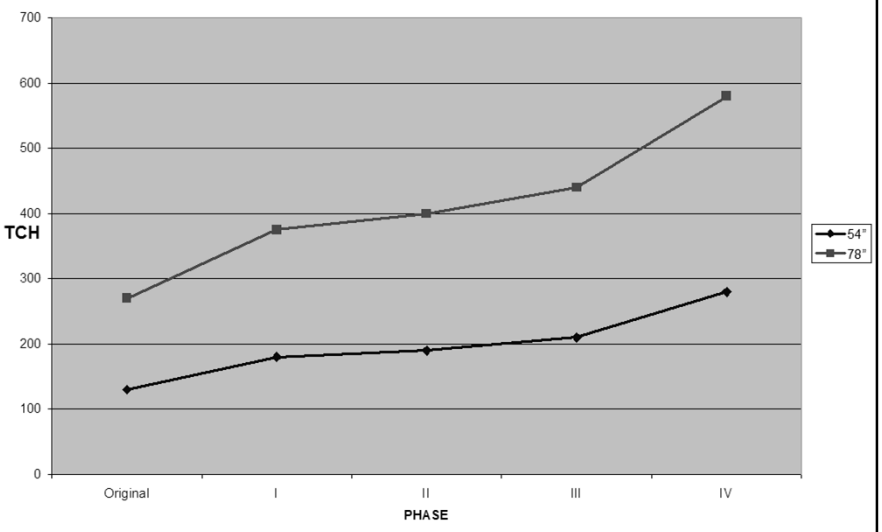
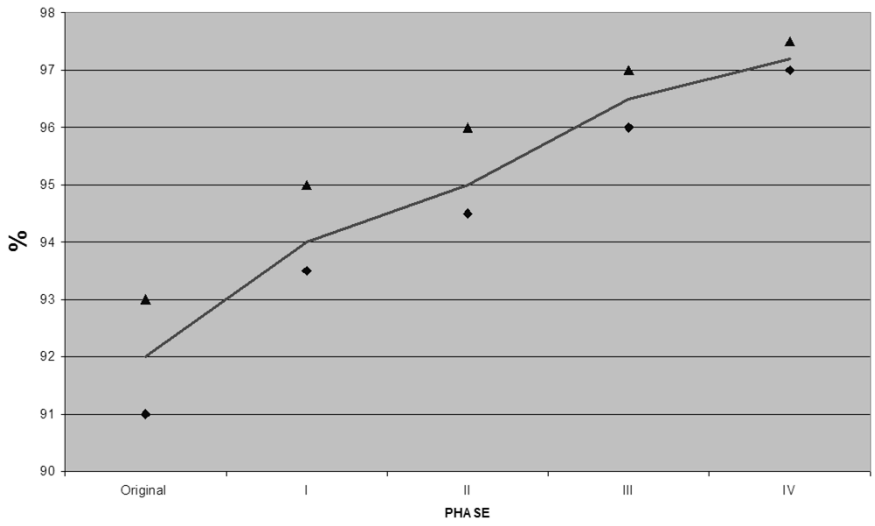
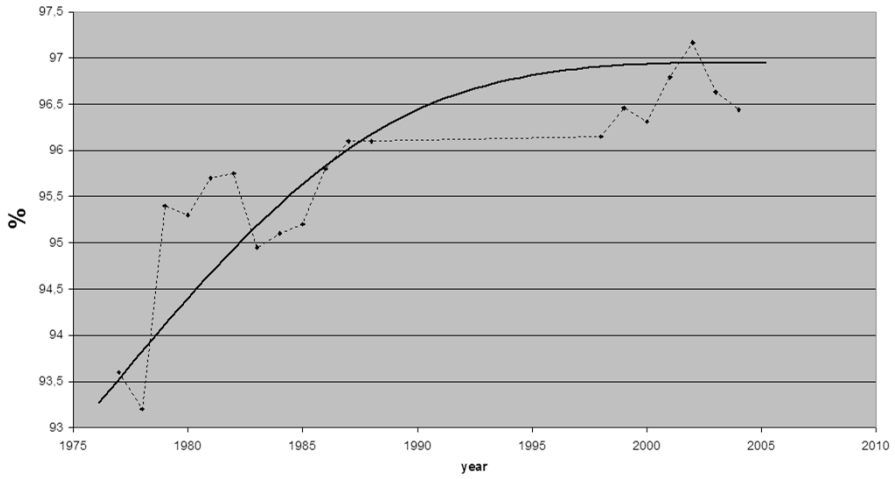
EVOLUTION OF MILLING CAPACITY



EVOLUTION OF MILLING EFFICIENCY



EVOLUTION OF MILLING EFFICEINCY (real data)



MILLING EVOLUTION

Evolution in Milling Capacity					
Mill	Original	I	II	III	IV
54”	130	180	190	210	280
78”	270	375	400	440	580
		Cane prepar.+ press roller	45º+Feed System+ Donelly	Reform Mill House	Special Mill House+ larger diam.+ incr.rotation

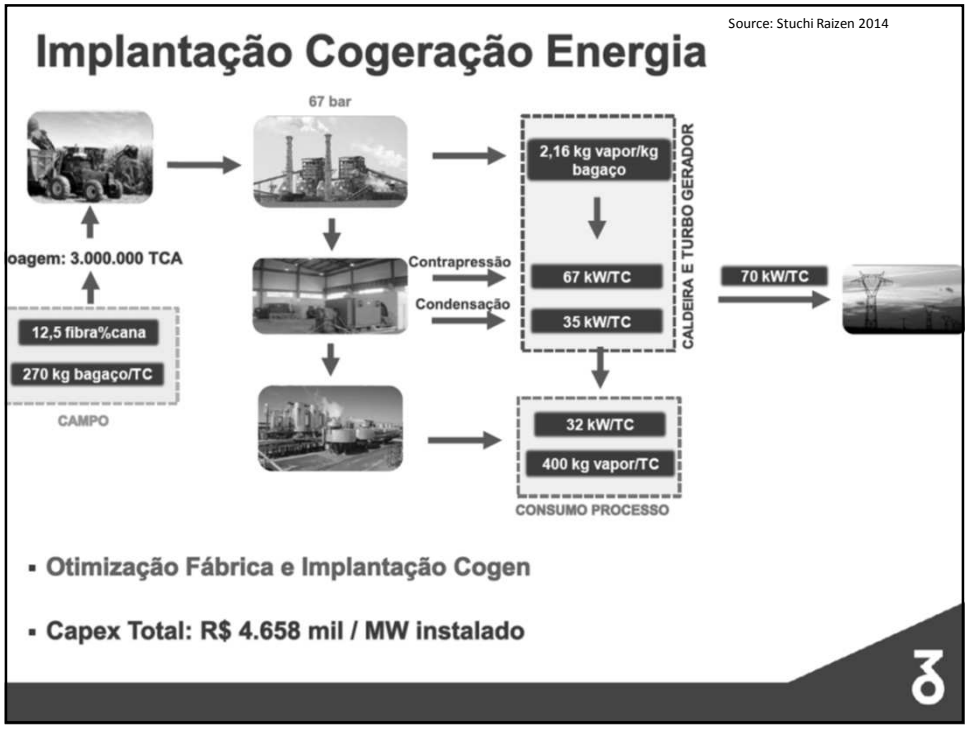
MILLING EVOLUTION

Evolution in Milling Efficiency					
	Original	I	II	III	IV
	91-93%	93.5-95	94.5-96	96-97	97-97.5
		Cane prepar.+ pressroller +embib.	Feed System+ Donelly+ roll welding	Full Donelly+ Automation	Adjustments + Control

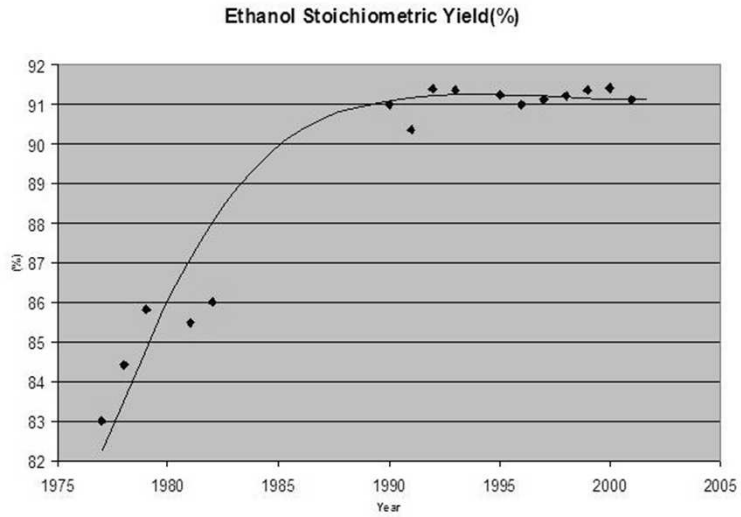
Table 1. Technical comparison between mills and diffusers

	Characteristic	Mill	CANE DIFFUSER Chain and Modular Diffuser
Process parameter	Cane preparation		
	(Voigt, 2009)	Attain good extraction rates with 85% preparation. Accepts greater amounts of fines or small particles.	Requires higher preparation, over 90%. Long fibres are desirable, but fines hinder adequate bed percolation.
	Impact of mineral impurities	Causes mill wear but do not affect momentary extraction rates	Causes low impact on the apparatus maintenance. The effect of impurities on extraction cannot be generally quantified both for diffusers and mills.
	Impact of soil type / bed colmatation (clogging)	Low impact on extraction / Higher wear of rollers in clay soils	Clay soils / sludge / gels tend to prevent adequate percolation, causing choking and extraction losses (Rama et al., 2006)
	Impact of vegetable impurities (Dias Paes, 2011)	Loss of 2.3 percentage points of capacity for every 1.0% of vegetable impurity	Loss of 3.1 percentage points of capacity for every 1.0% of vegetal impurities. Short fibre and fines tend to prevent adequate percolation
	Quality of extracted juice		
	(Rein, 1995)	Higher levels of suspended solids. Requires filtration.	Lower concentrations of suspended solids. Extracts higher amounts of non-sugars substances (ex: phenols, colorants, polysaccharides, etc.) (Manechini, 2011)
	Juice dilution	Allows up to 80% separation of cane absolute juice. Remaining mixed juice is more diluted.	Does not allow separation of absolute juice. Mixed juice usually with higher brix if in tandem mill, absolute juice is extracted.
	Usual imbibition rate		
		Typical: 200% – 250% of fibre / limited by the mills operation. May use higher imbibition with low capacity.	Allows adjustments to achieve improved process balance: juice brix / bagasse moisture / extraction / energy consumption in juice evaporation. Typical: 200% – 300% of fibre. (Voigt, 2010)
	Required juice evaporation	Typically lower imbibition requires lower thermal energy, as steam consumption and/or waste heat recovery from process stream.	The learning curve of operational experience will determine the optimum point, particularly in mills producing ethanol and bioelectricity, but preliminary indicators show that imbibition may be optimised from the experience learned from the use of the not burned and mechanically harvested cane. (Voigt, 2010)
Process parameter	Characteristic	Mill	CANE DIFFUSER
	Chain and Modular Diffuser		
	Sugars extraction rates in juice	Hardly exceeds 98%, and tends to decline during the milling season.	98.5% may be achieved with two dewatering stages, and is barely impacted by wear during the milling season. (Delfini, 2012)
	Thermal energy in the system as steam demand	Operates at 60 Celsius. Requires lower thermal energy in extraction	Typically operates between 80 to 90 Celsius. Requires more thermal energy in extraction and, usually, in evaporation for higher imbibition water rate.
	Required electric power for drive	6000 kW installed for a capacity of 13 000 TCD, except for preparation	3500 kW installed for a capacity of 13 000 TCD, except for preparation. The electric power consumption in preparation is similar to the mills.
	Bioelectricity available for exports	Higher electric power demand for drive / lower thermal energy demand.	Lower electric power demand for drive / higher thermal energy demand. Depending on the cogeneration design, similar exports can be obtained, especially in systems with low percentage of condensation in the last cogeneration turbine stage
	Biological contamination		
	(Mackrory, 1984)	Operates at lower temperature, enhancing biological activity.	Operates between 80 and 90 Celsius, reducing microbial activity and losses of reducing sugars.

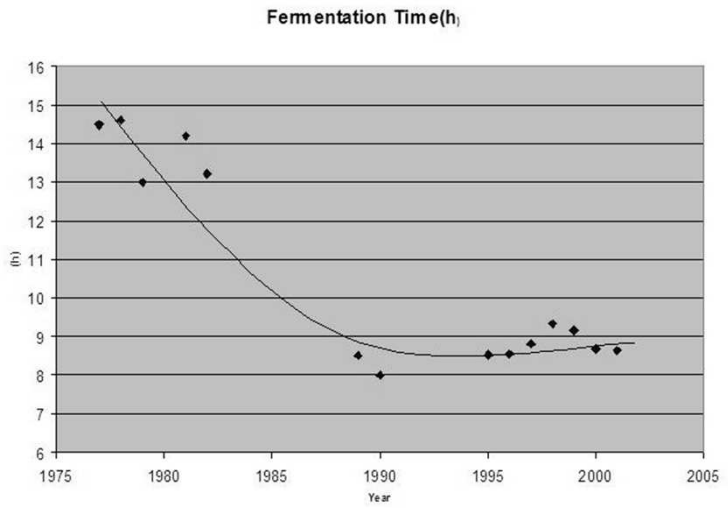
Source: Stuchi Raizen 2014



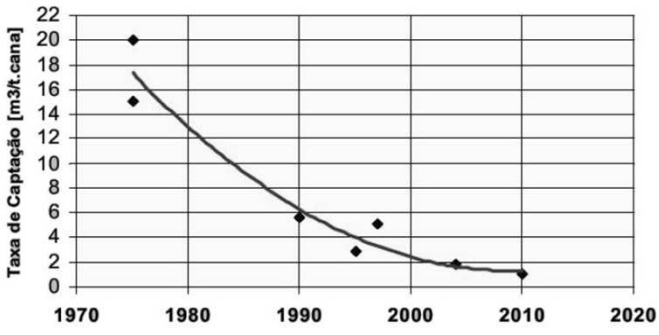
EVOLUTION OF FERMENTATION PROCESS



EVOLUTION OF FERMENTATION PROCESS



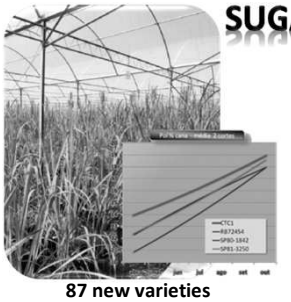
EVOLUTION OF WATER USE



Fonte: Elia Neto - CTC (2009)

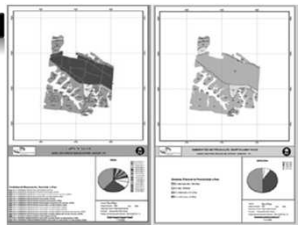
CTC TECHNOLOGIES

SUGARCANE PRODUCTION



87 new varieties

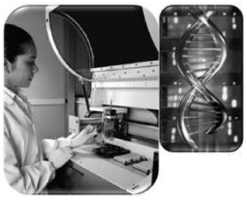
Biological Control of Pests: 3,000,000 ha



Soil Maps and Production Environments: 3,000,000 ha

Mechanized planting

Sugarcane Genoma



CTC TECHNOLOGIES

SUGARCANE PRODUCTION

Satellite Images in production management

Cutting, Loading and Transportation technologies

Simulation Software in production management

By-product use and recycle techniques

CTC TECHNOLOGIES

INDUSTRIAL PROCESSING

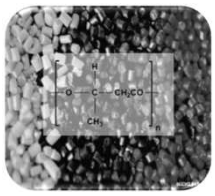
VHP AND VVHP Sugar Production

Sugar and Ethanol Reference Laboratory

Food safety compliance

Benzene replacement in dehydration

Water Catchment Reduction in 10 times



Biodegradabe Plastic from sugar (PHB)

CTC TECHNOLOGIES

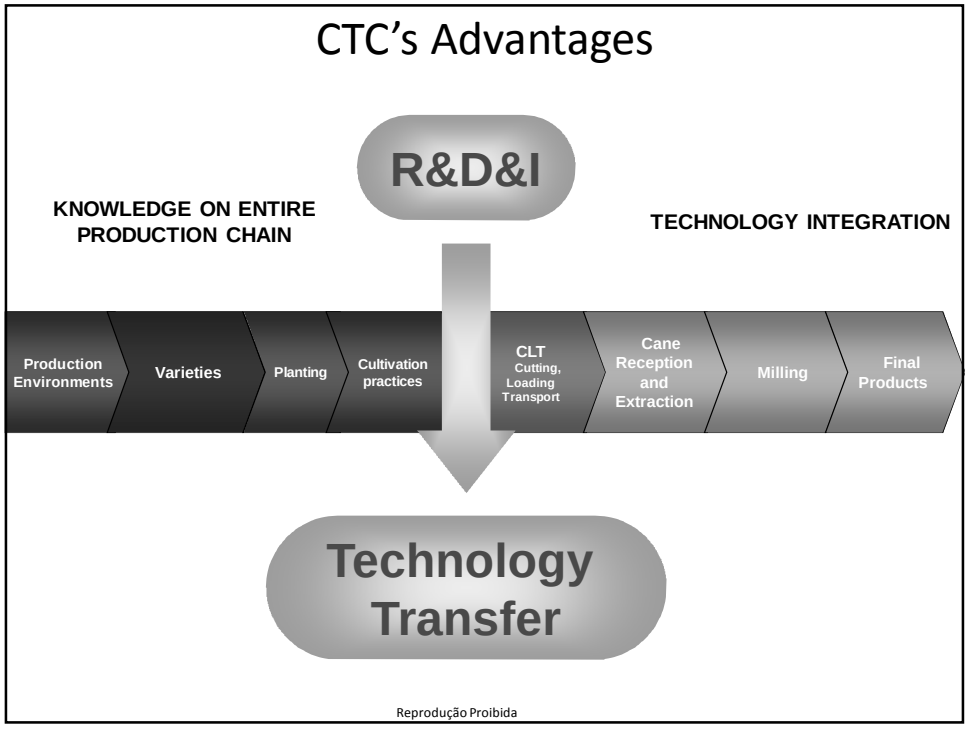
INDUSTRIAL PROCESSING

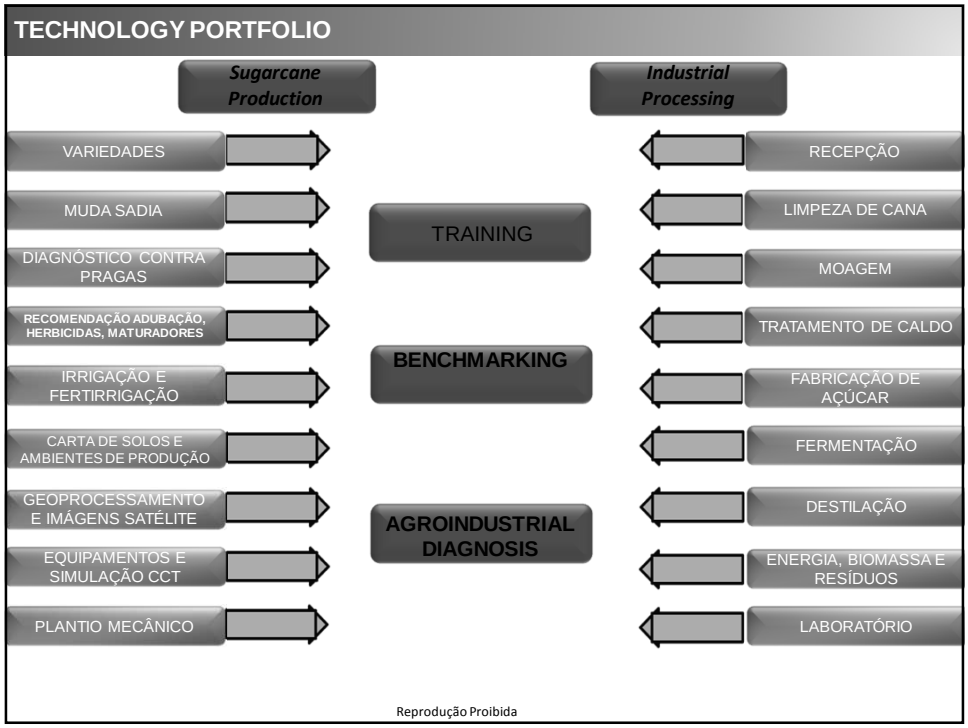
Productivity and Yield increases in sugar extraction, fermentation and distillation

Continuous Fermentation

Energy self sufficiency

Dry yeast production

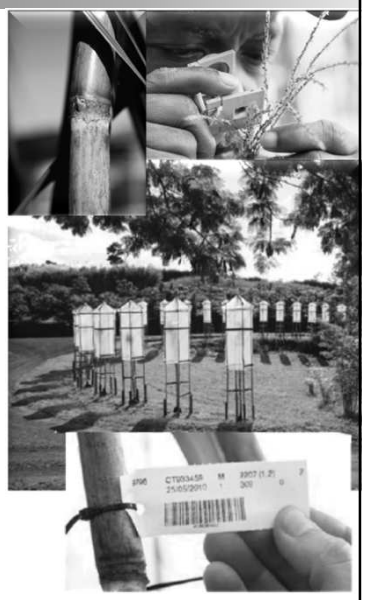

CTC's Advantages
R&D&I
KNOWLEDGE ON ENTIRE PRODUCTION CHAIN
TECHNOLOGY INTEGRATION
Production Environments
Varieties
Planting
Cultivation practices
CLT Cutting, Loading Transport
Cane Reception and Extraction
Milling
Final Products
Technology Transfer
Reprodução Proibida


TECHNOLOGY PORTFOLIO
Sugarcane Production
Industrial Processing
VARIEDADES
MUDA SADIA
DIAGNÓSTICO CONTRA PRAGAS
RECOMENDAÇÃO ADUBAÇÃO, HERBICIDAS, MATURADORES
IRRIGAÇÃO E FERTIRRIGAÇÃO
CARTA DE SOLOS E AMBIENTES DE PRODUÇÃO
GEOPROCESSAMENTO E IMÁGENS SATÉLITE
EQUIPAMENTOS E SIMULAÇÃO CCT
PLANTIO MECÂNICO
TRAINING
BENCHMARKING
AGROINDUSTRIAL DIAGNOSIS
RECEPÇÃO
LIMPEZA DE CANA
MOAGEM
TRATAMENTO DE CALDO
FABRICAÇÃO DE AÇÚCAR
FERMENTAÇÃO
DESTILAÇÃO
ENERGIA, BIOMASSA E RESÍDUOS
LABORATÓRIO
Reprodução Proibida

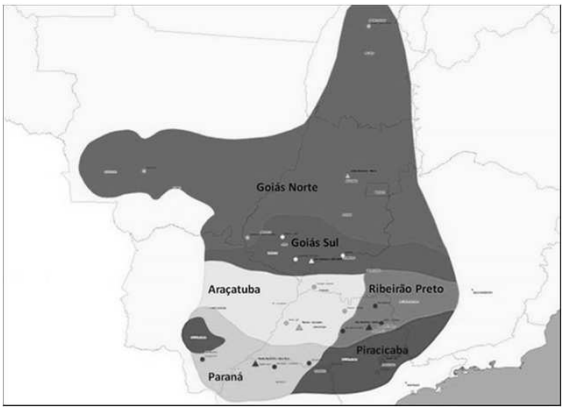
CTC RESEARCH AREAS

VARIETIES

- **Bigger and most complete germplasm**
- **Adapted varieties**
- **154 selection places**
- **Energy cane program**



Polos Regionais – cobertura edafoclimática



SP/Piracicaba	A-I, B-I, C-I	PR/Paraná	C-I, D-I e E-I
SP/Ribeirão Preto	A-II, B-II, C-II A-III, B-III, C-III	SP/Araçatuba	C-II, D-II e E-II C-III, D-III e E-III
GO/Goiás norte	B-IV, C-IV; D-IV B-V, C-V; D-V	GO/Goiás sul	C-IV, D-IV, E-IV C-V, D-V, E-V

BIOTECHNOLOGY & GMOs

- **1994 – 1st GMO Sugarcane**
- **2000 – CTC leadership in the Sugarcane Genoma**
- **Molecular Markers – agronomic characterization**
- **GMO Sugarcane :**
  - **High sugar**
  - **Drought tolerance**
  - **More Biomass**
  - **Herbicide tolerance**
  - **Insects**

SUGARCANE PRODUCTION

- **Trash Collection**

- **Next Generation Trash Collection**

ENERGY & INDUSTRIAL ENGINEERING

- **Sugarcane and trash reception and processing systems**

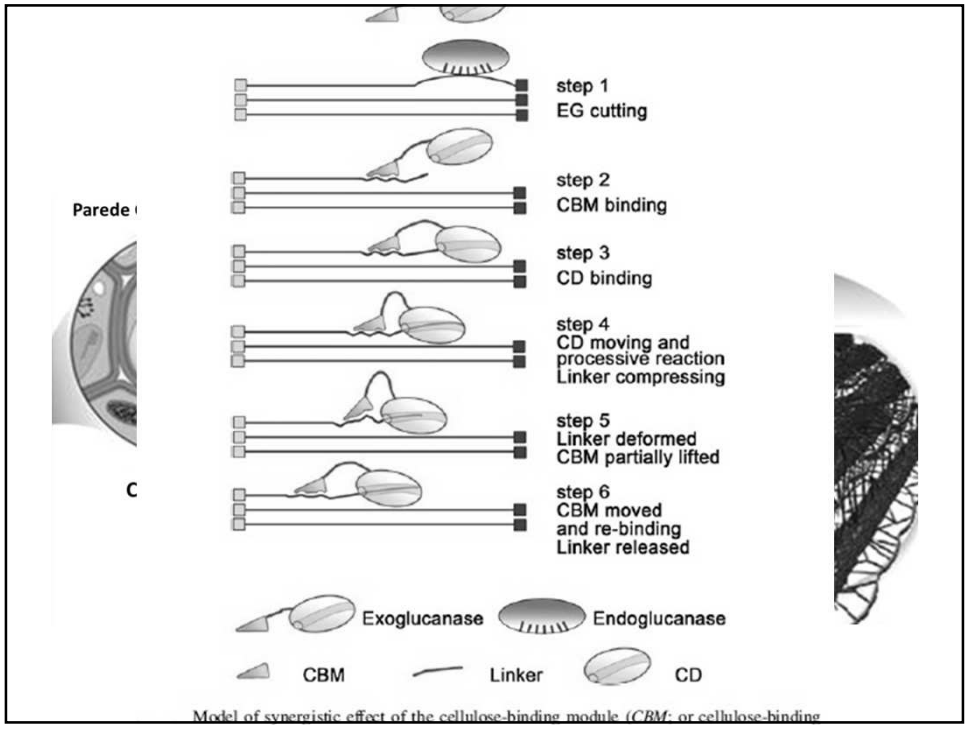
- **Baled trash reception and processing**

ETHANOL PRODUCTION- PILOT PLANT FERMENTATION

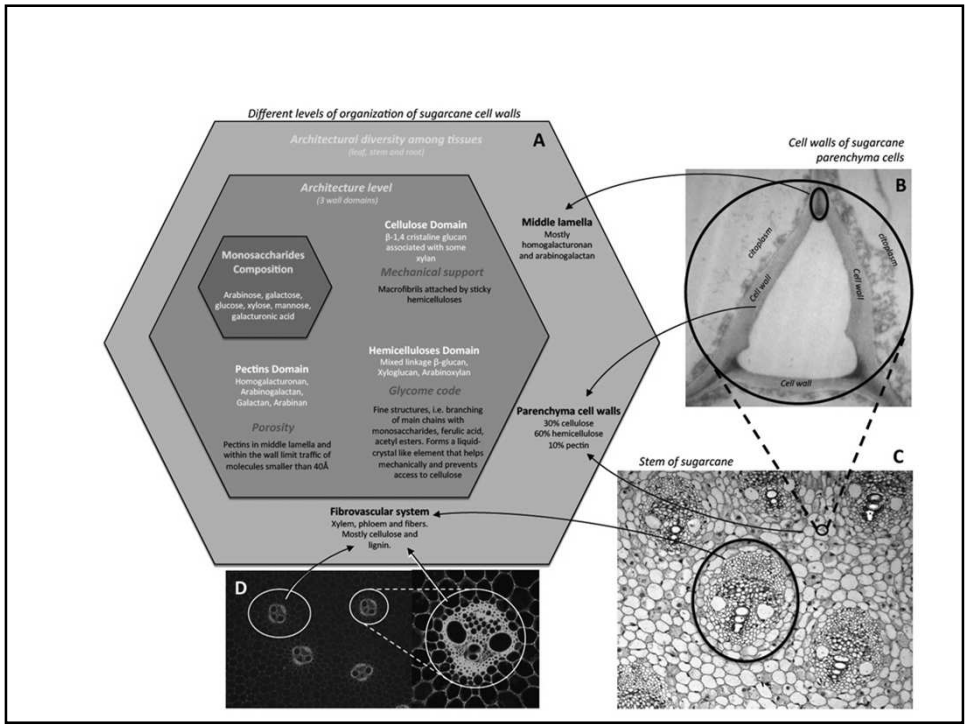
- **2009 –Pilot-Plant at CTC**
- **Thermodynamics and Process Improvement**
- **60% vinasse reduction**
- **Cooling water minimization**
- **Energy use minimization**

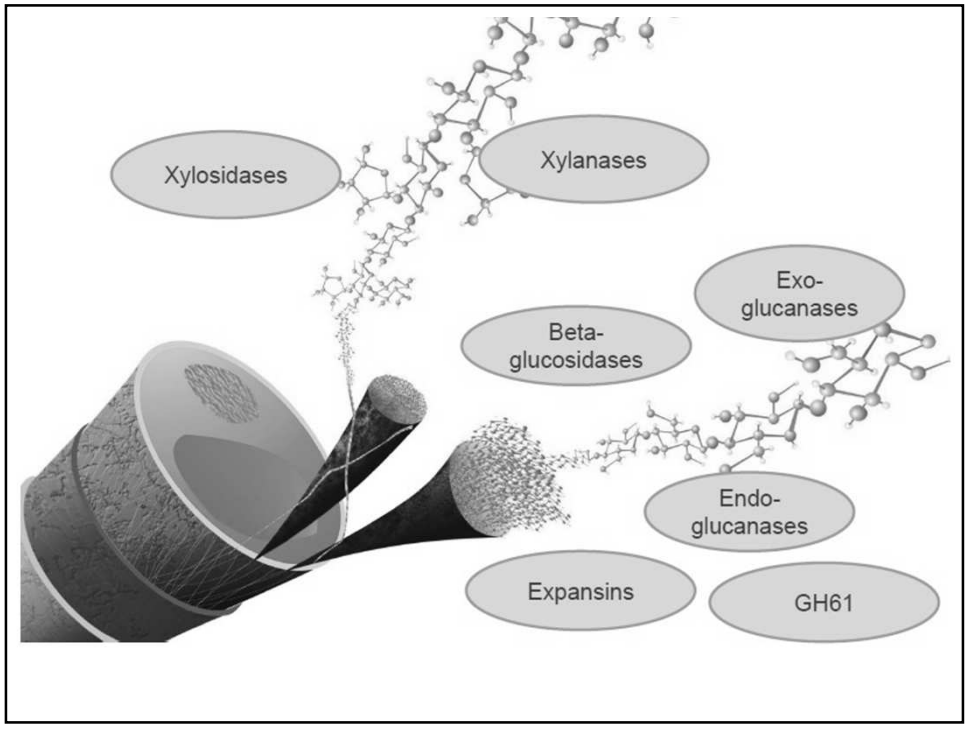
CELLULOSIC ETHANOL

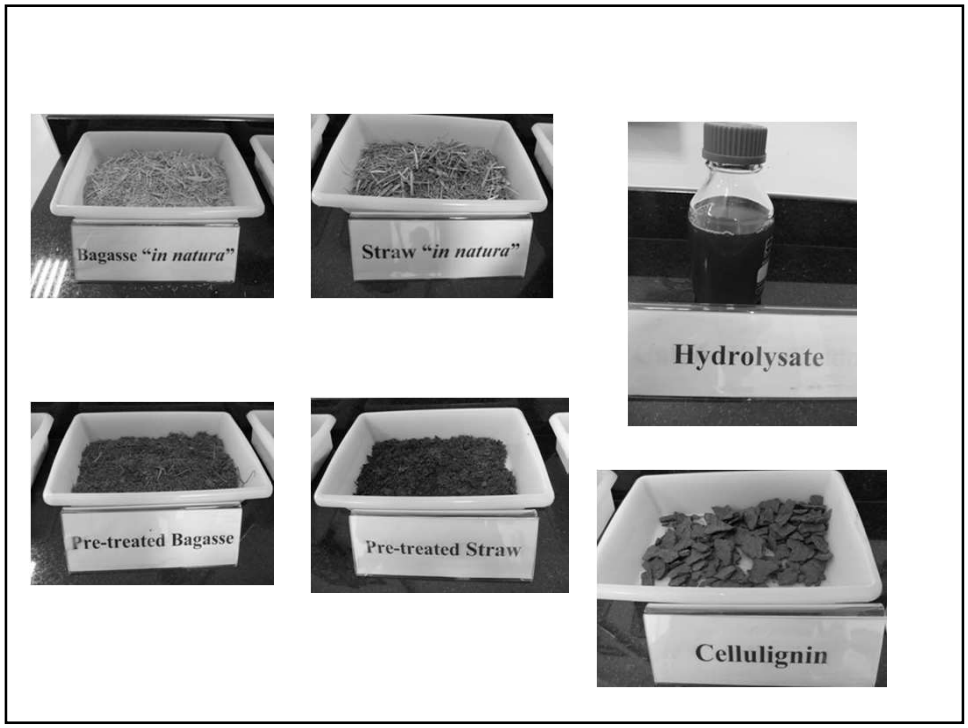
- **2009 – Full operational pilot - plant at CTC**
- **Proven technology for 30% increase per hectare per year**
- **2014 – Demo Plant in a sugar mill**



Model of synergistic effect of the cellulose-binding module (*CBM*; or cellulose-binding




Xylosidases
Xylanases
Exo-
glucanases
Beta-
glucosidases
Endo-
glucanases
Expansins
GH61


Bagasse "*in natura*"
Straw "*in natura*"
Hydrolysate
Pre-treated Bagasse
Pre-treated Straw
Cellulignin

2007 / 2010 Evolution–2011 / 2014 Projection

✓ **Learning Curve – 2G Biomass Ethanol**

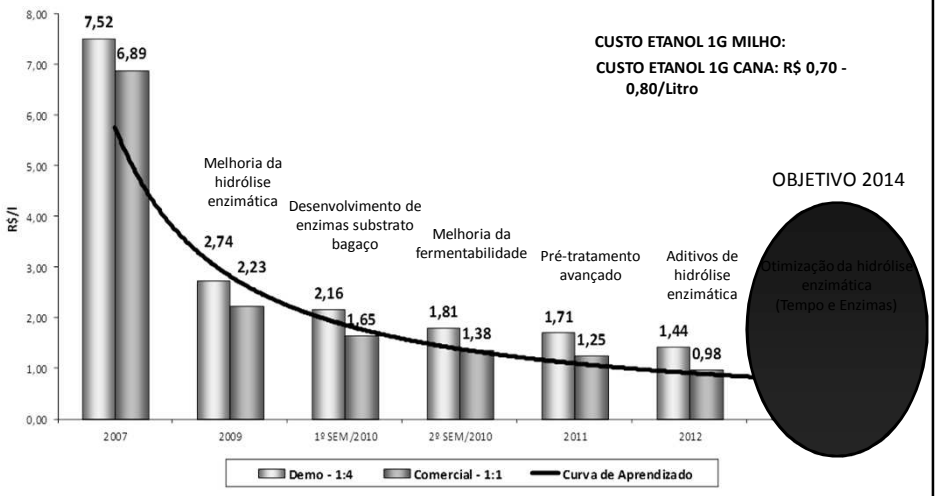
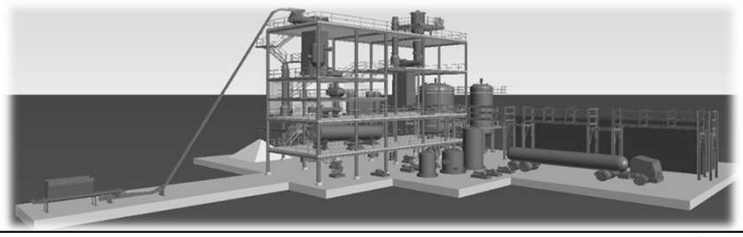


Gráfico 1. Evolução do Custo do Etanol Celulósico

Demonstration Plant E2G

- R&D began in 2007, process IP 100% CTC (for increases in 30% capacity)
- Maximize global efficiency
- Specific pretreatment for sugarcane biomass.
- Total integration with 1G
- Main *milestones*:
  - *Q3 2013: construction starts*
  - *Q3 2014: demo plant start-up*
  - *2016: commercialization*



76

CTC

Status – Demonstration Plant
Usina São Manoel

Status – Planta Demonstração
Usina São Manoel

Status – Demonstration Plant
Usina São Manoel

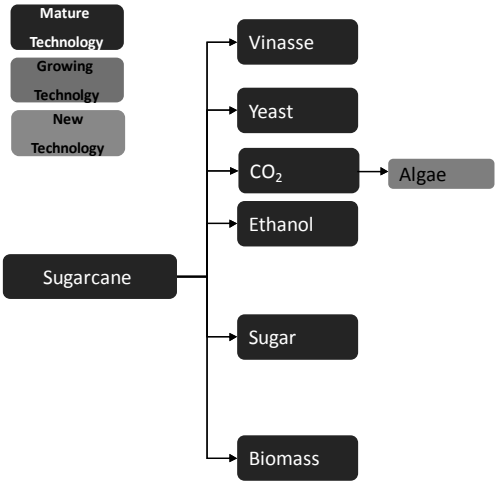
CTC
CENTRO DE TECNOLOGIA CANAVIEIRA

CTC SUGAR AND ETHANOL REFERENCE LABORATORY

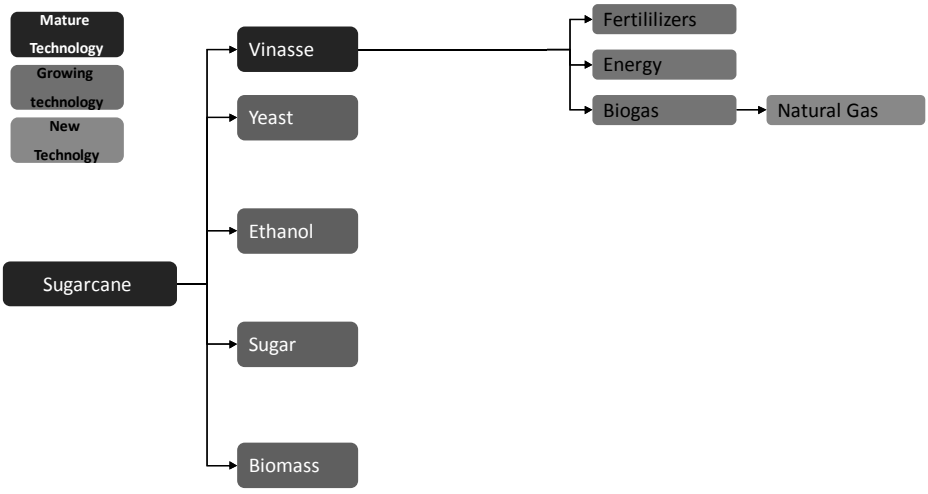
- **Full R&D support and calibration, including at industrial sites**

- **Personal training**
- **Industrial losses reduction**
- **Equipment calibration, etc**

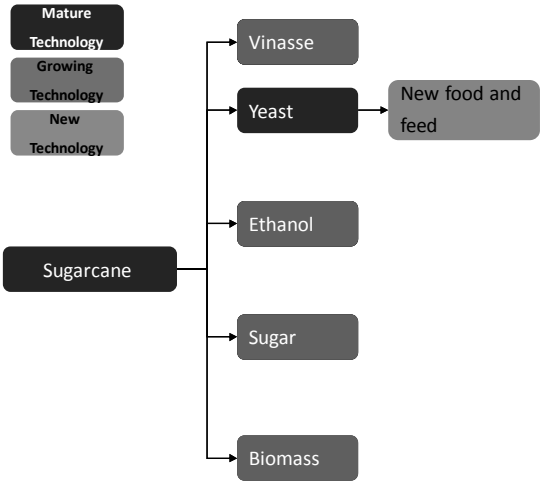
R&D&I: INNOVATION



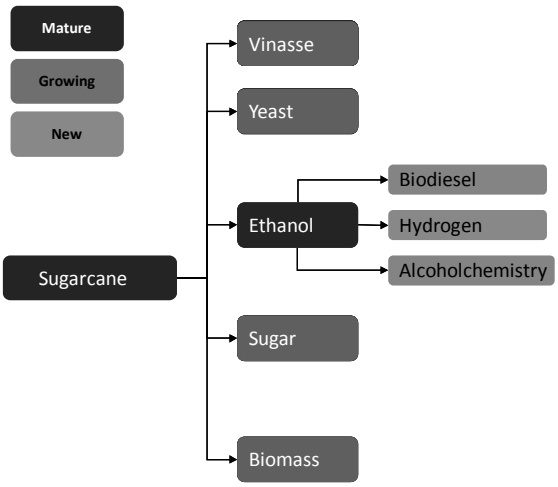
R&D&I: INNOVATION



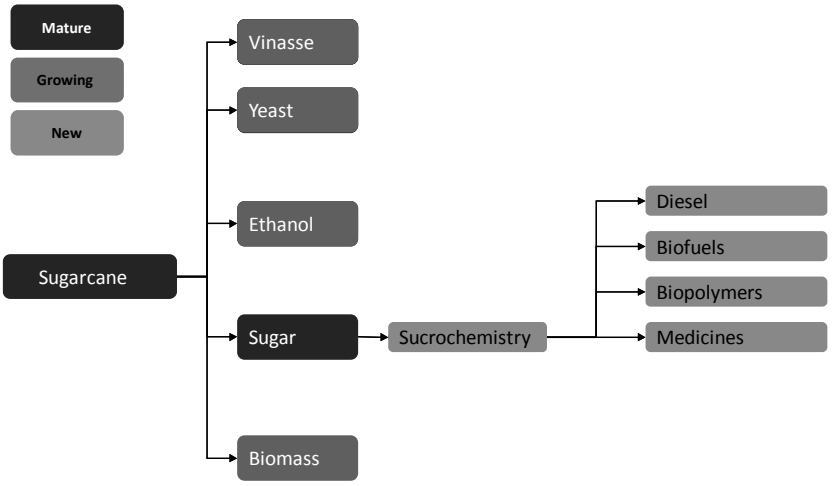
R&D&I: INNOVATION



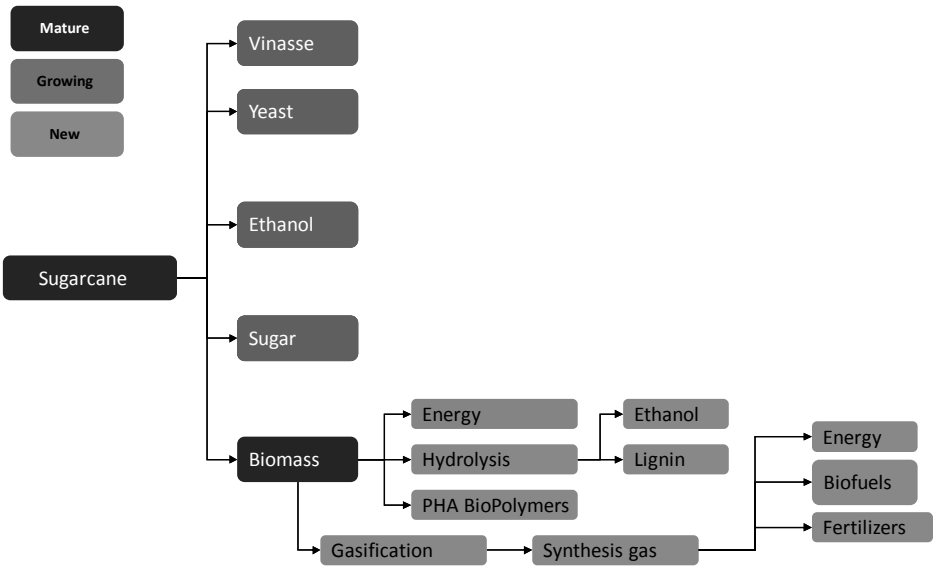
R&D&I: INNOVATION



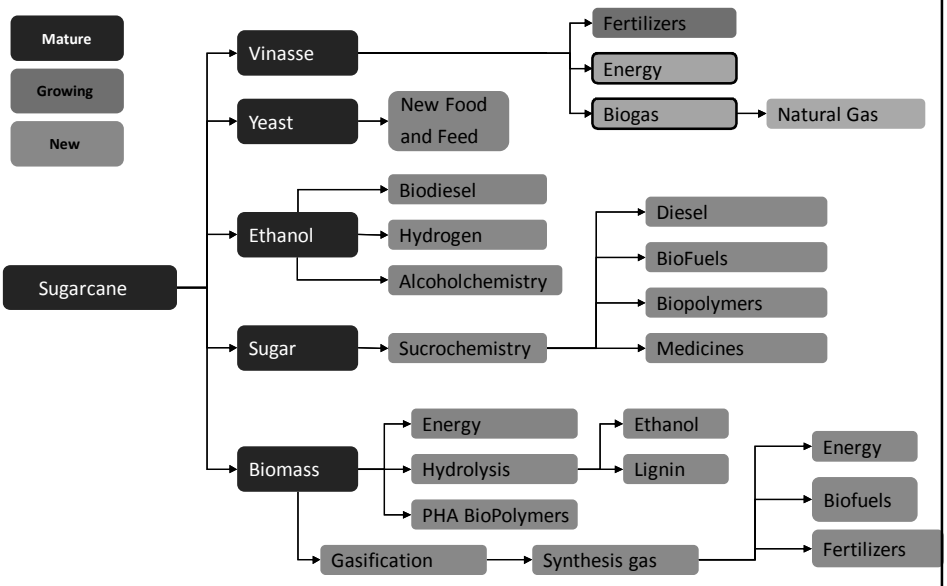
R&D&I: INNOVATION



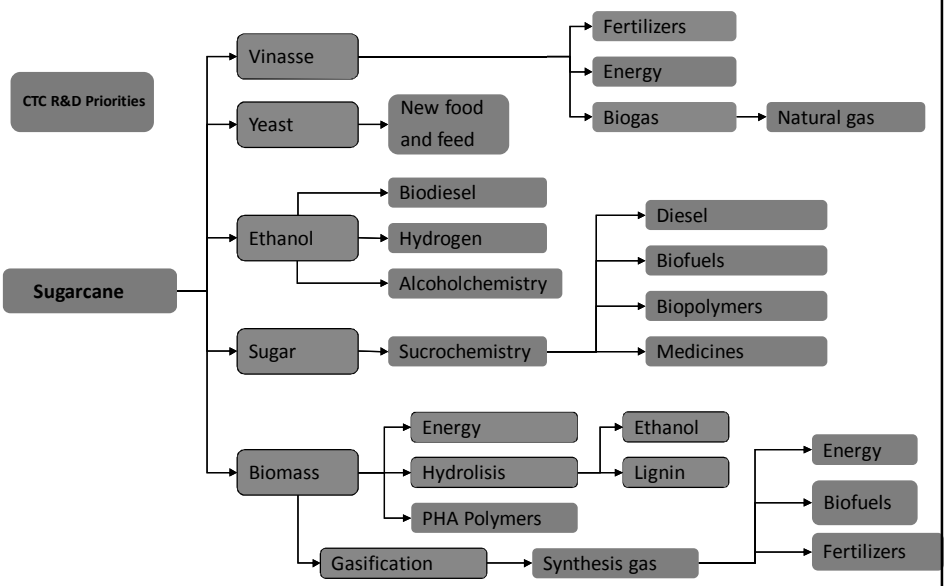
R&D&I: INNOVATION



R&D&I: INNOVATION



R&D&I: INNOVATION



Jaime Finguerut
19 3429 8147
jaime@ctc.com.br

jaime@ctc.com.br