



# Reducing Costs and Increasing Sustainability of Ethanol as a Feedstock for Alcohol-to-Jet

Technology advancements delivering sustainability solutions



# Disclaimer and Important Notice

The views and opinions expressed in this presentation are those of the author/s and do not necessarily reflect the views of MicroBioGen Pty Ltd ACN 096 059 700.

The information presented in this presentation is of a general nature only and does not purport to be complete. You should assess this information in light of your own circumstances, and take appropriate advice.

Prior results and case studies do not guarantee a similar outcome in future.

Where indicated, certain content has been sourced from third parties; we have not independently verified it.

Neither MicroBioGen nor the author makes any warranty as to the accuracy, completeness or reliability of this presentation, nor do those parties accept any liability or responsibility arising in any way from omissions or errors contained in the content.

# Global SAF Industry Opportunity

MicroBioGen's advanced fermentation technology significantly improves the **sustainability, efficiency & economics** of SAF by improving the conversion of biomass-to-alcohol for alcohol-to-jet

- 1 SAF is the future fuel for the aviation industry globally
- 2 How can SAF be produced more economically and sustainably?
- 3 MicroBioGen's yeast is key to ethanol production efficiency
- 4 MicroBioGen expects strong growth in 2G ethanol plants globally to meet emerging SAF demand
- 5 Future of sustainable ethanol for SAF requires fully integrated ethanol plants that deliver fuel as well as feed/food solutions

# MicroBioGen: Company Highlights

Founded in  
**2001**

Partnered with  
**Novozymes**  
since 2014

**8 ethanol**  
**products**  
commercialised

World Leading  
**Yeast Innovation**  
**As a Service**

**ESG focused**

Already the leading biocatalyst  
solution provider for ethanol

**1 Partner**  
**8 Collaborators**

Global license & collaboration model

**Multi-Industry**  
**Platform Technology**

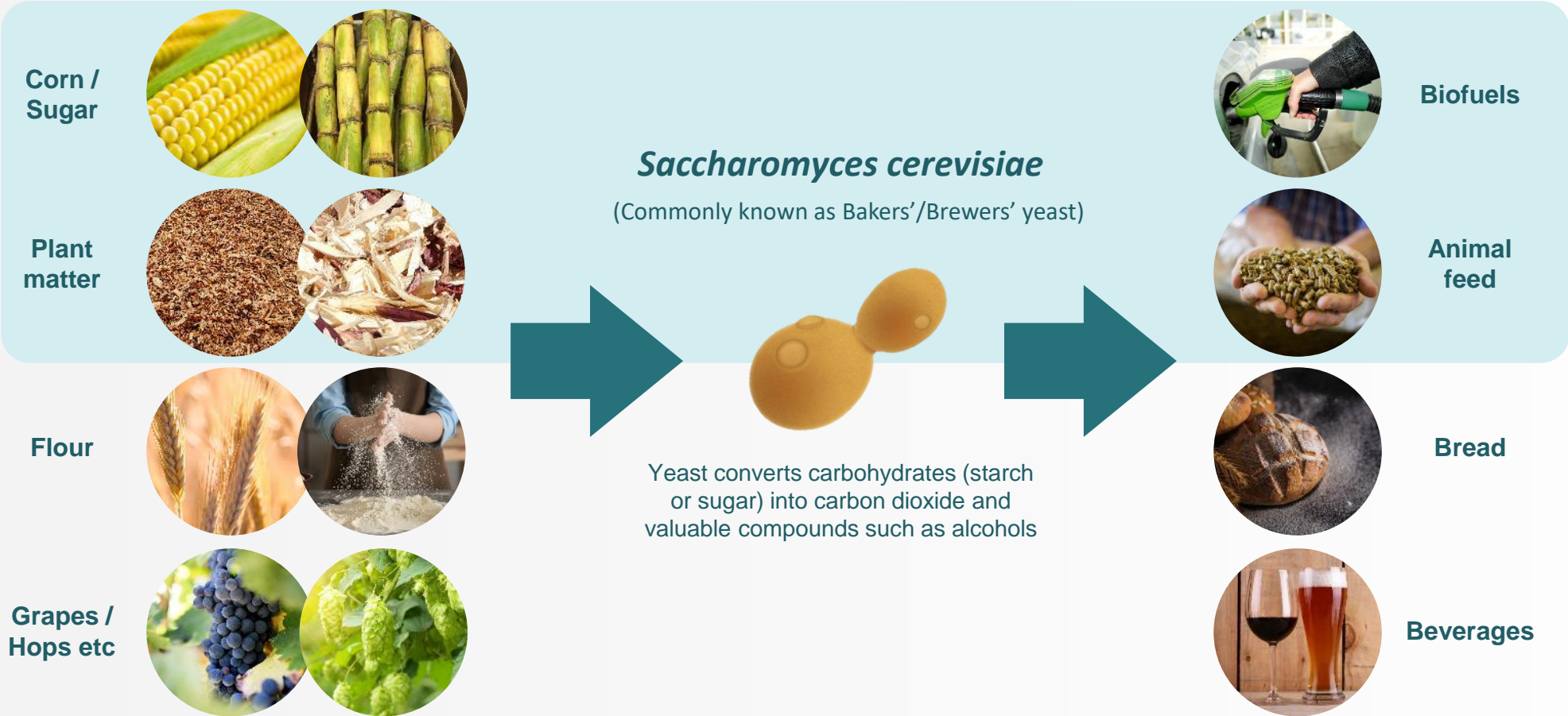
Fuels | Feed | Foods | Biochemicals

Unparalleled library of  
**Elite Yeast**  
**Genetics**

**65%**

Revenue Growth  
(4-year CAGR)




# MicroBioGen Leverages The World's Most Widely Used Microorganism



# Platform Technology Delivers Unmatched Industrial Performance

**Step 1:** Elite Genetics are developed and continuously improved over time

**Step 2:** Stacking enables characteristics to be selected and combined based on a customer's specific requirements

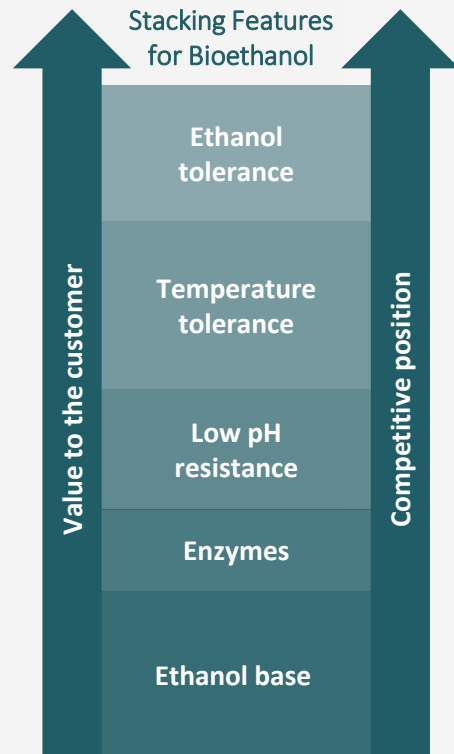
MicroBioGen's elite yeast genetic library - examples										
Application	Ethanol tolerance	Temperature tolerance	Acid resistance	Osmotic stress resistant	Low glycerol by-product	Produce enzymes non-GM	Convert xylose to ethanol	Grow on organic acids	High protein	Grow on glycerol
1G bioethanol <sup>1</sup>	✓	✓	✓		✓					
2G bioethanol <sup>2</sup>	✓	✓	✓	✓	✓		✓	✓	✓	✓
Feed yeast						✓		✓	✓	✓
Baking yeast			✓	✓		✓		✓		✓
Industrial Benefits		 <b>Robustness</b>		 <b>Optimisation</b>		 <b>Innovation / Agility</b>				

1. First-generation (1G) biofuels: Biofuels produced from food crops, e.g. corn or sugarcane

2. Second-generation (2G) biofuels: Biofuels produced from agricultural waste products, e.g. timber offcuts, crop residues or waste sugarcane pulp (bagasse)

# MicroBioGen/Novozymes Collaboration – Case Study

Through the incorporation of multiple unmatched improvements into bioethanol strains, efficiency and sustainability improved



MicroBioGen/Novozymes developed yeast (Innova®) is the leading bioethanol producer in North America - the world's largest bioethanol market

With **Innova yeasts** your plant can overcome operational barriers to profitability, efficiency and yield

- Exceptional ethanol yield improvement, lower glycerol
- Thrives in high solids fermentations
- Fermentation reliability on-par with the industry's most trusted yeast
- Flexible, broad operational application reduces organizational and fermentation stress
- Opportunity for urea cost savings

- Up to 3% more ethanol ✓
- Reduces stress and inputs ✓
- Breaks profitability hurdles ✓
- Eases operational demands ✓
- Increases conversion efficiency ✓

Market Segmentation: The Innova® Series of Yeasts						
Product	Launch date	High acid tolerance	Enzyme expressing	Non-GM	Faster	Higher yield
Innova® Drive	Feb-18	✓	✓		✓	
Innova® Lift	Oct-18	✓	✓			✓
Innova® Force	Jun-19	✓	✓		✓	✓
Innova® Fit	Feb-20			✓	✓	✓
Innova® Element	Jul-21	✓	✓		✓	✓
Innova® Quantum	Oct-21	✓	✓			✓
Innova® Apex	Jul-22	✓	✓		✓	✓
Innova® Turbo	Jul-22	✓	✓		✓	✓



# Ethanol As A Feedstock For Jet Fuel

- Global jet fuel consumption >360 billion liters (~80 billion gallons) per year
- To produce ~1 billion liters of SAF via ethanol-to-jet (ETJ) requires ~2 billion liters of ethanol
- Require ~700 billion liters of ethanol as feedstock for SAF per year
- Currently, global ethanol production is ~120 billion liters (31.7 billion gallons) per year

## Global ethanol production will have to be increased by almost 6 times to meet SAF demand

- How can we protect arable land and existing food crops?
- How will we feed a growing global population?



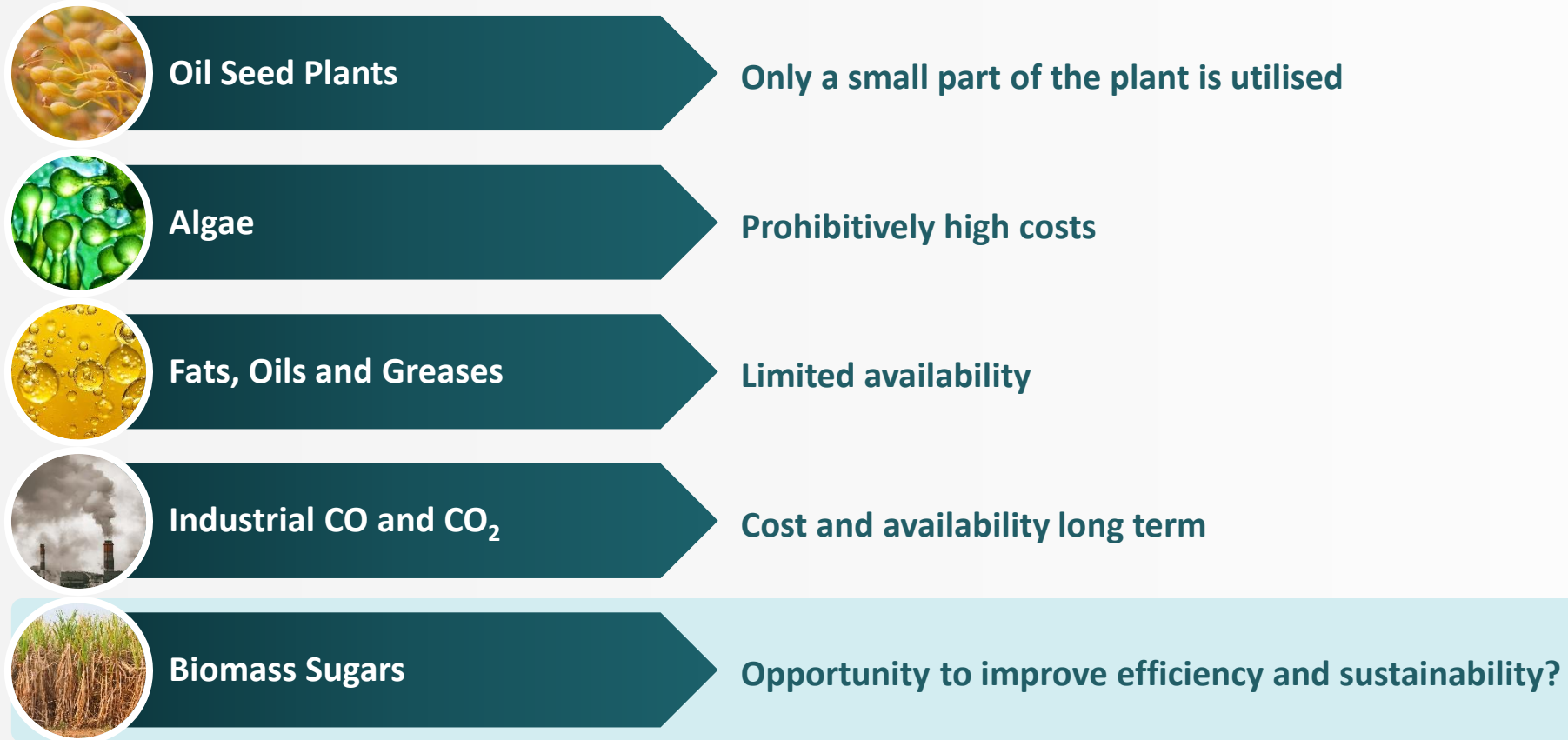


# Sugar-to-Jet: Leveraging MicroBioGen's Technology

Sustainably Converting Biomass Sugars → Alcohol → Jet Fuel

# Multiple Routes to Sustainable Aviation Fuel

There are multiple ways to produce SAF. All have different costs, substrate availability and sustainability credentials



# MicroBioGen Yeast Maximise Usage of Biomass Sugars

Improving the conversion of biomass sugars to ethanol for alcohol-to-jet (ATJ) presents multiple advantages

## Key Advantages: Improved Conversion of Biomass Sugars → Alcohol → Jet Fuel

- |                             |   |
|-----------------------------|---|
| <b>1. Availability</b>      | Most available biomass sources are sugar based                    |
| <b>2. Single molecule</b>   | Ethanol is a single molecule - simplifying process                |
| <b>3. Efficiency</b>        | >90% energy conversion efficiency from sugar to ethanol           |
| <b>4. Waste-to-food</b>     | Can upgrade side streams to high value food/feed                  |
| <b>5. Negative CI score</b> | Through CO <sub>2</sub> sequestration, negative CI score possible |

MicroBioGen's technology presents a number of significant opportunities to improve the efficiency and sustainability of ethanol production.



*“Saccharomyces”*  
*“sugar-fungus”*  
(Latinized Greek)

*“cerevisiae”*  
*“of beer”*  
(Latin)

# Sugarcane: Leading Candidate for Alcohol-to-Jet

## Using Sugar Cane as Substrate for Sustainable Ethanol Production

### Advantages

- Sugarcane biomass yield = high
- ~50% sugarcane biomass = readily available sugars
- Compelling CI score vs starch ethanol
- Waste streams - potential revenue opportunity?

### Disadvantages

- Processes could be more efficient
- Vinasse not valorised
- Fermentation efficiency declines over the season
- Production costs are high

**Bagasse** = Dry pulpy fibrous material that remains after extracting sugar juices from crushed sugar cane

**Vinasse** = Vinasse is the liquid waste that remains after distilling ethanol from sugar juices or molasses

# Achieving Maximum Conversion Efficiency and Sustainability

MicroBioGen's yeast innovation has application in both 1G and 2G ethanol plants

## MicroBioGen's Advanced Fermentation Technology Breakthroughs

#1	Yeast that can grow at industrial rates on vinasse	1G & 2G
#2	Faster and higher yielding yeast	1G
#3	Stacking a single yeast with #1 and #2 (in progress)	1G
#4	Optimised GM yeast* that can convert biomass sugars (C6 and C5) to ethanol	2G

\*In collaboration with Novozymes

**Bioethanol is classified based on the type of feedstocks used**

**1G (First-generation ethanol)**

Feedstocks = Food crops

E.G. CORN | SUGARCANE | BEET MOLASSES

**2G (Second-generation ethanol)**

Feedstocks = Non-food biomass

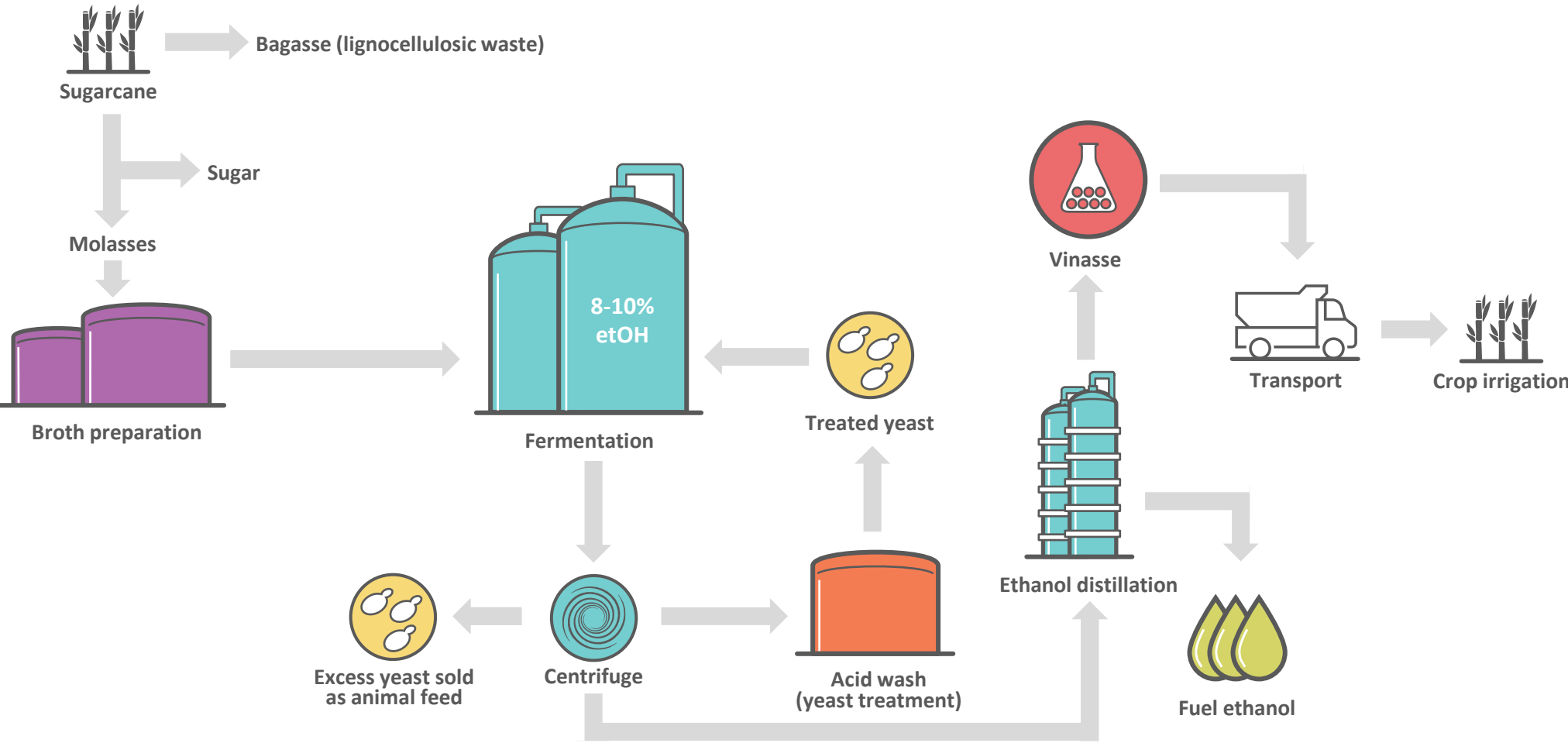
E.G. AGRICULTURAL AND FORESTRY RESIDUES |  
DEDICATED ENERGY CROPS | BAGASSE



# Advanced Fermentation Technology for 1G Ethanol

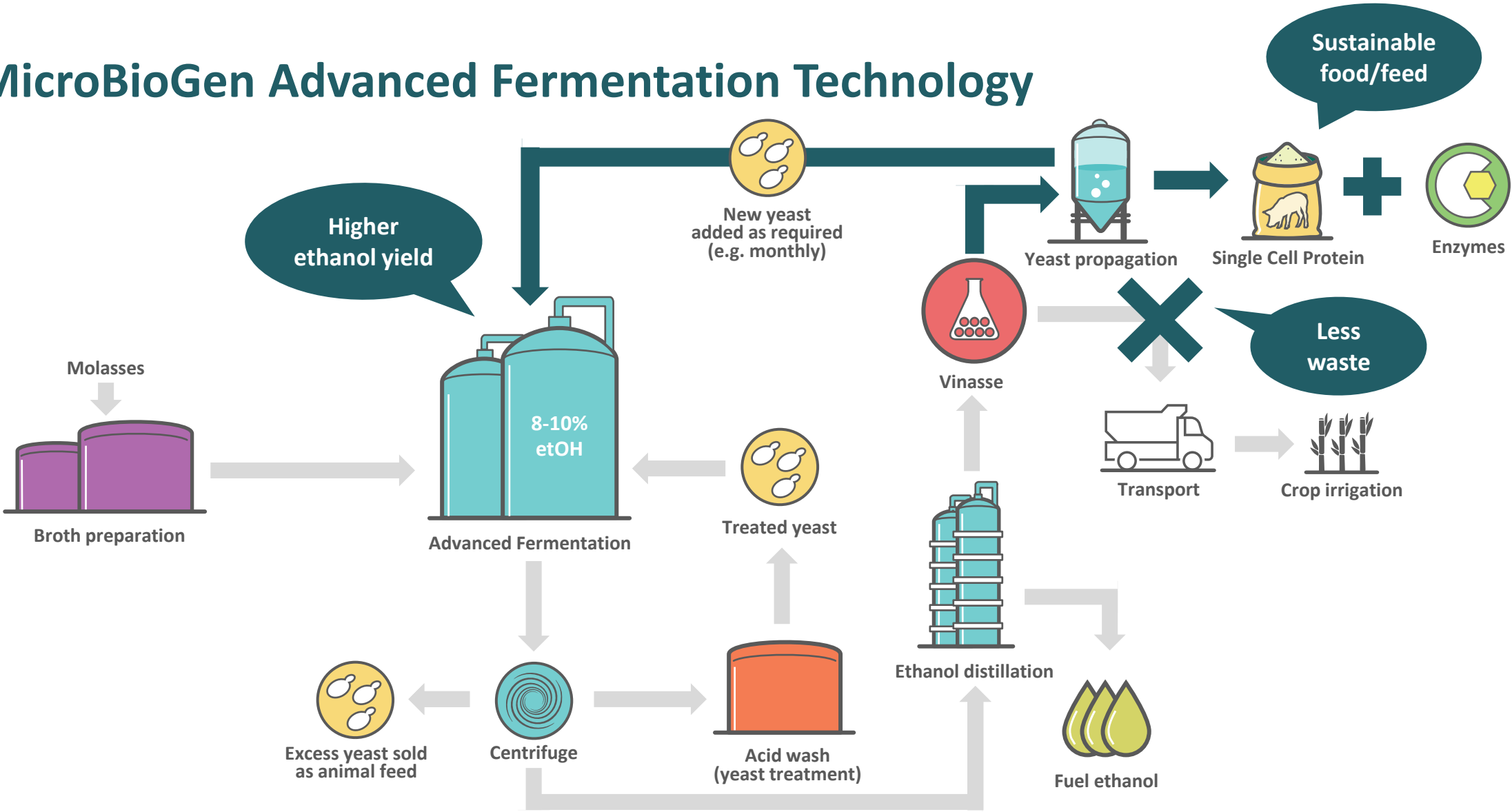
Key benefits for 1G sugarcane ethanol plants

# Industry Standard 1G Sugarcane Ethanol Plant

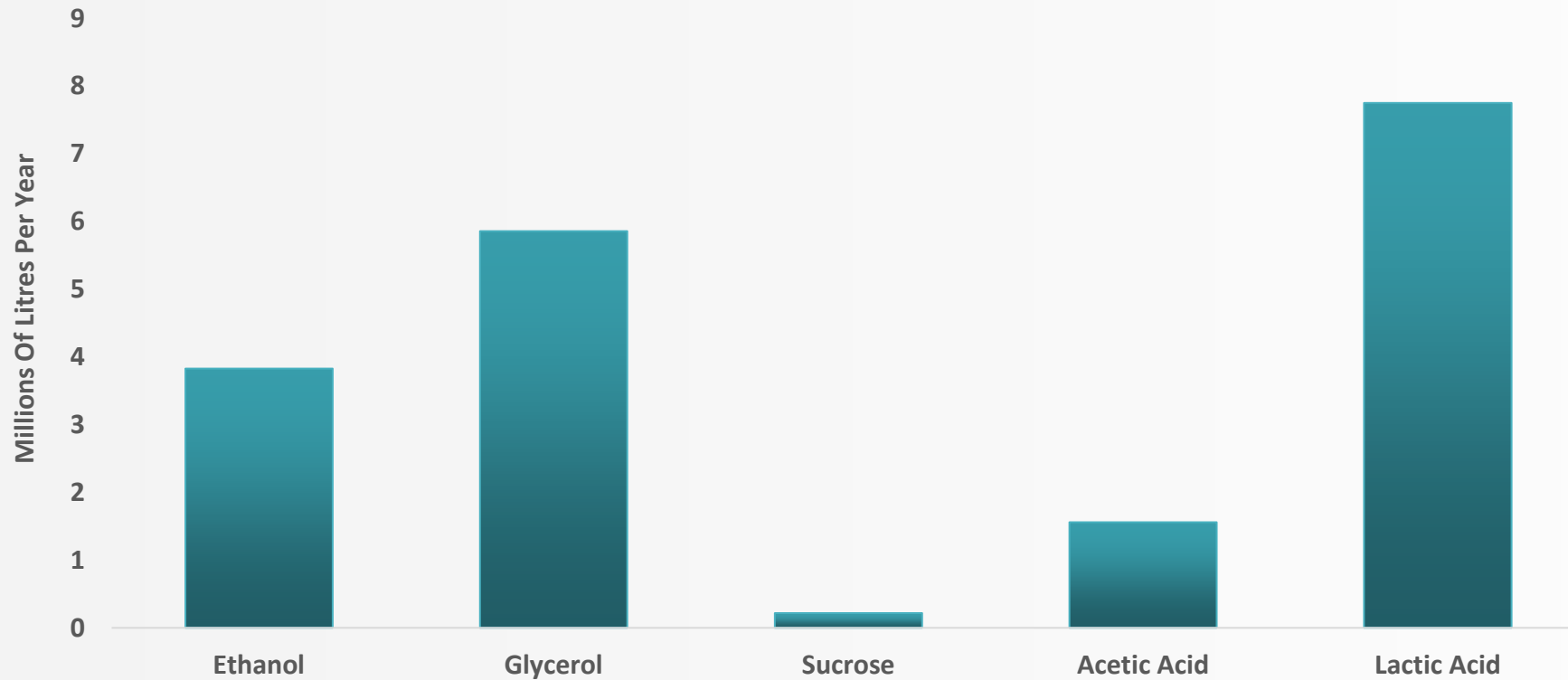




# MicroBioGen Advanced Fermentation Technology



# Typical Utilisable Carbon in Vinasse – 100ML/year Plant (Brazil)

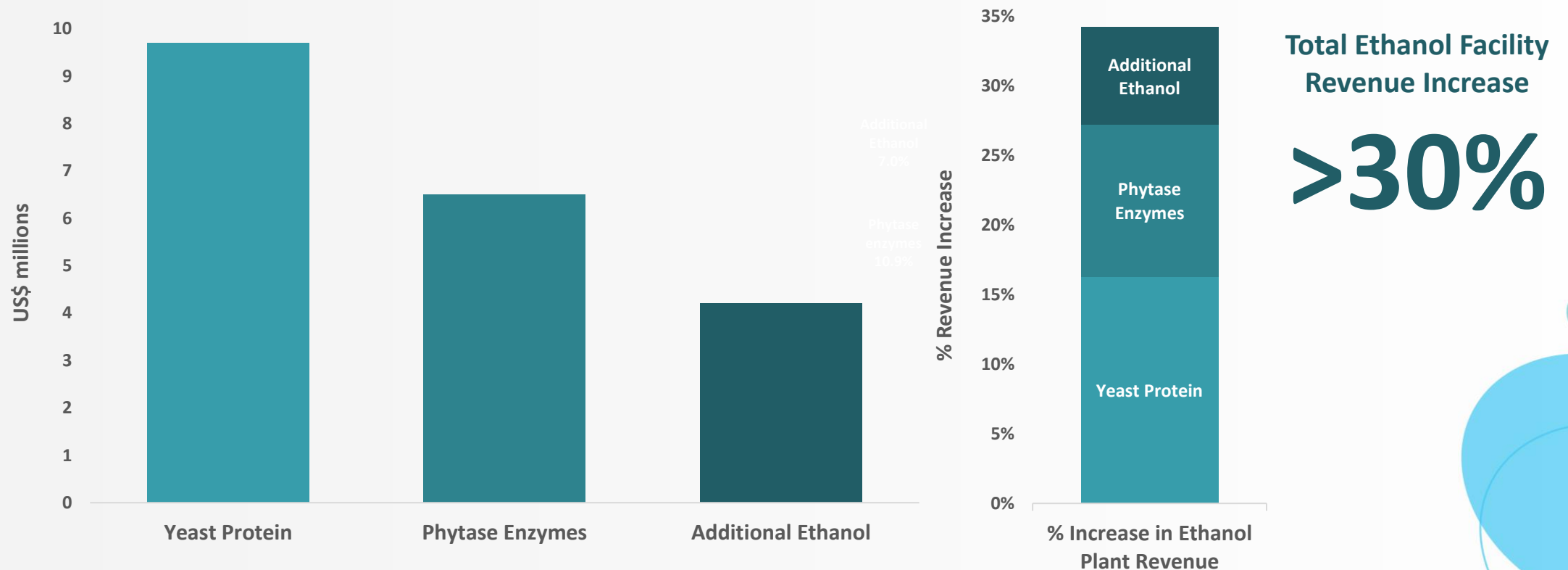


Data based on Reis and Hu: University of Minnesota 2017

# Significant Value-Add & Revenue Diversification Opportunity (1G)

Estimated value for upgrading vinasse to protein and phytase enzymes

In a 100 million L/year ethanol facility – just over 8,000 t of yeast produced



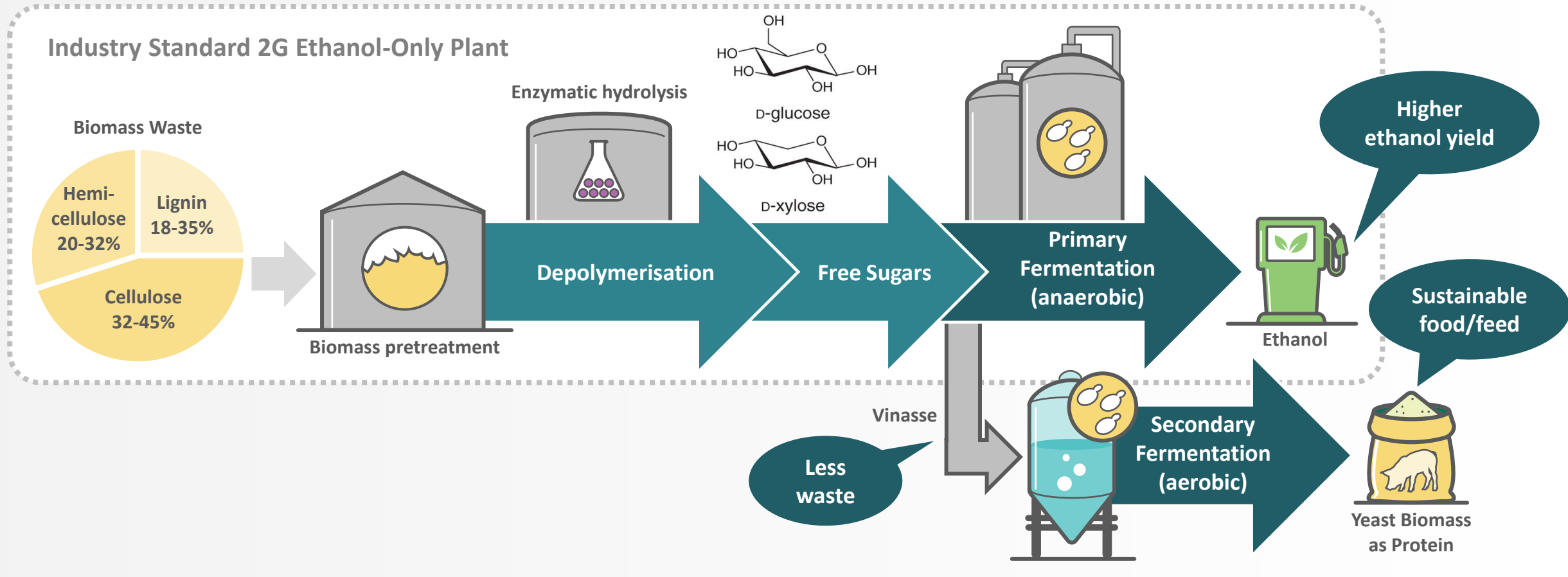


# Advanced Fermentation Technology for 2G Ethanol

Key benefits for 2G sugarcane ethanol plants

# MicroBioGen Technology for an Integrated 2G Food and Fuel Refinery

More Ethanol, Food/Feed and Materially Less Waste



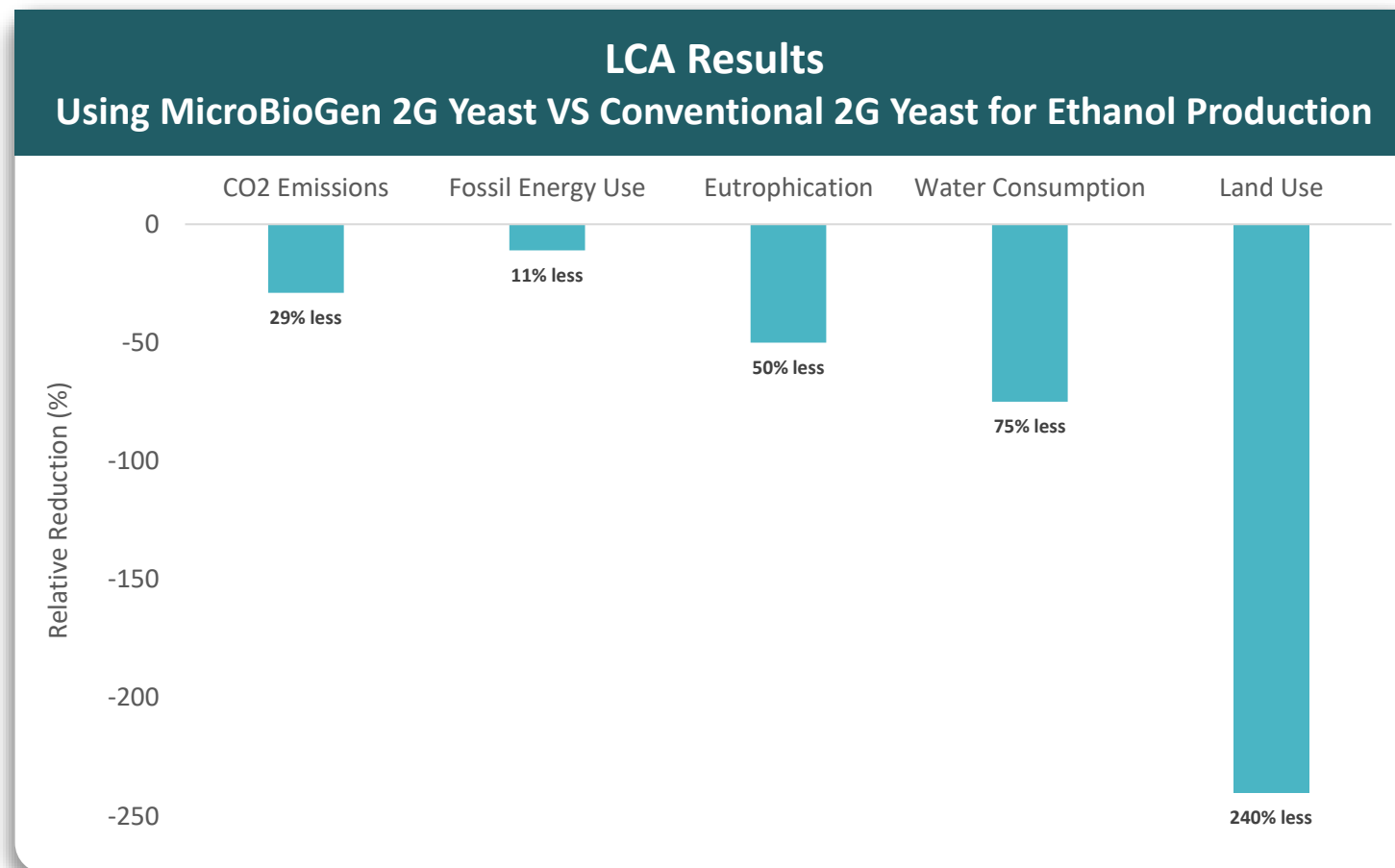
# How MicroBioGen Yeast is Optimising 2G Fuel and Feed Biorefineries

- 15-year R&D project
- Recently completed A\$8M optimization
- Collaboration with Novozymes, half-funded by Australia's Federal Government

## Outcomes

An independent, peer-reviewed Life Cycle Analysis (LCA) indicated significant ESG benefits could be achieved across several key measures

LCA Report: [https://microbiogen.com/wp-content/uploads/2021/07/Lifecycles\\_Microbiogen\\_ProofofConcept\\_final\\_for-public-release-1.pdf](https://microbiogen.com/wp-content/uploads/2021/07/Lifecycles_Microbiogen_ProofofConcept_final_for-public-release-1.pdf)



# Global SAF Industry Opportunity

MicroBioGen's advanced fermentation technology significantly improves the **sustainability, efficiency & economics** of SAF by improving the conversion of biomass-to-alcohol for alcohol-to-jet

- 1 SAF is the future fuel for the aviation industry globally
- 2 How can SAF be produced more economically and sustainably?
- 3 MicroBioGen's yeast is key to ethanol production efficiency
- 4 MicroBioGen expects strong growth in 2G ethanol plants globally to meet emerging SAF demand
- 5 The future for SAF requires fully integrated ethanol plants that deliver fuel as well as feed/food solutions





# Thank You

**An Grobler**

Business Development

[an.grobler@microbiogen.com](mailto:an.grobler@microbiogen.com)



**MicroBioGen Laboratories**

Level 4, 78 Waterloo Road, Macquarie Park  
New South Wales, AUSTRALIA, 2113  
Tel: +61 2 9418 3182



[www.microbiogen.com](http://www.microbiogen.com)