Sugarcane biotechnology and production of fermentable sugars from biomass

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Queensland University of Technology

- Leading Australian university
  - 42,500 students
- Emphasis on applied research
- Needs of industry and community
- Brisbane based – global outlook

Centre for Tropical Crops and Biocommodities

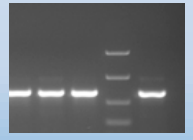
Enhanced levels of micronutrients

BILL & MELINDA GATES foundation

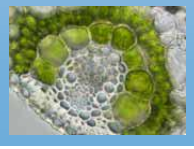
NARO

Fungal and viral disease resistance





Crops for Future Environments



Centre for Tropical Crops and Biocommodities

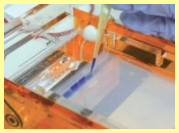
Fuel chemicals and bioproducts



Syngenta Centre for Sugarcane Biofuels Development


Extreme protein expression in plants

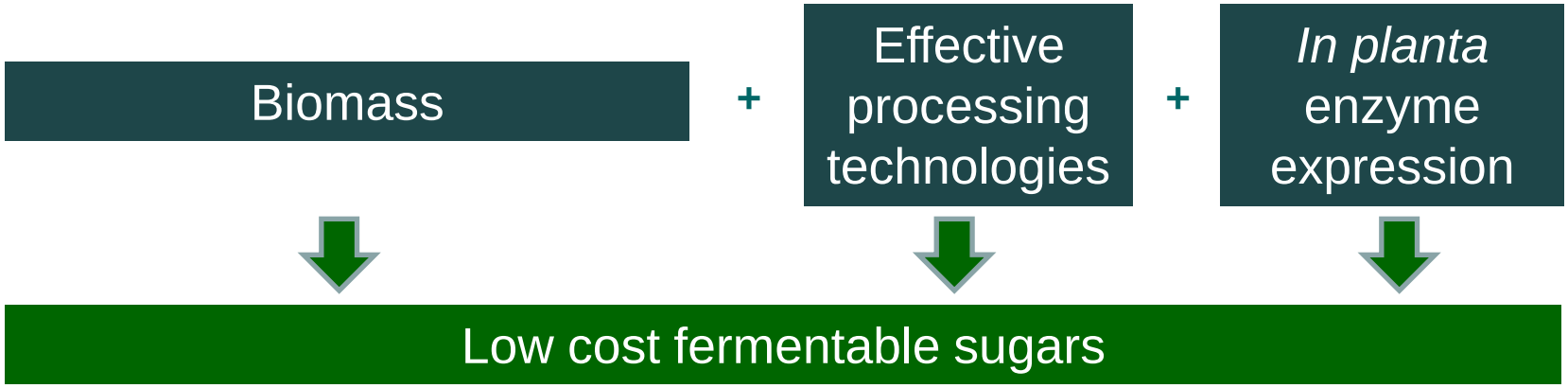




Biomass to fermentable sugars

- Bio-products (including ethanol) are critically dependent upon low cost, fermentable sugars

Efficient, sustainable crop + **Efficient harvesting & transport** + **Effective processing technologies** + **Ready access to sugars**



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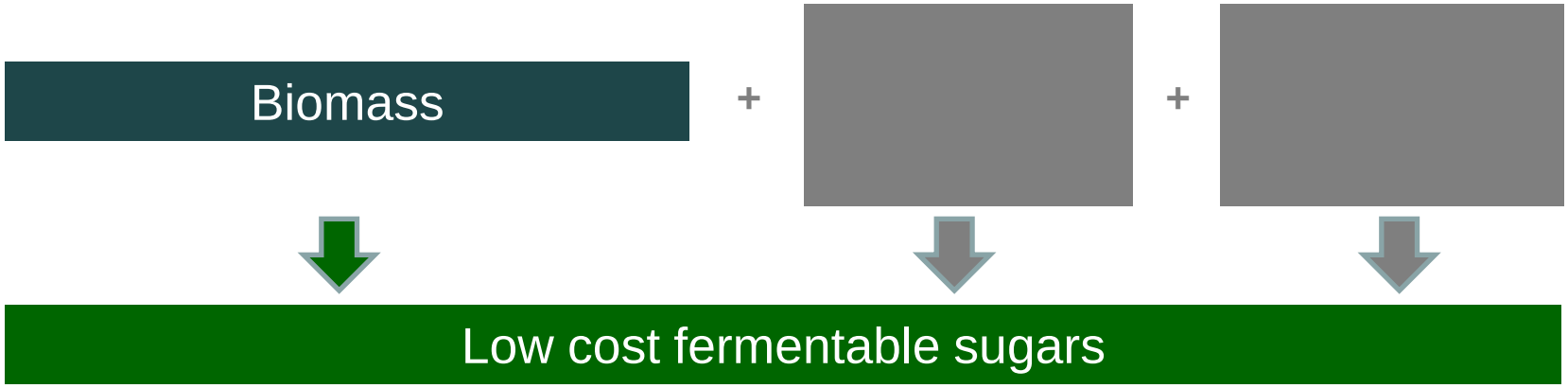

Sugarcane... the best bioenergy crop?

Five reasons why sugarcane is the best bioenergy crop in Australia (and perhaps even the world…)

1	• Highly efficient photosynthetic crop
2	• Huge resource - global
3	• Established industrial crop
4	• Resource - vastly under-utilised
5	• Crop residue already at factory

Biomass to fermentable sugars

- Bio-products (including ethanol) are critically dependent upon low cost fermentable sugars
- The Syngenta Centre for Sugarcane Biofuels Development was established in 2008

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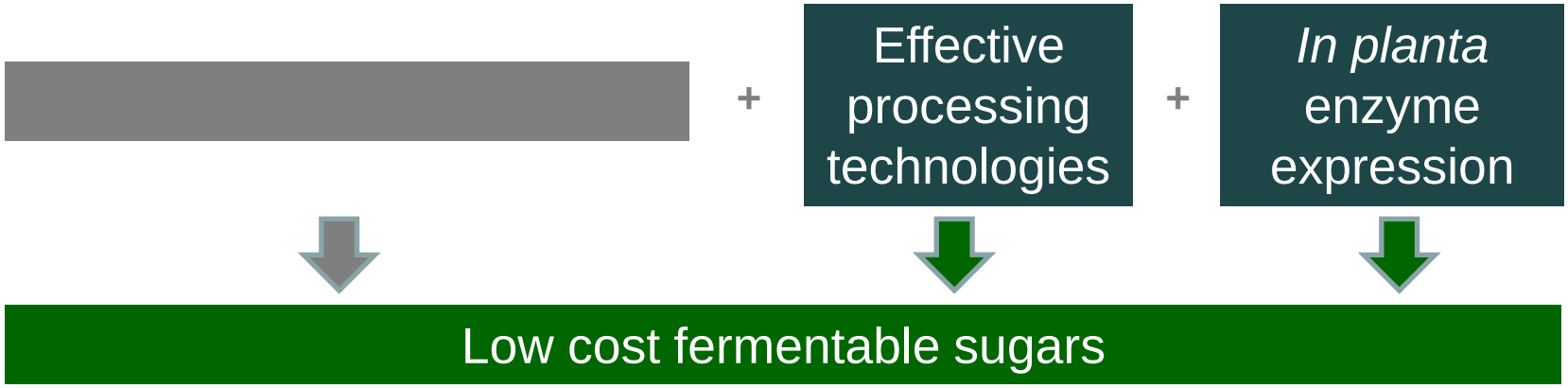

Plant made enzymes

- Major hurdle: cost of enzymes to convert biomass into fermentable sugars
- Production of tonnes of enzyme per day required
- Innovation: plant-made enzymes
- Production of fibrolytic enzymes in transgenic sugarcane brings together *in planta* expression with the best biomass crop
- Higher embedded value in sugarcane
- Significant and commercially-focussed global partner

Plant made enzymes

- Innovation across 4 major areas required to deliver success:
- efficient genetic transformation of sugarcane
- a transgene expression “tool-kit” for sugarcane
- biochemistry/enzymology of fibroloytic enzymes
- complementary processing and pretreatment technologies

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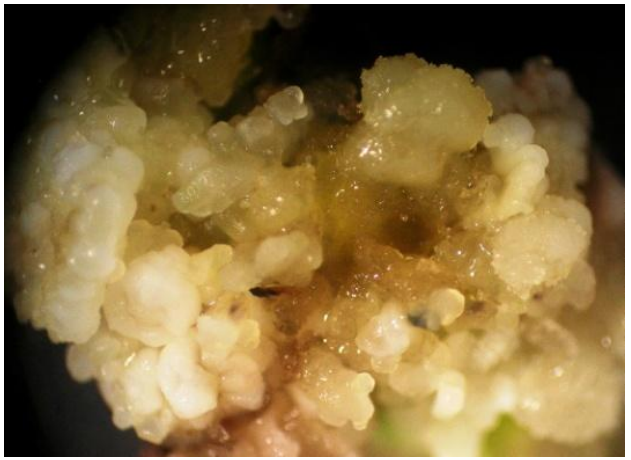

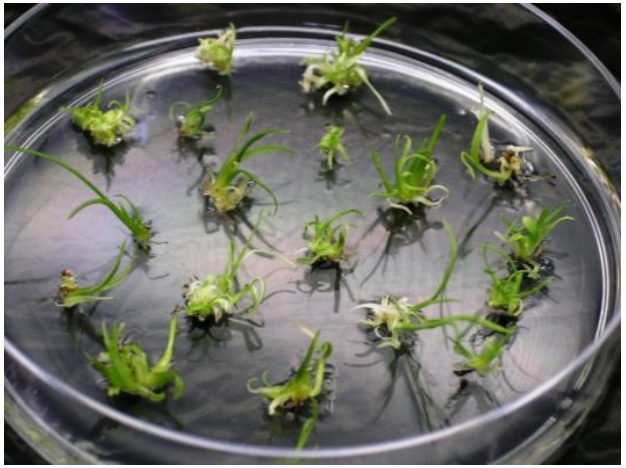

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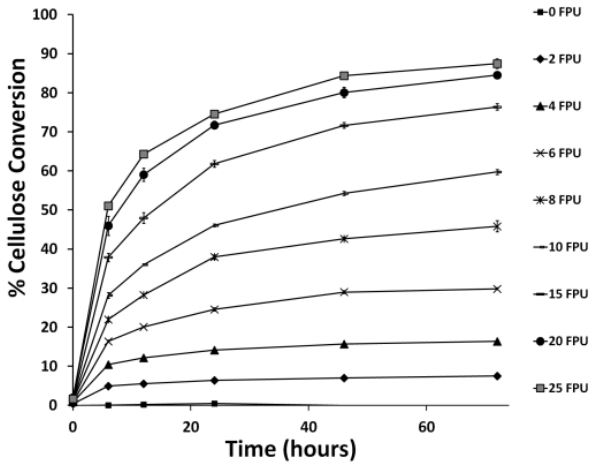

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QUT Mackay Renewable Biocommodities Pilot Plant

- Pilot-scale research and development integrated biorefinery
- The facility links innovations in plant biotechnology and process development with assessment of commercial viability
- Funding for the facility was contingent on providing access to both academia and industry

An Australian Government Initiative
National Collaborative Research Infrastructure Strategy
Queensland Government
QUT
MACKAY SUGAR

Pilot scale and demonstration

Laboratory scale	Pilot scale	Commercial

- Reduce the risk associated with new technology
- Reduce investment risk
- Understand the process at a pre-commercial scale (lower cost)
- Produce product for market testing
- Provide data for commercial plant design

Biomass feed and pretreatment

Biomass preparation

- Biomass storage, size reduction
- Weighing machine

Andritz steam-ex pretreatment reactor

- Two-stage Hastelloy reactor with
- Integral hydraulic press
- Steam explosion vertical reactor

- Acid, alkali, solvent based processes

Hydrolysis and fermentation

- Hydrolysis reactors

- Fermentation equipment
  - Stirred fermenters – 10, 100, 1,000, 10,000 L
  - Airlift fermenters – 10, 100, 1,000 L
  - DO, pH, Temp, flow control
  - Aerobic, anaerobic
  - Batch, fed-batch, continuous

Bio-separation and product recovery

- Bio-separations equipment
- Centrifuges
- Rotary drum vacuum filtration
- Membrane filtration
- Distillation column
- Spray drier
- Fluidised bed dryer
- Autoclave
- Steriliser, CIP unit
- Assorted tanks and pumps

Acknowledgements

- Staff and students in the Centre for Tropical Crops and Biocommodities
- The staff of the Syngenta Centre for Sugarcane Biofuels Development
- Our colleagues at Syngenta Biotechnology Inc
- The funding bodies and organisations that have supported our work

leaf energy
HARNESSING PLANT ENERGY

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Further information: **www.ctcb.qut.edu.au**