

High fiber sugarcane impact on sugar and cogeneration plant

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Sugarcane in Reunion Island

- 2 MT Cane / crops
- Harvest from July to december
- Sugarcane harvest :
 - Manually cut,
 - Whole-stalk green sugarcane,
 - Few bundle cane
 - Mechanical loading



Sugar industry in Reunion Island

- 2 sugar mill (Tereos group since 2010):
 - Le Gol
 - Bois Rouge



- Research institute financed by the 2 mills:
 - eRcane

- Breeding
- Agronomy
- Automation
- Sugar processing
- Biorefining

Bois Rouge mill

- Capacity : 8 000 t cane / day
- Shredder 2 x 2500kW
- Extraction (electric drive):
 - 1 mill (Bundaberg 2 roller mills)
 - Diffuser (De Smett)
 - 2 Dewatering mills



- Distillery



- Small refining plant

Bois Rouge mill

- Evaporation : 6 effects since 2007
 - 2.32 BarA
 - 1st effect Falling Film evaporator (Five)
 - Steam on cane 43%
- Bois Rouge Cogeneration plants (1992)
 - 80 bar boiler
 - Bagasse (crops)
 - Coal (off crops)
 - 2 x 130 T steam / hour
 - 2x30MW
 - 175€ / MWh (France green energy policy)
 - 12€ / TC for growers

The new R585 variety Released in 2010

- Agronomical performance
 - Yield based on :
 - 45 m²,
 - 4 replicates,
 - 6 localisations
 - 3 years

	Yield / ha		Sugar content		Fibre content		Sugar / ha	
	in tons	% / R579	g%g	% / R579	g%g	% / R579	T/ha	% / R579
R570	82.5	-6.2%	13.0	-0.5%	16.5	11.9%	8.4	-6.4%
R579	88.1	0.0%	13.1	0.0%	14.8	0.0%	9.1	0.0%
R585	123.2	44.2%	12.6	-3.6%	19.0	28.9%	12.1	38.4%

Trial objective

- Impact of R585 on sugar processing:
 - Extraction energy
 - Extraction yield
 - Juice flow
 - Electrical production
- Comparison to a trial with R579
- Mechanical harvesting

Trial description

- Day 1:
 - Trials with R579
 - 334 T in 55min
- Day 2:
 - Trials with R585
 - 282T in 50 minutes



- For both trials
 - Same mills parameters
 - Continuous sampling of each product
 - 2 series of analysis: S1, S2

Shredded cane analysis

- Same sugar content
- 22% fibre increased
 - Lower than in agronomical trials

Shredded cane

	Sugar content	Fibres	Purity	Moisture
R579	12.27	12.93	86.73	72.95
R585	12.26	15.80	87.43	70.18
%/R579	-0.1%	22.2%	0.8%	-3.8%

Capacity

- With R585 :
 - Cane capacity decreased of 7.2%

Mills capacity

	Mills capacity (T Cane /h)	Mills capacity (T Fibre/h)		
	Weight	S1	S2	Average
R579	364.8	47.73	46.62	47.17
R585	338.7	55.68	51.32	53.50
% / R579	-7.2%			13.4%

- Bagasse% cane increased of 14%

Bagasse flow

	TC/h	T Bag calculated / Hour			Bagasse calculated % canne		
		S1	S2	Average	S1	S2	Average
R579	364.8	107.5	97.7	102.6	29.5	26.8	28.1
R585	338.7	112.8	104.7	108.7	33.3	30.9	32.1
% / R579		5.0%	7.1%	6.0%	13.0%	15.4%	14.1%

Juice flow

- With R585 :
 - First mill juice flow decreased : - 18.8%

Juice Flow

	First mill juice			Diffusion juice			Mixed juice		Imbibition	
	(m3/h)	(m3/TC)	Brix	(m3/h)	(m3/TC)	Brix	(m3/h)	(m3/TC)	(m3/h)	(m3/TC)
R579	223.8	0.61	16.12	245	0.67	6.61	541.1	1.48	132.8	0.36
R585	181.7	0.54	16.21	265.8	0.78	6.82	544.4	1.61	134.9	0.40
% / R579	-18.8%	-12.5%	0.5%	8.5%	16.9%	3.1%	0.6%	8.4%	1.6%	9.4%

- Imbibition % cane increased !
 - Due to operator (diffusor speed change)
 - => + 8,5% diffusion juice
 - ~ same mixed juice flow
 - ! Trials duration = diffusor retention time

Impact on extraction yield

- Global extraction not affected (-0.3%):
- Extraction decreased for:
 - 1st mill (-5.3%)
 - Dewatering mills (-1.9%)

First mill

	Extraction yield			Bagasse 1 Moisture		
	S1	S2	Average	S1	S2	Average
R579	71.0%	75.0%	73.0%	56.05	56.20	56.13
R585	68.8%	69.4%	69.1%	53.84	56.19	55.01
% / R579	-3.1%	-7.4%	-5.3%	-3.9%	0.0%	-2.0%

Diffusion

	Extraction yield			Bagasse 2 Moisture		
	S1	S2	Average	S1	S2	Average
R579	77.2%	73.4%	75.3%	83.02	84.00	83.51
R585	74.9%	76.9%	75.9%	82.58	82.82	82.70
% / R579	-3.0%	4.8%	0.8%	-0.5%	-1.4%	-1.0%

Dewatering mill

	Extraction yield			Final bagasse moisture		
	S1	S2	Average	S1	S2	Average
R579	71.4%	64.2%	67.8%	54.55	50.95	52.75
R585	71.8%	61.3%	66.5%	49.60	49.73	49.66
% / R579	0.5%	-4.5%	-1.9%	-9.1%	-2.4%	-5.9%

Global

	Extraction yield			Pol in bagasse		
	S1	S2	Average	S1	S2	Average
R579	98.1%	97.6%	97.9%	0.79	1.08	0.94
R585	97.8%	97.3%	97.5%	0.81	1.08	0.95
% / R579	-0.3%	-0.4%	-0.3%	2.8%	-0.2%	1.1%

Impact on extraction yield

- R585 => +15.7% bagasse losses
 - Due to
 - increased of fiber
 - decreased in bagasse moisture

Bagasse losses (T sugar in bagasse / 100 TC)

	TC/h	T fibre/Hour			Bagasse losses		
		S1	S2	Average	S1	S2	Average
R579	364.8	47.73	46.62	47.17	0.23	0.29	0.26
R585	338.7	55.68	51.32	53.50	0.27	0.33	0.30
% / R579		16.7%	10.1%	13.4%	16.3%	15.2%	15.7%

Bagasse PCI

- Wiensee (2001)

$$\text{PCI (kJ.kg}^{-1}\text{)} = 18\,260 - 207.01 \cdot \text{Hum}_B - 182.60 \cdot \text{Ash}_B - 31.14 \cdot \text{Brix}_B$$

– Hypothesis : ash = 1,68 g Ash/100 g of dry bagasse

Bagasse PCI (kJ / kg)

	Bagasse Moisture			Bagasse Brix			PCI Calculated		
	S1	S2	Average	S1	S2	Average	S1	S2	Average
R579	54.6	51.0	52.8	1.0	1.4	1.2	6 768	7 514	7 141
R585	49.6	49.7	49.7	1.0	1.2	1.1	7 808	7 775	7 791
% / R579	-9.1%	-2.4%	-5.9%	-0.6%	-7.8%	-4.7%	15.4%	3.5%	9.1%

– PCI increased of 9%

Energy consumption / Ton cane

- Energy consumption for R585 compared to R579:
 - Per ton of cane = + 12.7%
 - Per ton of fibre = -7.8%

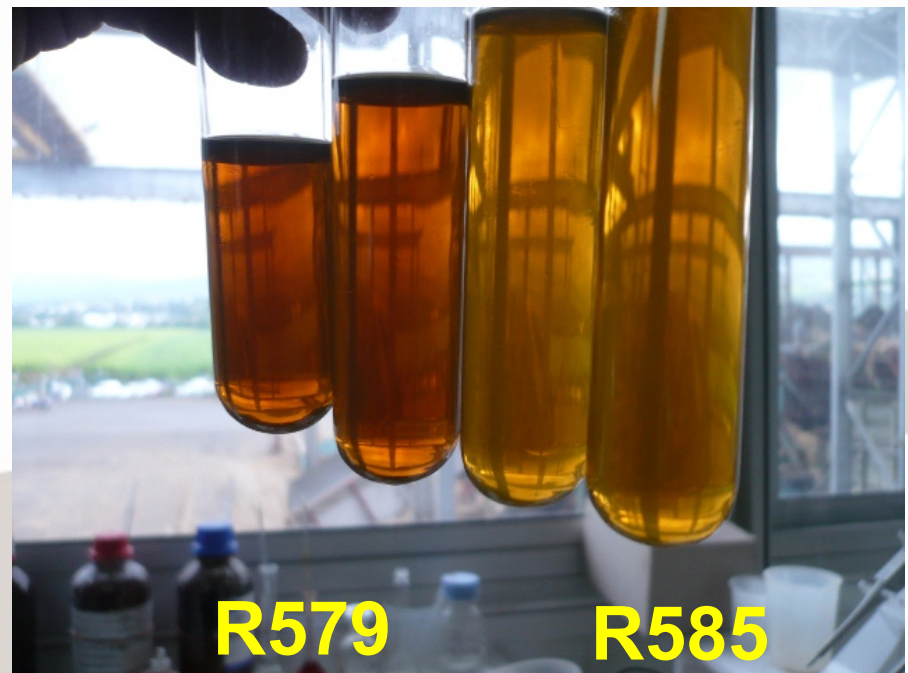
	Shredder (kWh)	First mill (kWh)	Diffusion (kWh)	Dewatering mills (kWh)	Total extraction (kWh)
% / R579					
Kwh	5.2%	3.7%	-0.2%	7.0%	4.6%
kWh/TC	13.3%	11.7%	7.5%	15.2%	12.7%
kWh/T Fibre	-7.3%	-8.6%	-12.1%	-5.7%	-7.8%

Energy production

- Increase of parameter with R585:
 - Bag%canne : +14%
 - PCI : + 9%
 - Electrical consumption : +12.7%
- Energy balance per ton of cane:
 - $R585 \% / R579 = +21\%$ electricity exported

R585 influence juice color

- Juice color:
 - First mill juice : -37%
 - Diffusion juice : -13%
 - Clarified juice : -32%
 - R579: 25 860 UI
 - R585: 17 510 UI



- Compared to R579, in this trial R585 has:
 - Fibre%C = + 22%
 - Cane flow = - 7.2 %
 - Bagasse%canne = + 14%
 - 1st mill juice flow = -19%
 - Total extraction = -0.3%
 - 1st mill extraction= -5.3%, Dewatering mills = -1.9%
 - Bagasse losses = + 15.7%
 - Extraction energy consumption = +12.7% kwh/TC
 - Dewatering mills (+15%), shredder (+13%).
 - Bagasse PCI = +9% (bagasse moisture decrease)
 - Electricity exported /TC = +21%
 - Juice color = -32%

Conclusions

- The mill was not at the maximum capacity
 - 330 TCH instead of 360TCH
 - Imbibition has been modified during the trials !
- Preliminary results that will be confirmed next crops in Le Gol mill (5 milling tandem)

Conclusions

- R585 is a « mixt » cane / sugarenergy cane
 - Standard sugar content
 - Increased in bagasse losses
 - Increased electrical production per ton of cane
 - Decreased on juice color

- This trial was prepared with many people :
 - Growers team from SAB
 - Bois Rouge team
 - eRcane team
 - ...