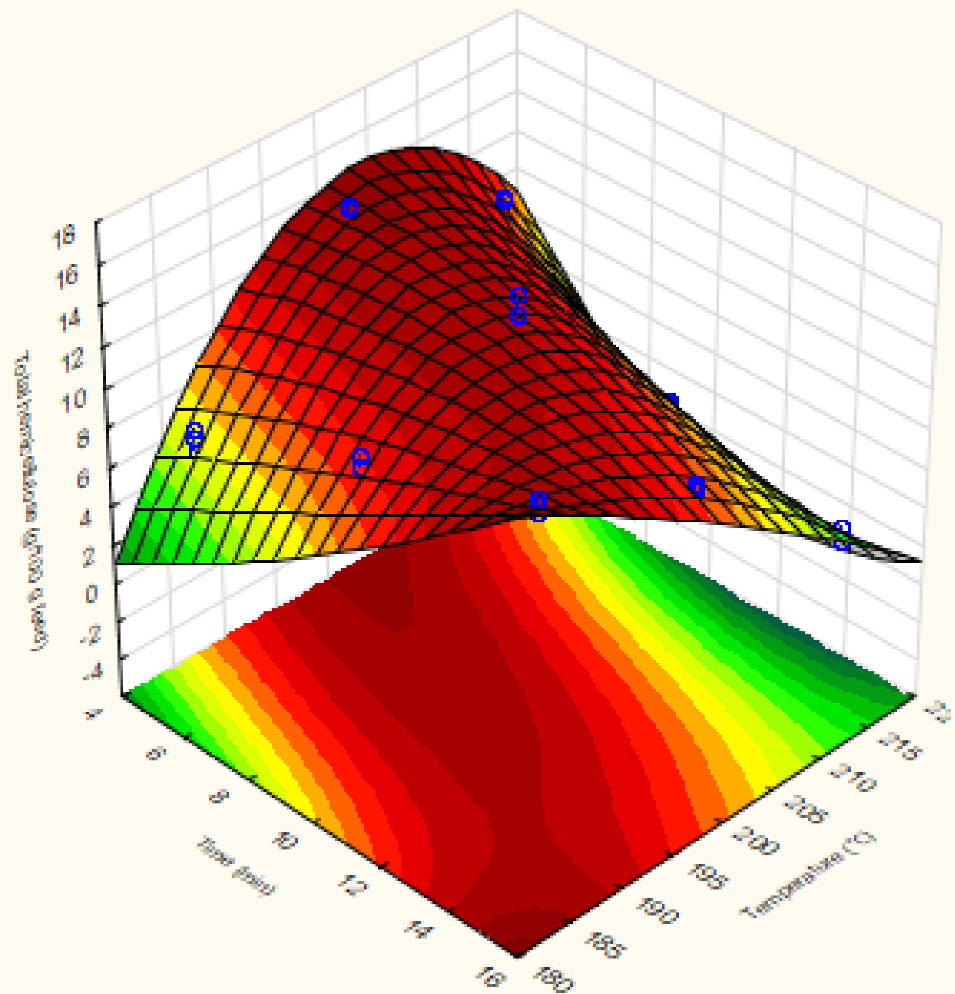


Harvest residues digestibility
(g glucose / 100 g WIS)

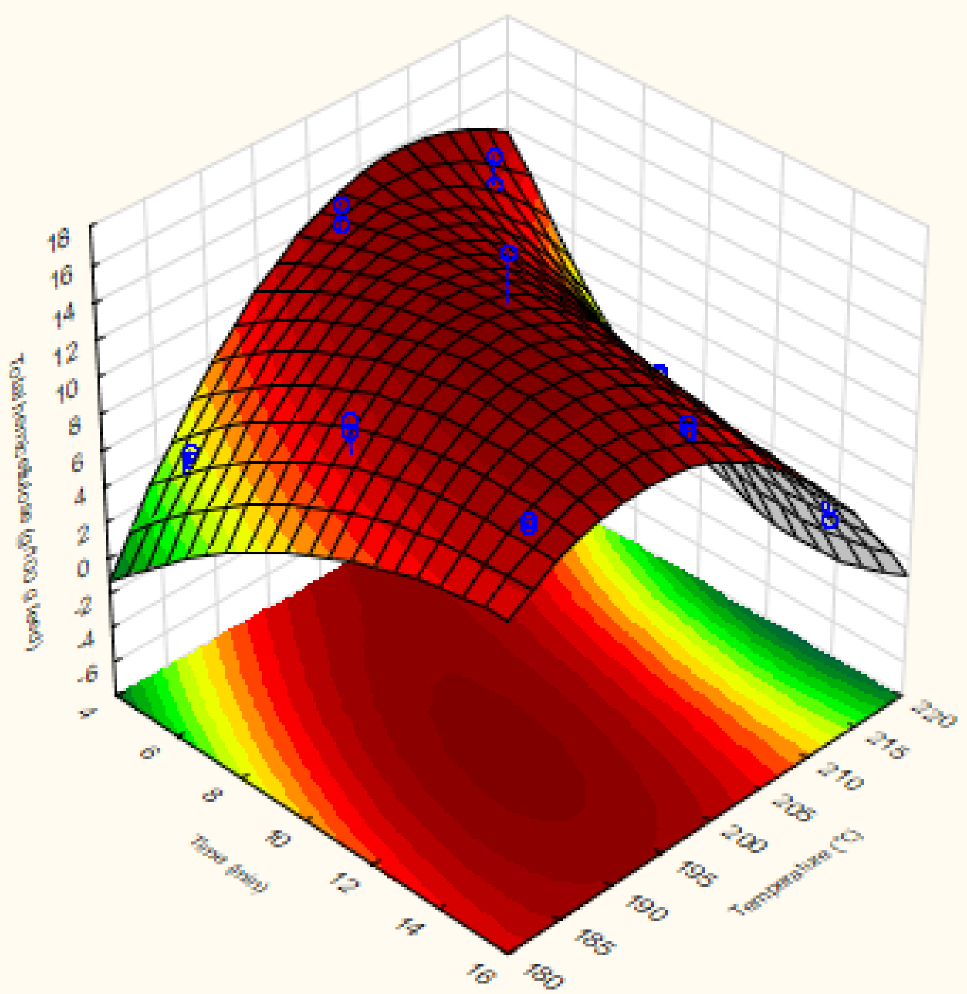


Hemicellulose recovery screening

Bagasse hemicellulose recovery
(g / 100 g feed)

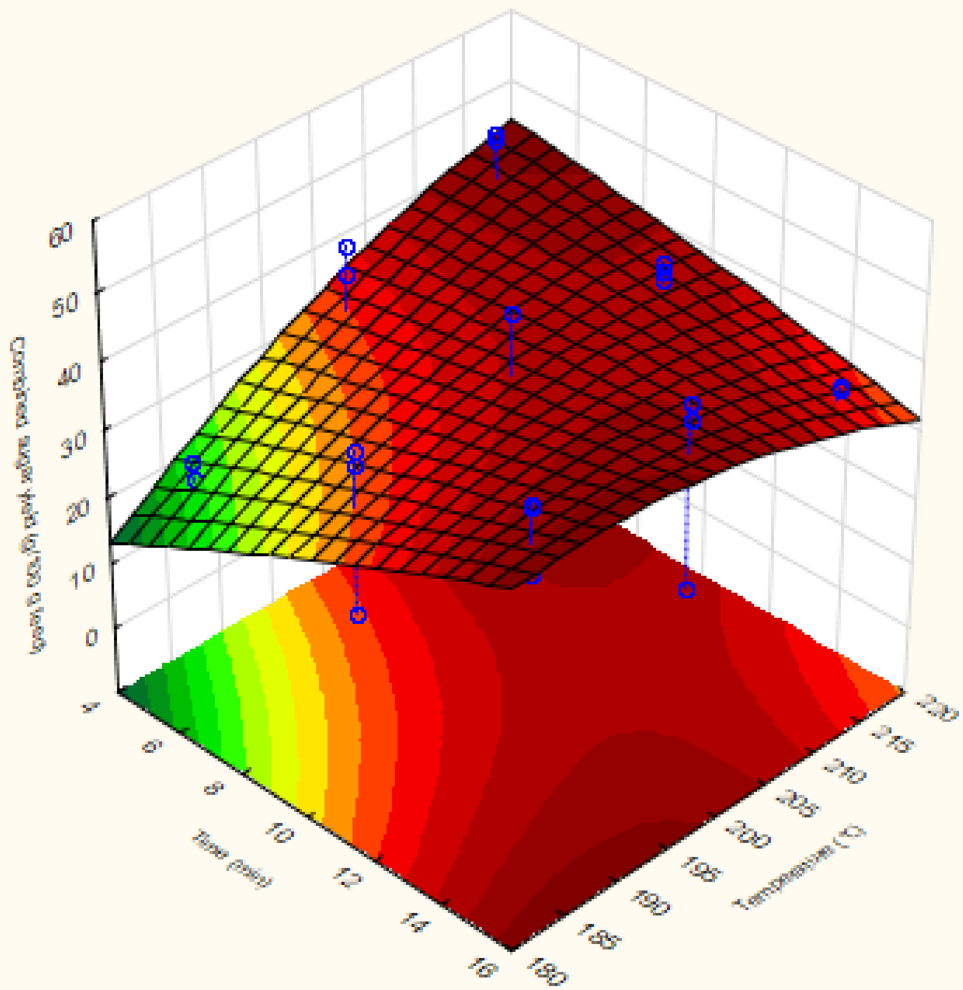


Harvest residues hemicellulose
(g / 100 g feed)

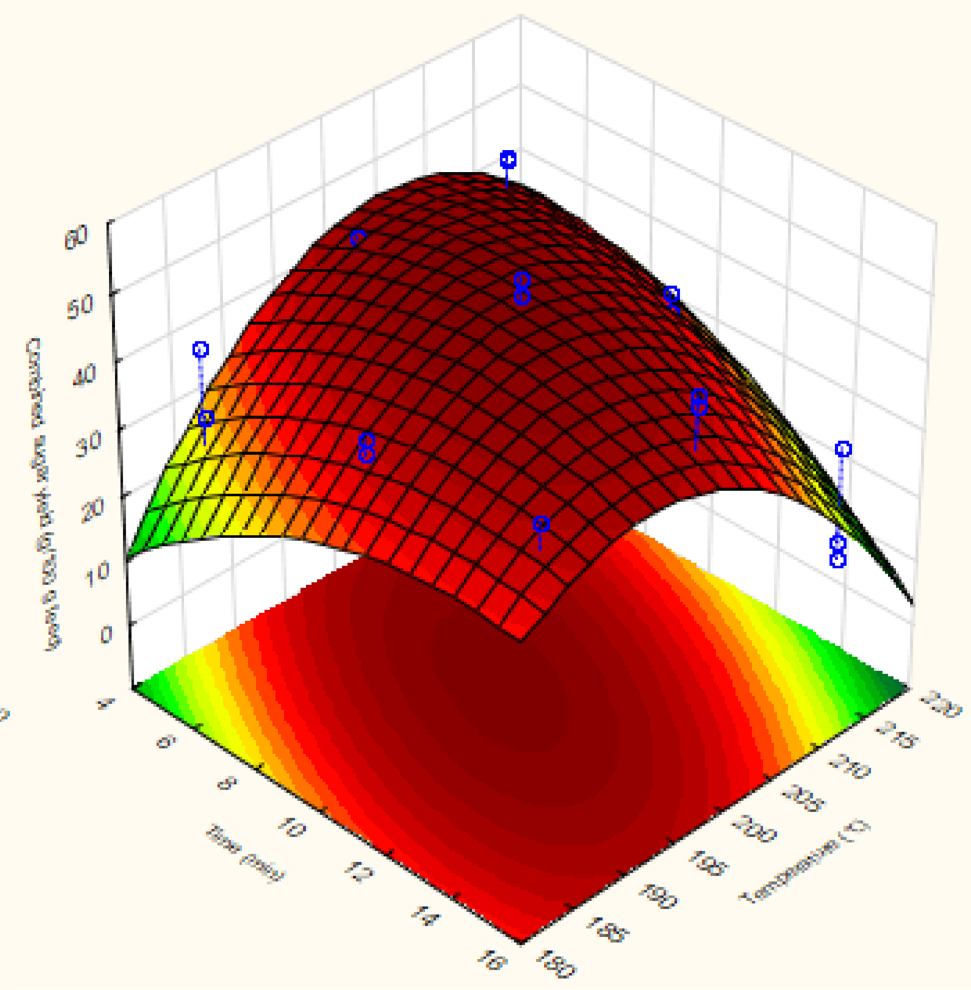


CSY screening

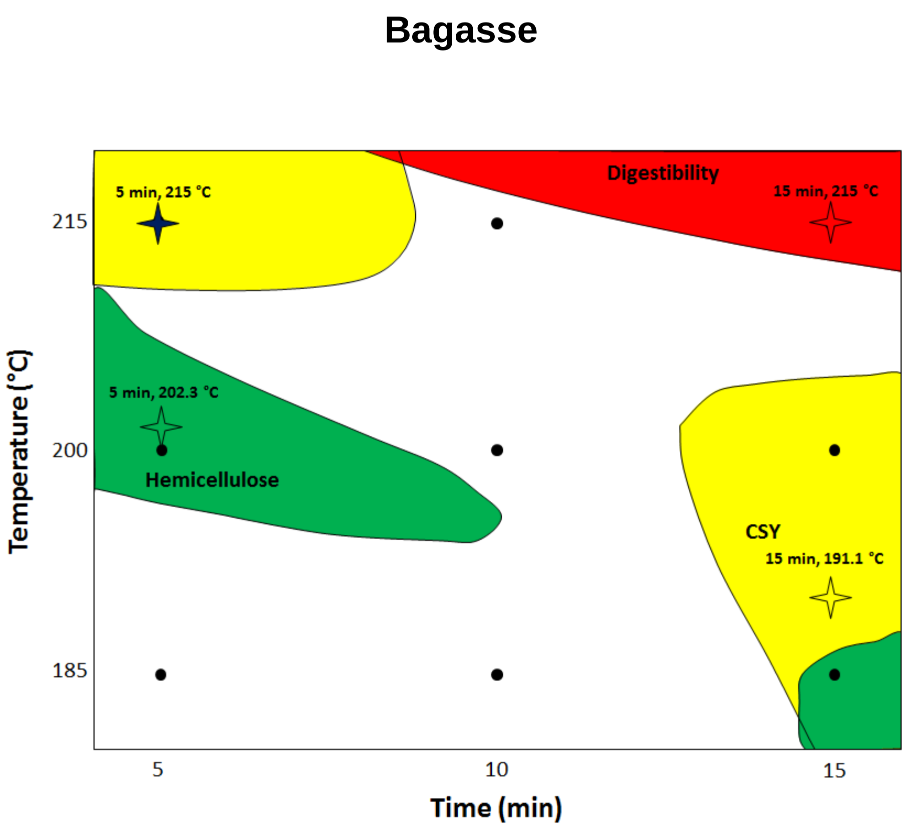
Bagasse CSY
(g / 100 g feed)

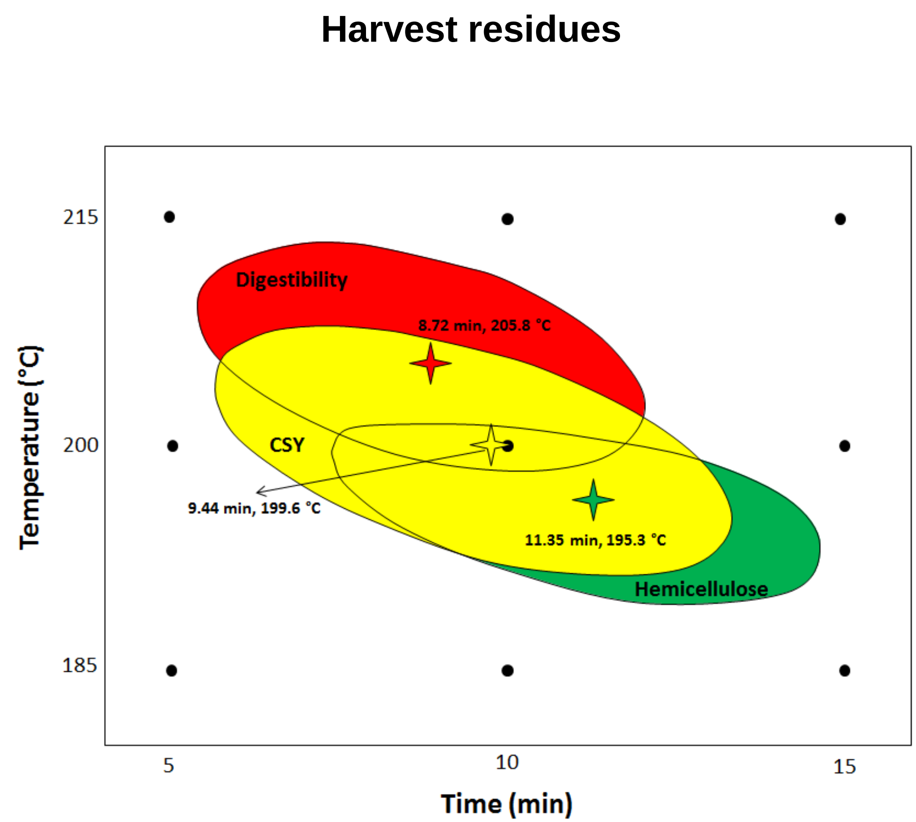


Harvest residues CSY
(g / 100 g feed)

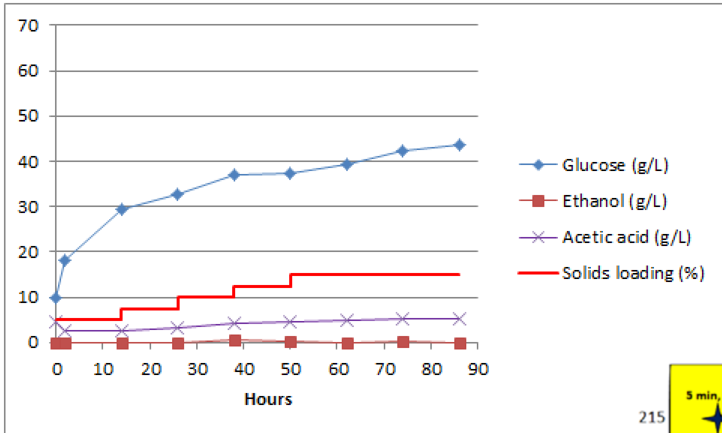


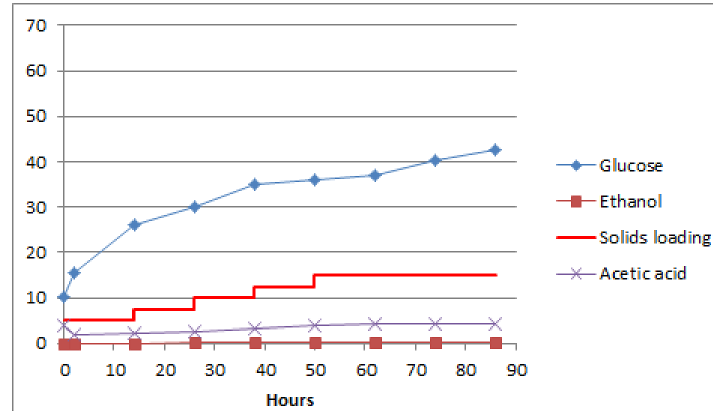
Areas of >95% responses

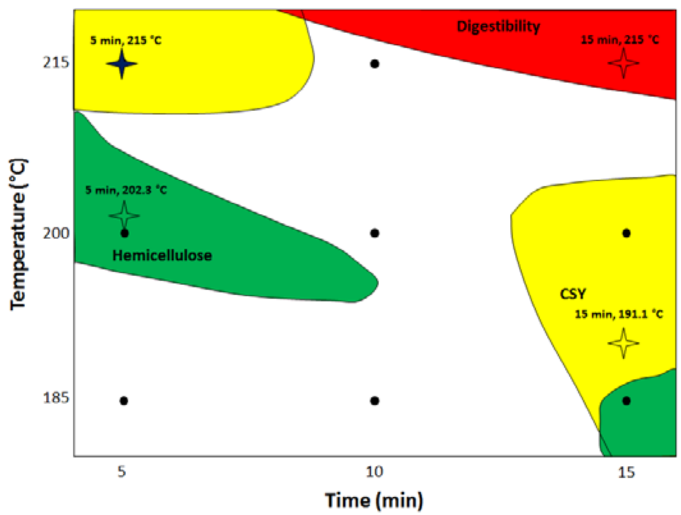


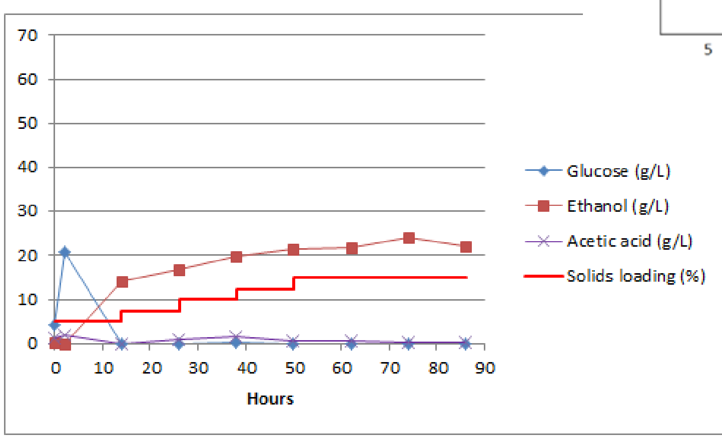


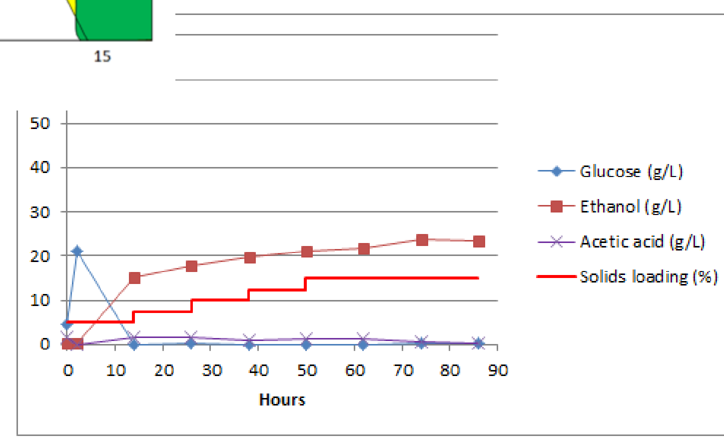
Fed-batch SSF - bagasse



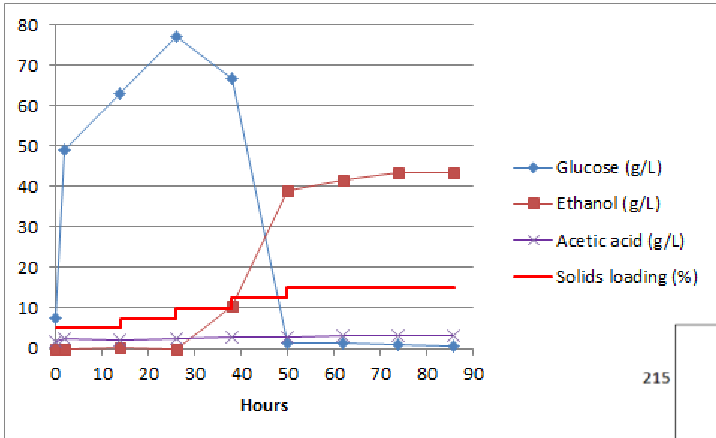


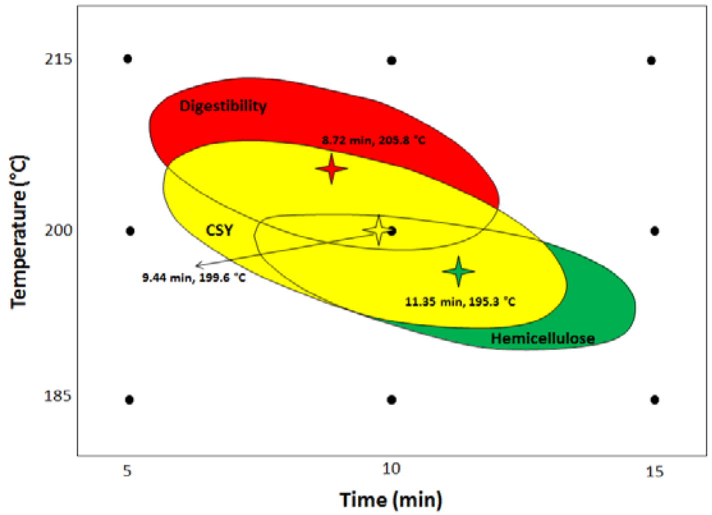


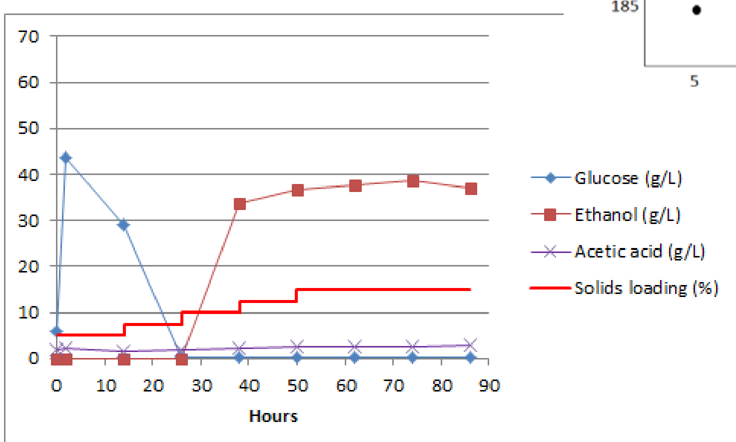


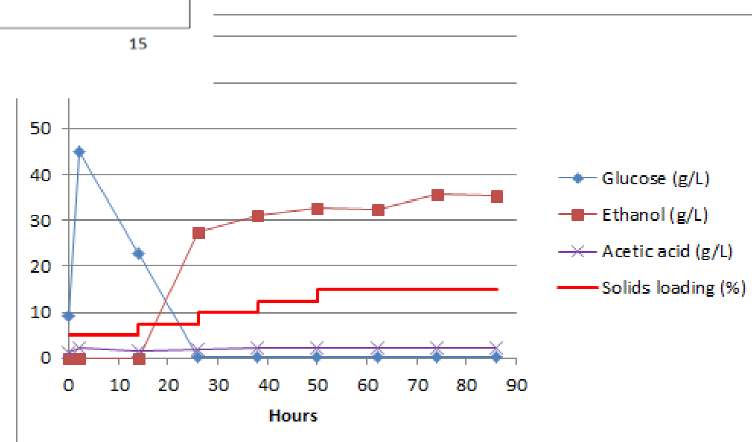


Fed-batch SSF – harvest residues









Conclusions

1) Bagasse and harvest residues have different compositions which have far reaching consequences for a sugarcane biorefinery:

    - Optima pretreatment conditions will have to change to suit feedstock
    - Bagasse seems better suited for electricity/steam generation
    - Harvest residues seems ideal for ethanol and chemicals production over sugar platforms – contain an operating envelope for all studied optima

2) Best digestibility does not always guarantee best fermentability