

A wide-angle photograph of a lush green field, likely a crop field, under a soft, hazy sunset sky. The plants are tall and dense, filling the foreground and middle ground. In the background, a line of trees is visible against the horizon. The overall mood is serene and natural.

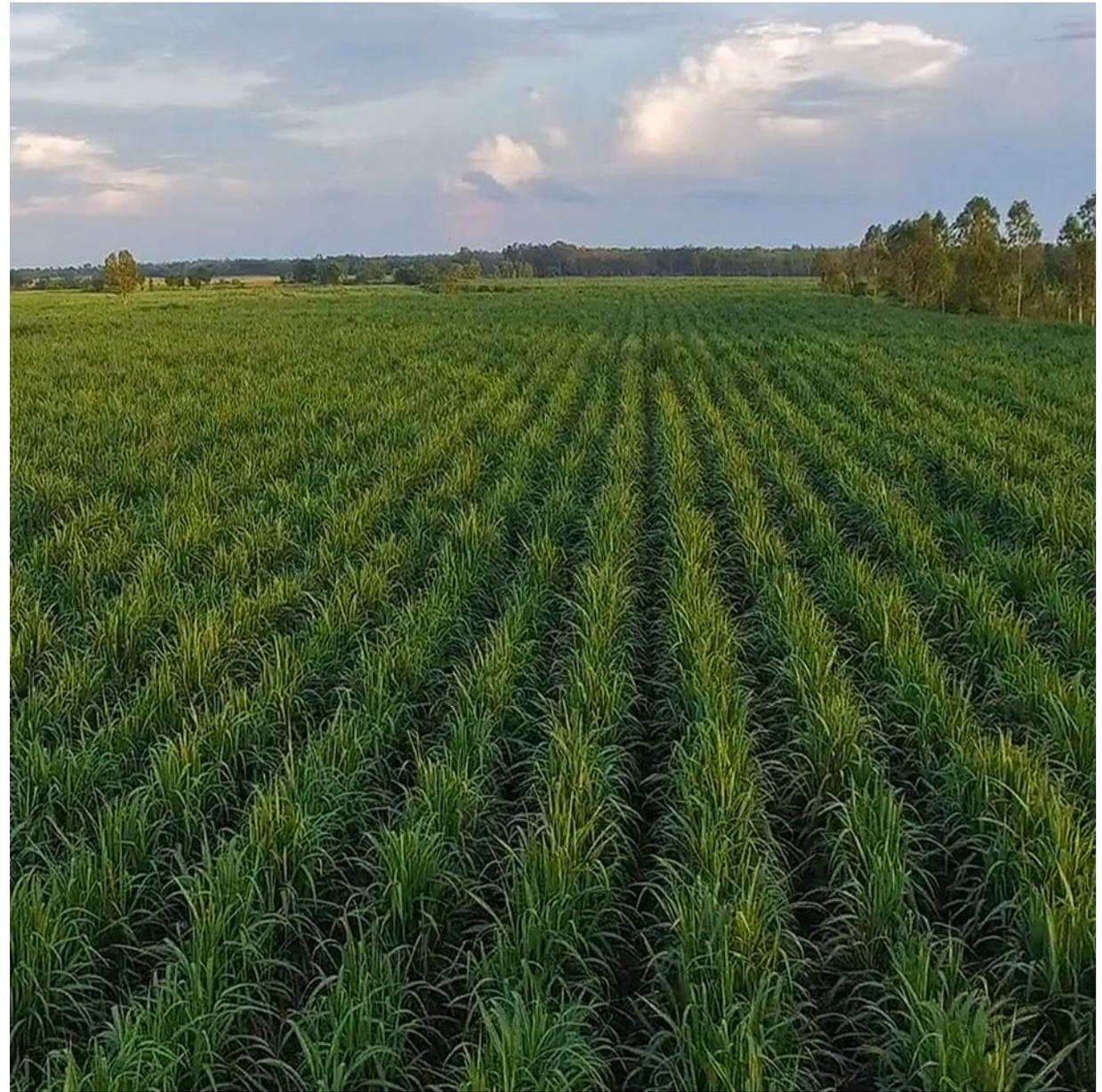
Why Not?

**Replacing Plastic Labware With
a 100% Plant-Based Alternative**

Gregory Kwak
Vice President, Business & Product Development
Diversified Biotech, Inc.

LEARNING OBJECTIVES

- Discuss the material and feedstock choice.
- Identify the challenges manufacturing and introducing plant-based labware.
- Analyze comparative cell culture data between plant-based and petrochemical labware.
- Understand the environmental and social advantages of switching to a plant-based material.
- Evaluate the future scalability of plant-based labware from a sustainability perspective.



BOLD SUSTAINABILITY

You've got to jump off the cliff all the time and build your wings on the way down.

– *Ray Bradbury*

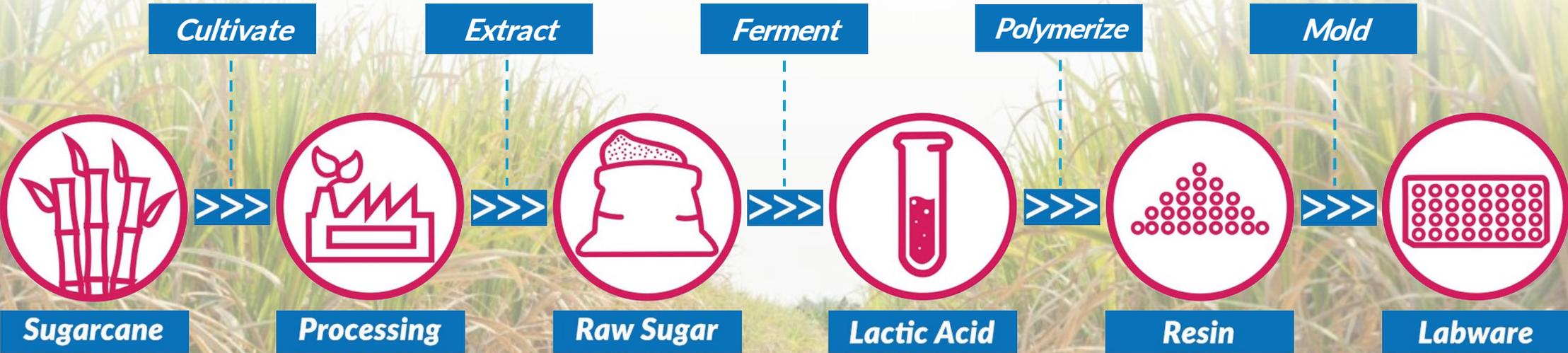
The truth of the matter is that you always know the right thing to do. The hard part is doing it. – *Gen. Norman Schwarzkopf*

Management is doing things right. Leadership is doing the right thing. – *Peter Drucker*

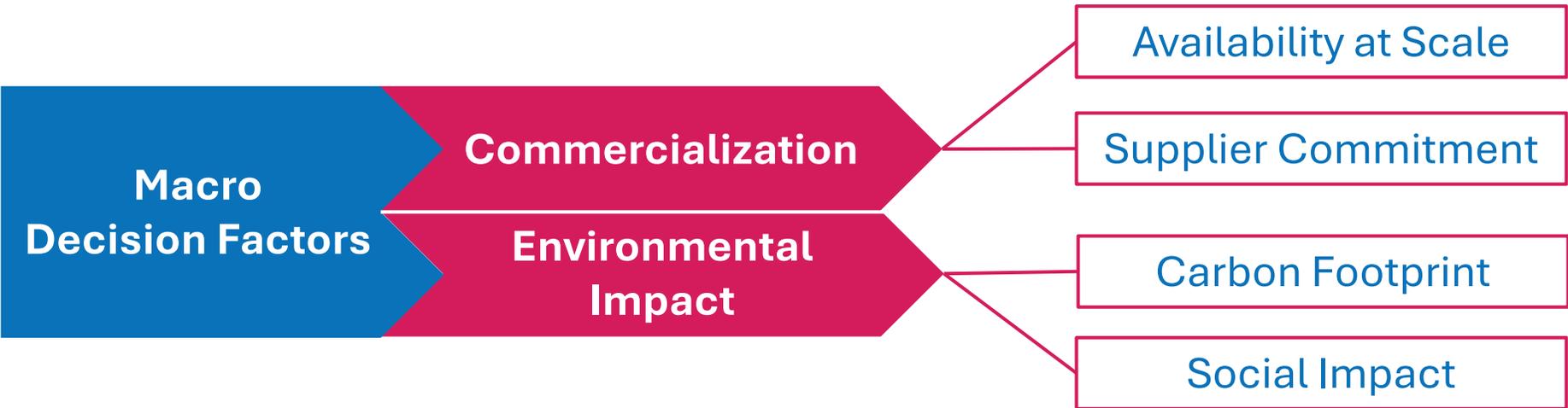
Boldly going where hundreds have gone before does not make headlines.

– *Neil deGrasse Tyson*

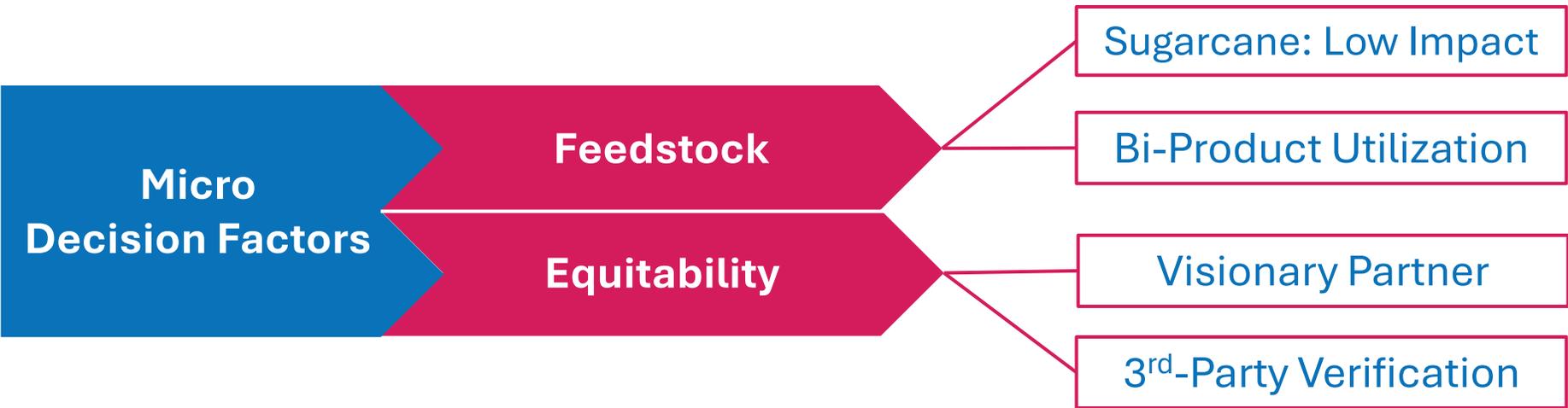
CHOOSING PLA (POLYLACTIC ACID)



CHOOSING PLA (POLYLACTIC ACID)



CHOOSING PLA (POLYLACTIC ACID)



CHALLENGE: MANUFACTURING

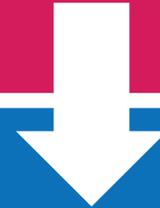
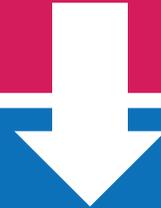
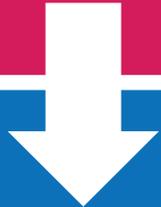


Challenges

25x higher moisture absorption
Issue: Clarity

2x more difficult mold removal
Issue: Flatness

Low melting point
Issue: Temperature Resistance



Implement advanced drying to
control relative humidity

Advanced tooling redesign
based on challenge

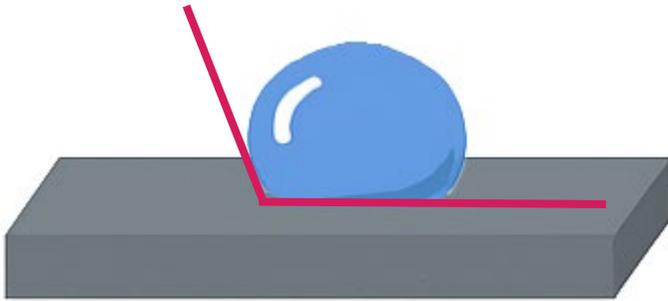
Manufacturing process
development & maximize
irradiation benefit

Solutions



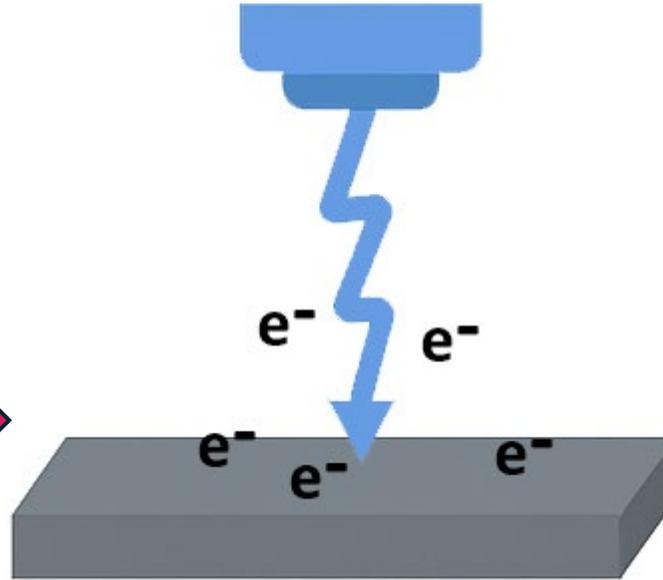
ENHANCEMENT: INCREASED WETTABILITY

Untreated PLA



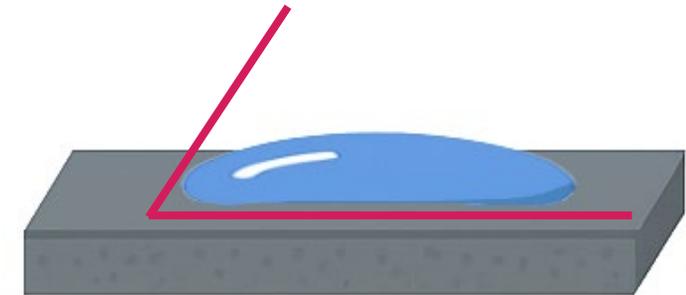
Untreated surface is dominated by nonpolar methyl and ester groups with low surface energy.

E-Beam Exposure



High energy electrons generate free radicals, creating polar groups and increasing surface energy

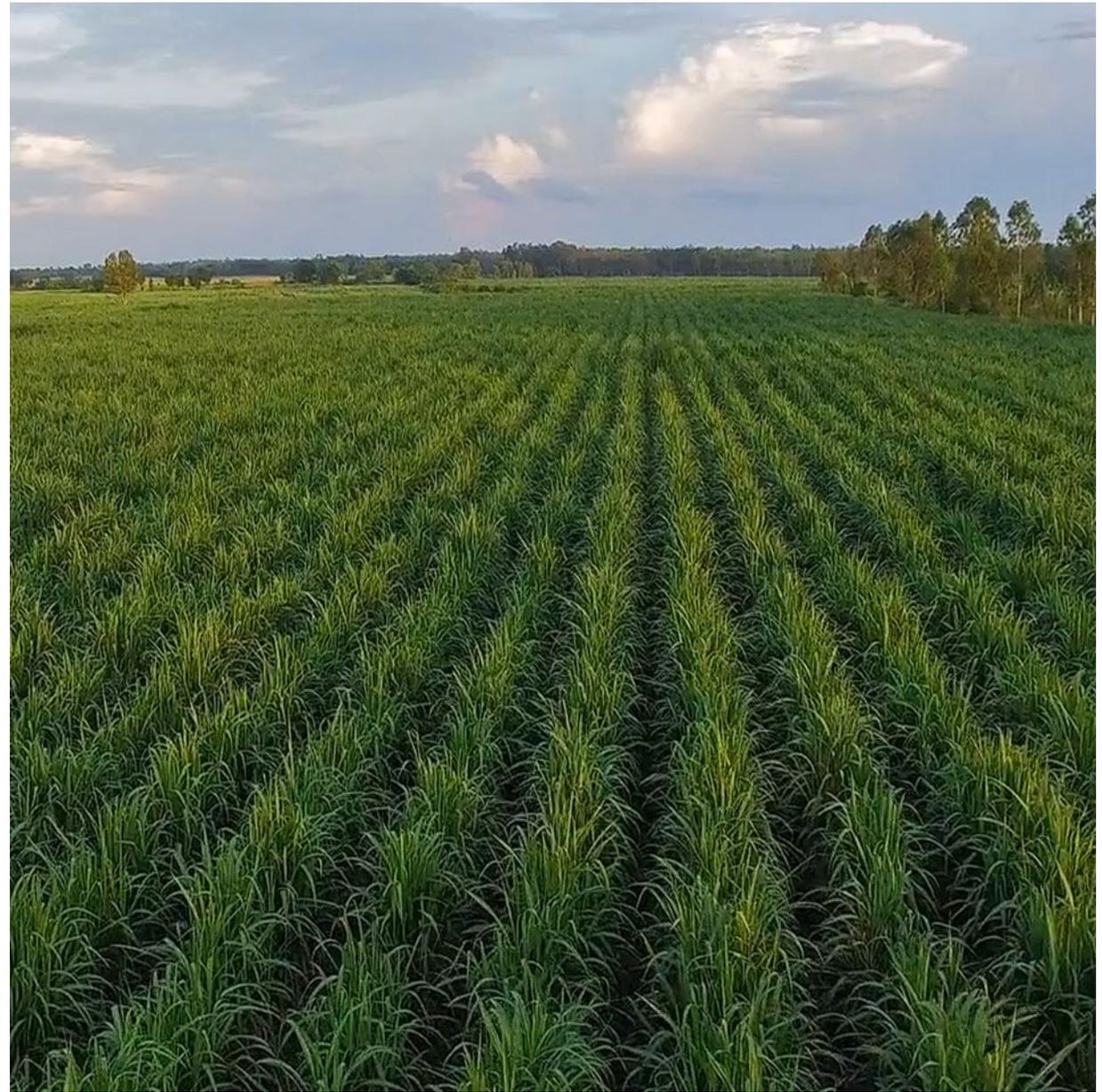
E-Beam Treated PLA



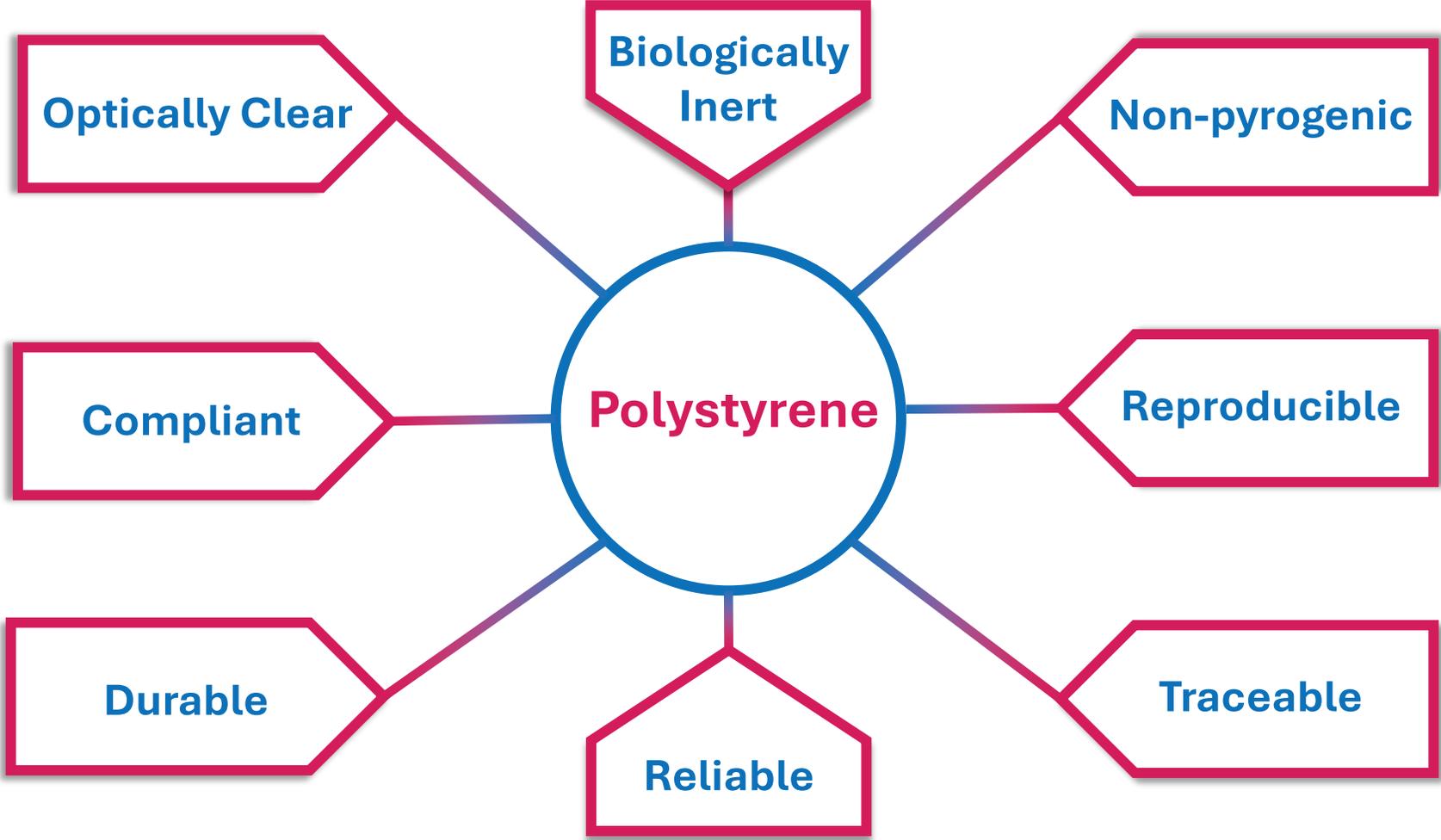
Treated surface is contains polar hydroxyl and carboxyl groups, raising surface energy and increasing adhesion.

CHALLENGE: USER ACCEPTANCE

Researchers are at the front of the line when it comes to sustainability, but the back of the line when it comes to flexibility – *Me*



CHALLENGE: USER ACCEPTANCE



CHALLENGE: USER ACCEPTANCE

Sustainability becomes irrelevant if it leads to bad science or compromised data – *Also Me*

Inserm



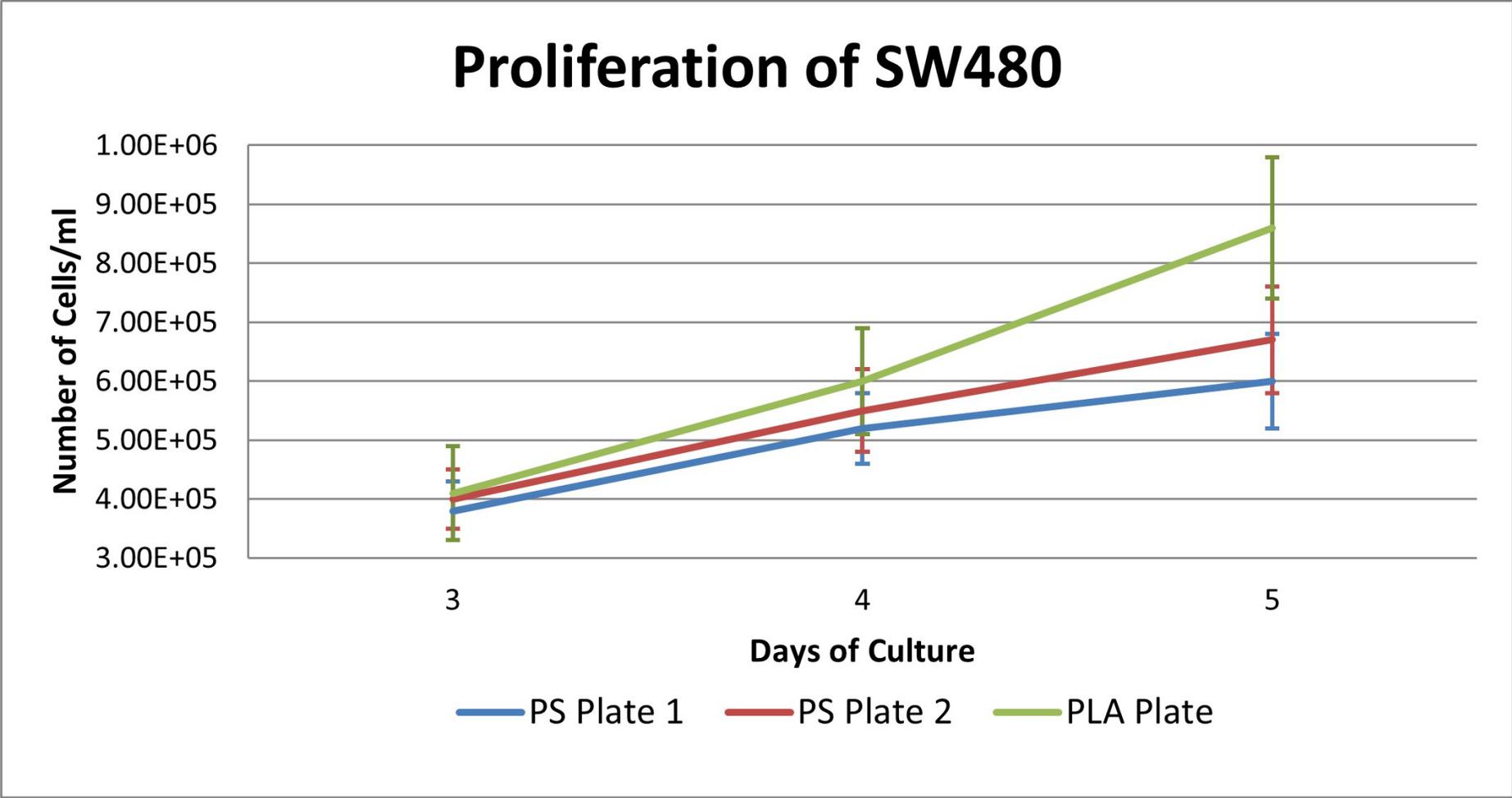
La science pour la santé _____
_____ From science to health



COMPARATIVE PERFORMANCE

Inserm

La science pour la santé
From science to health

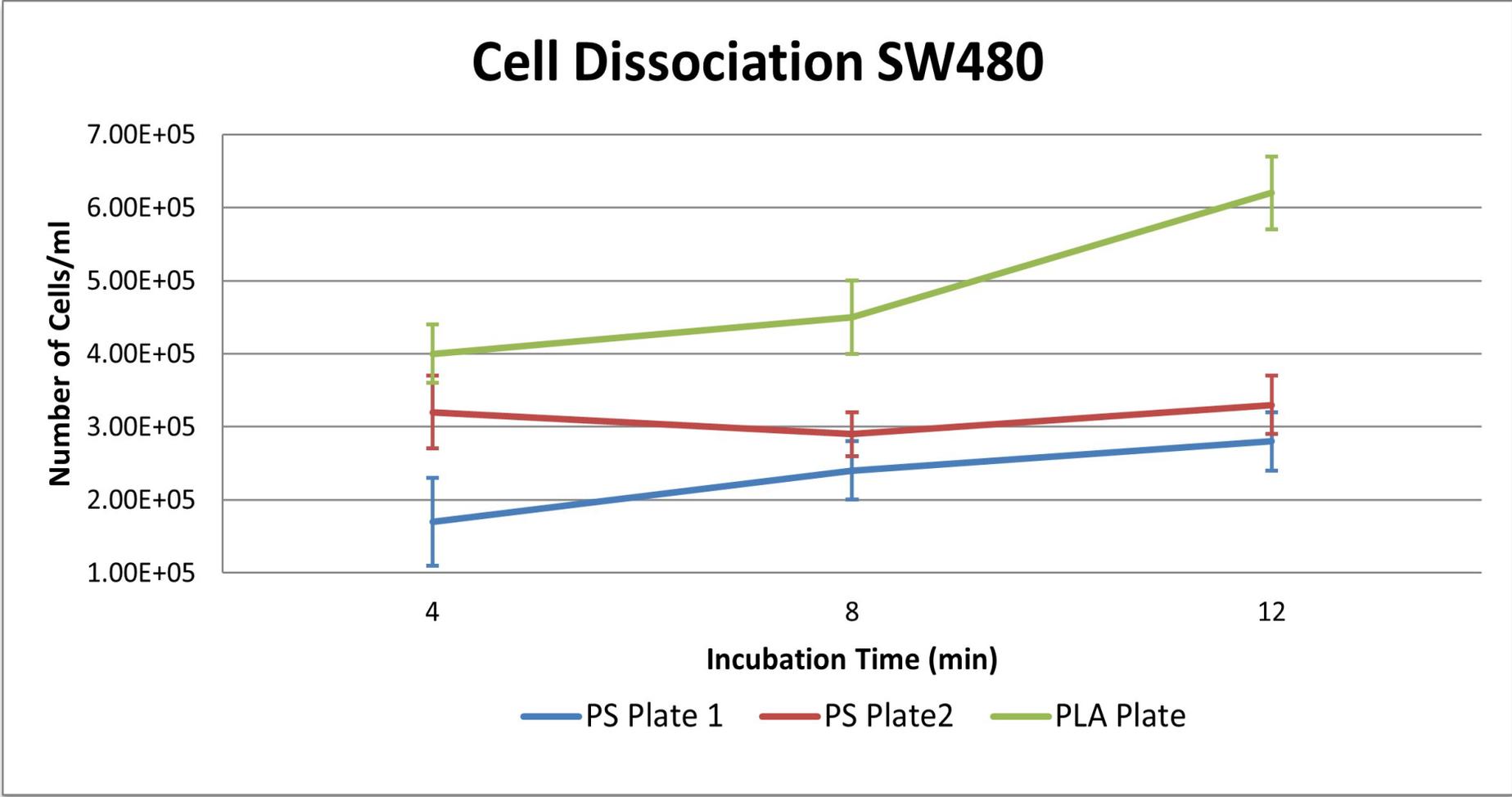


Proliferation values derived from total protein quantification using Sulforhodamine B (SRB) staining

COMPARATIVE PERFORMANCE

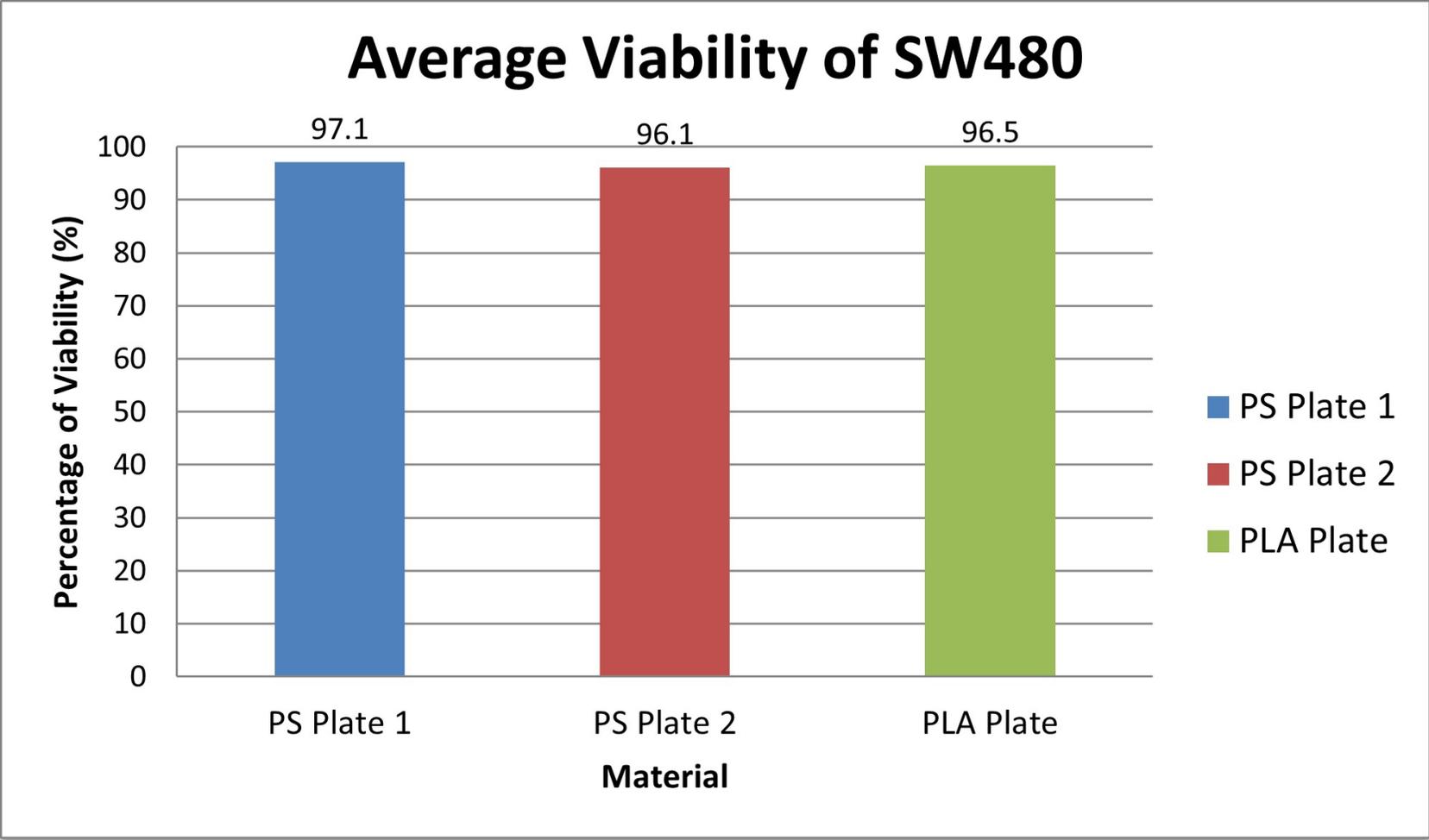
Inserm

La science pour la santé
From science to health



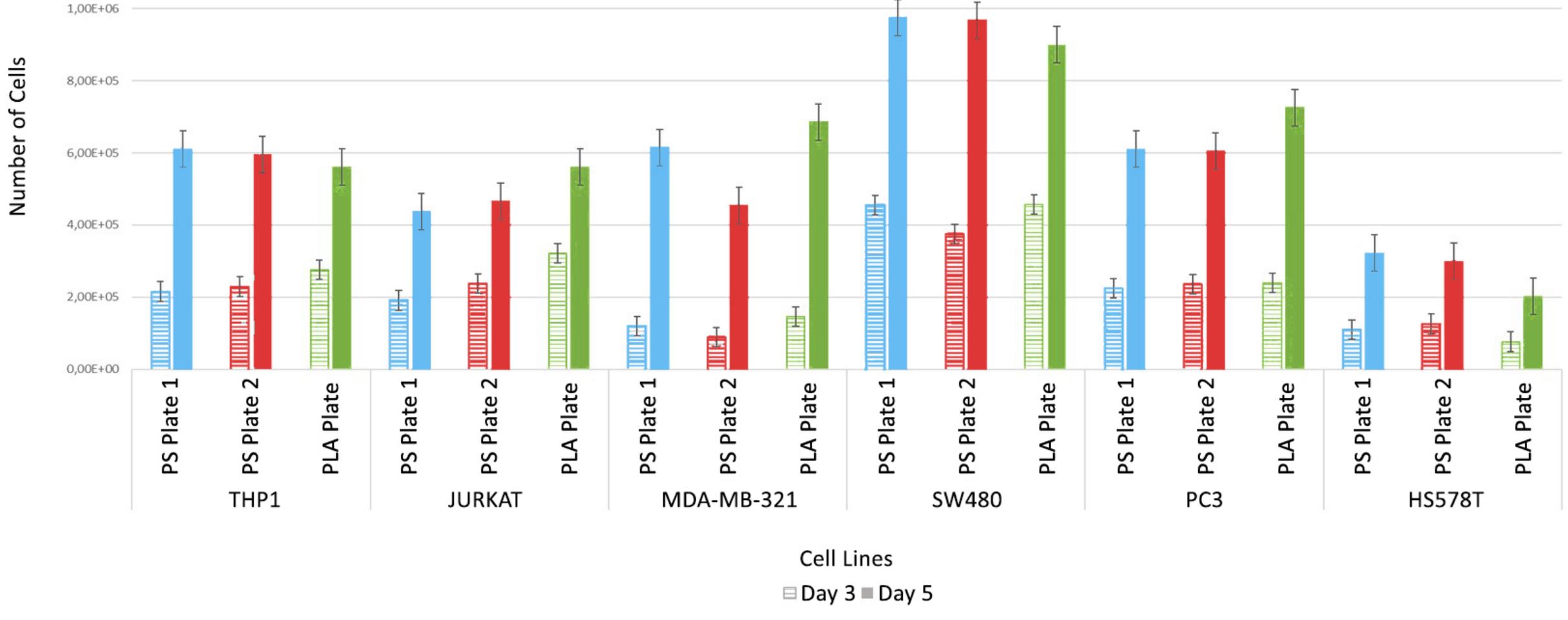
Inserm

La science pour la santé
From science to health



COMPARATIVE PERFORMANCE

Cell Proliferation



ADVANTAGES: PRACTICAL



Emissions Reduction

Manufacturing PLA produces **90%** fewer cradle-to-gate emissions compared to PS



Equitability Shift

Petroleum: No standardized social sustainability certification

PLA: 3rd-party certified via BonSucro



Fossil Fuel Independence

Every ton of PLA cuts petroleum demand and lessens environmentally destructive exploration and recovery

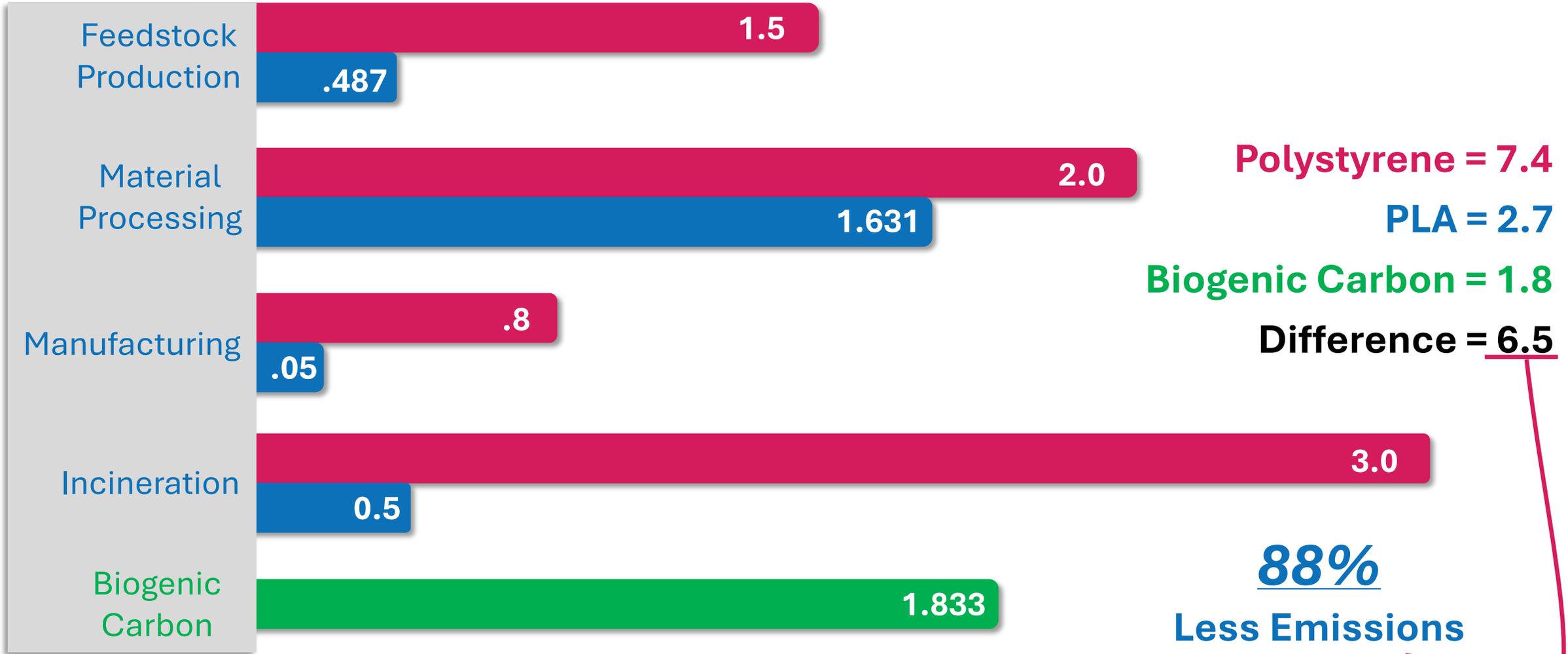


Reduced Marine Impact

Seismic surveys create intense underwater noise, harming marine life, disrupting behaviors, and damaging habitats

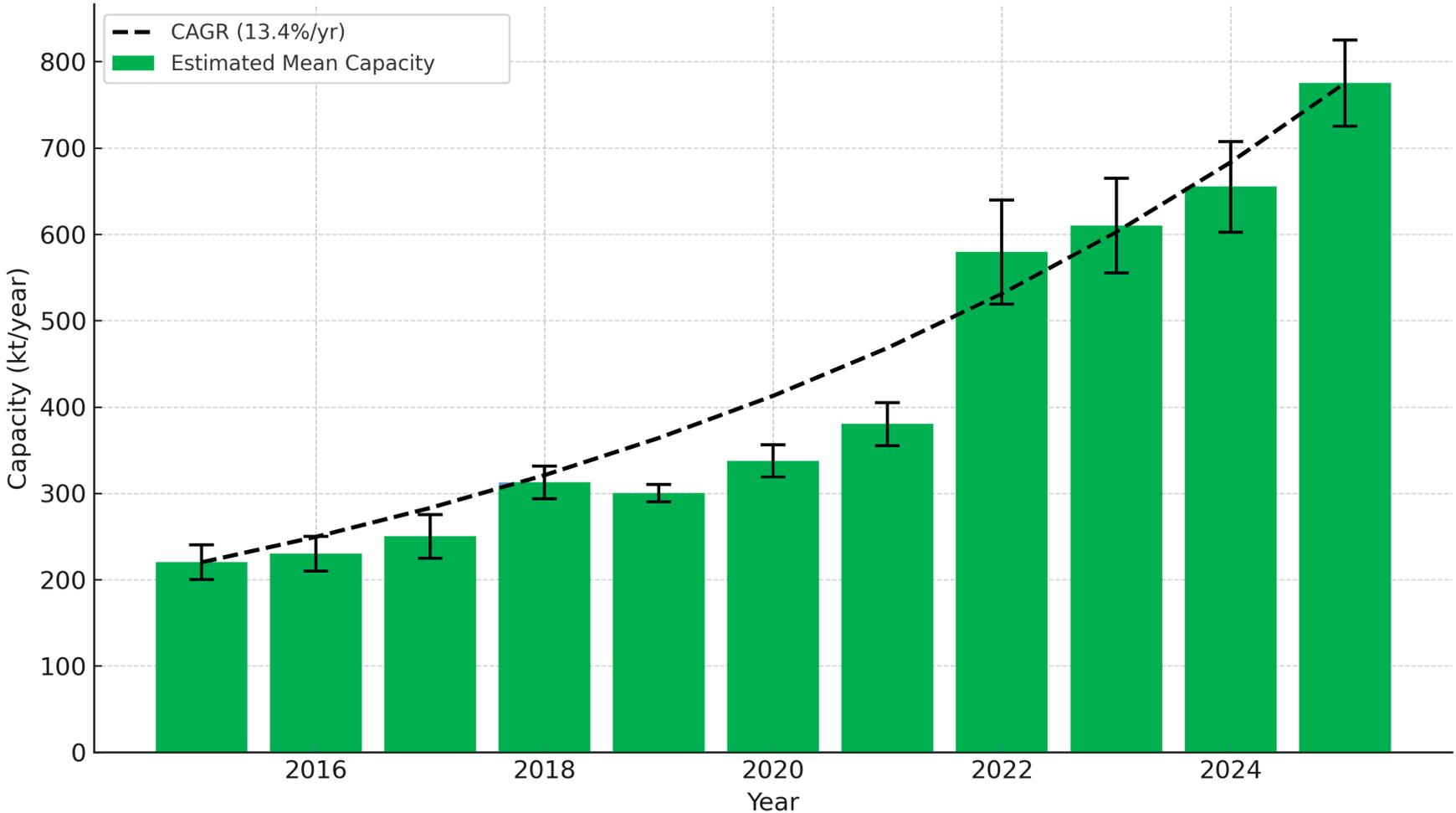
ADVANTAGES: INCINERATION

Life Cycle GHG Emissions Comparison (kg CO₂e per kg of material)



SUSTAINABLY SCALABLE: MATERIAL INNOVATION

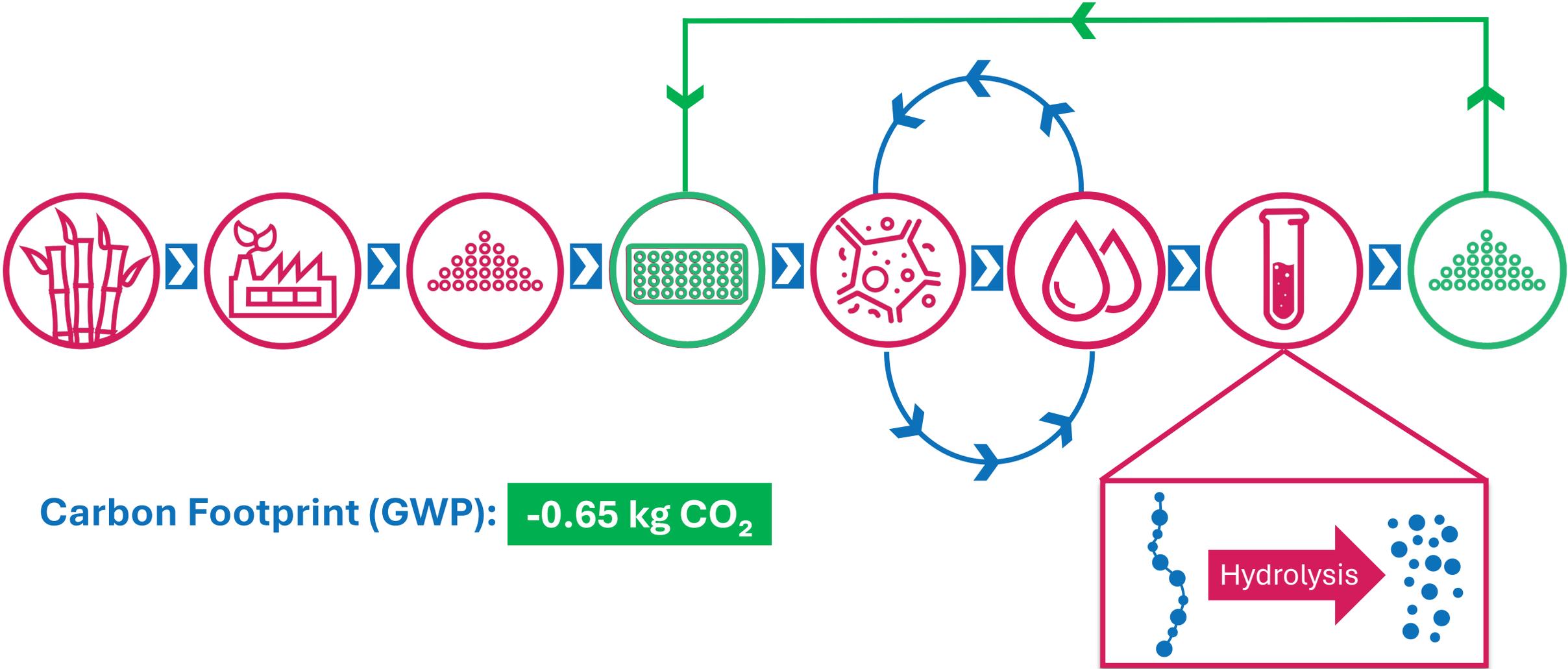
Global PLA Resin Production Capacity (2015-2025)



Emerging Sectors

- Specialty compounding
- Barrier coatings
- Sorting technology
- Re-processing
- Post-processing

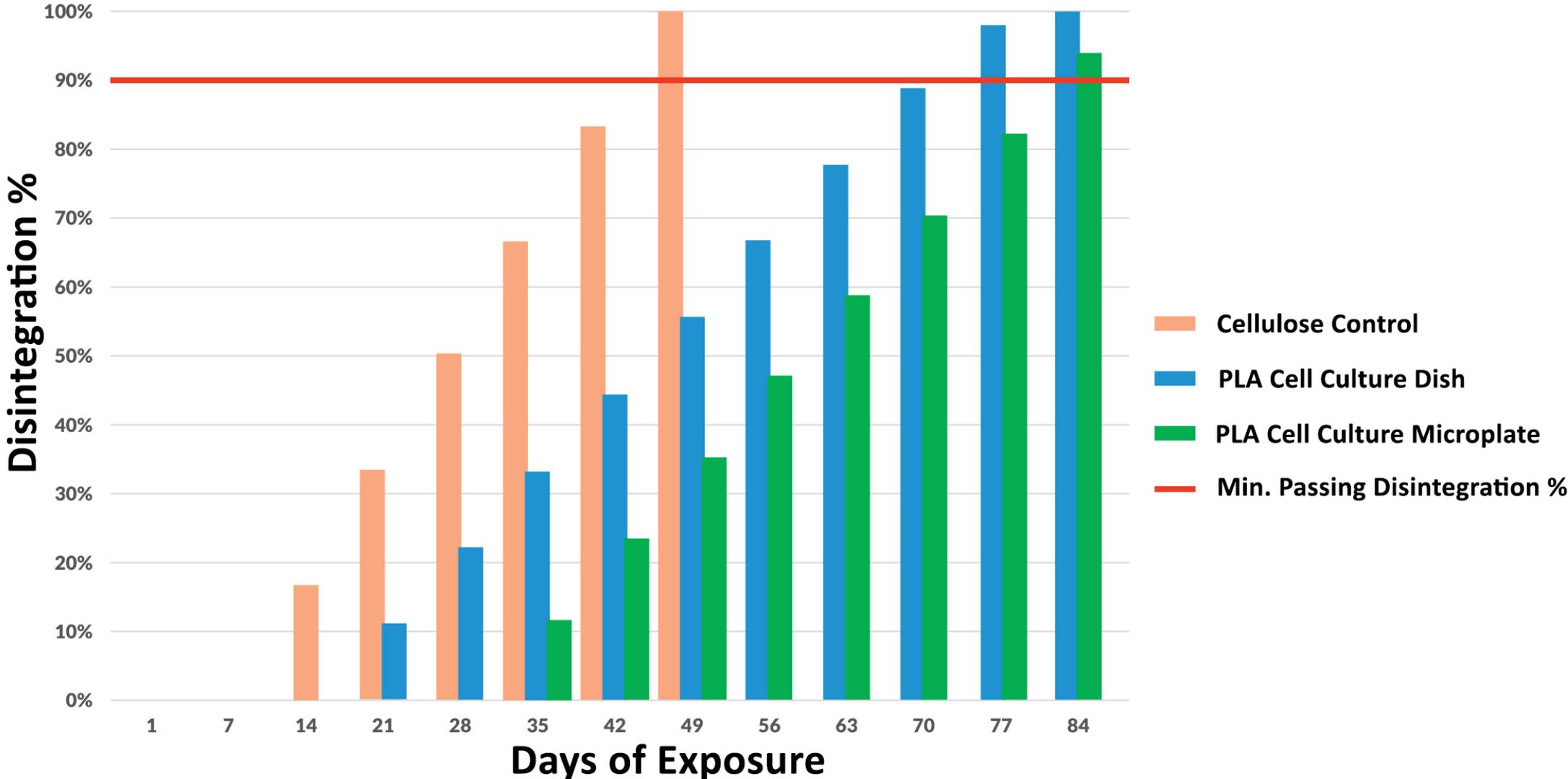
SUSTAINABLY SCALABLE: CIRCULARITY



Carbon Footprint (GWP): **-0.65 kg CO₂**

SUSTAINABLY SCALABLE: COMPOSTABILITY

ASTM D6400 Disintegration Analysis



SUSTAINABLY SCALABLE: CERTIFICATION & TRANSPARENCY

ACT. The Environmental Impact Factor Label

Diversified Biotech Planet-Safe® 96-well, Flat Bottom Cell Culture Microplates

Albany, Oregon, United States
SKU PLATE-1000

Environmental Impact Scale
Decreasing Environmental Impact

Manufacturing

- Manufacturing Impact Reduction: 1.0
- Renewable Energy Use: No
- Responsible Chemical Management: 1.0
- Shipping Impact: 1.0
- Product Content: 1.0
- Packaging Content: 5.0

User Impact

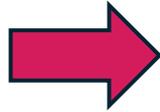
- Energy Consumption (kWh/day): N/A
- Water Consumption (gallons/day): N/A
- Product Lifetime: 10.0

End of Life

- Packaging: 5.2
- Product: 2.0

Environmental Impact Factor: 26.2
Label Valid Through: May 2026

act.mygreenlab.org



ACT Ecolabel

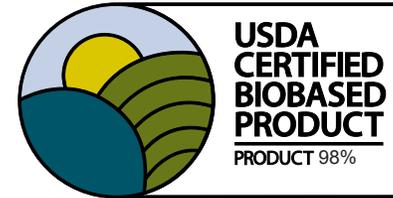
Environmental Performance

Product	Recycled/Renewable Content: 30%	Chemicals of Concern: Yes	Electricity Consumed/Day: 5 kWh	Water Consumed/Day: N/A	Refrigerant GWP: N/A	Supported Lifetime: 7 years	Recyclable Materials*: 40%	Circularity Support: Refurbishing Programs
Manufacturing Facility	Best Practices: 3/10	Renewable Electricity: 80%	Renewable Energy: 40%					
Company GHG Reductions	Scope 1/2/3 Tracking: Yes/Yes/Yes	Near-Term Target: Yes	Net-Zero Target: No					
Improvements	Increased Renewable Energy	Increased Recycled Content (Packaging)	Scope 3 Tracking					
Product Carbon Reporting	Reporting Framework: ISO 14067	Review: Third-party	Product CO ₂ e*: 1445 kg					
Audit Details	Third-Party Reviewer: Auditor *See Definitions							

Environmental Performance Factor: 54
Certified Month Year

my green lab.

ACT VERSION 2.0 | ACTDatabase.mygreenlab.org/company | act.mygreenlab.org



100% RECYCLED CONTENT
POST-CONSUMER/PRE-CONSUMER
MASS BALANCE ALLOCATION



30% RECYCLED CONTENT
POST-CONSUMER/PRE-CONSUMER
MASS BALANCE ALLOCATION

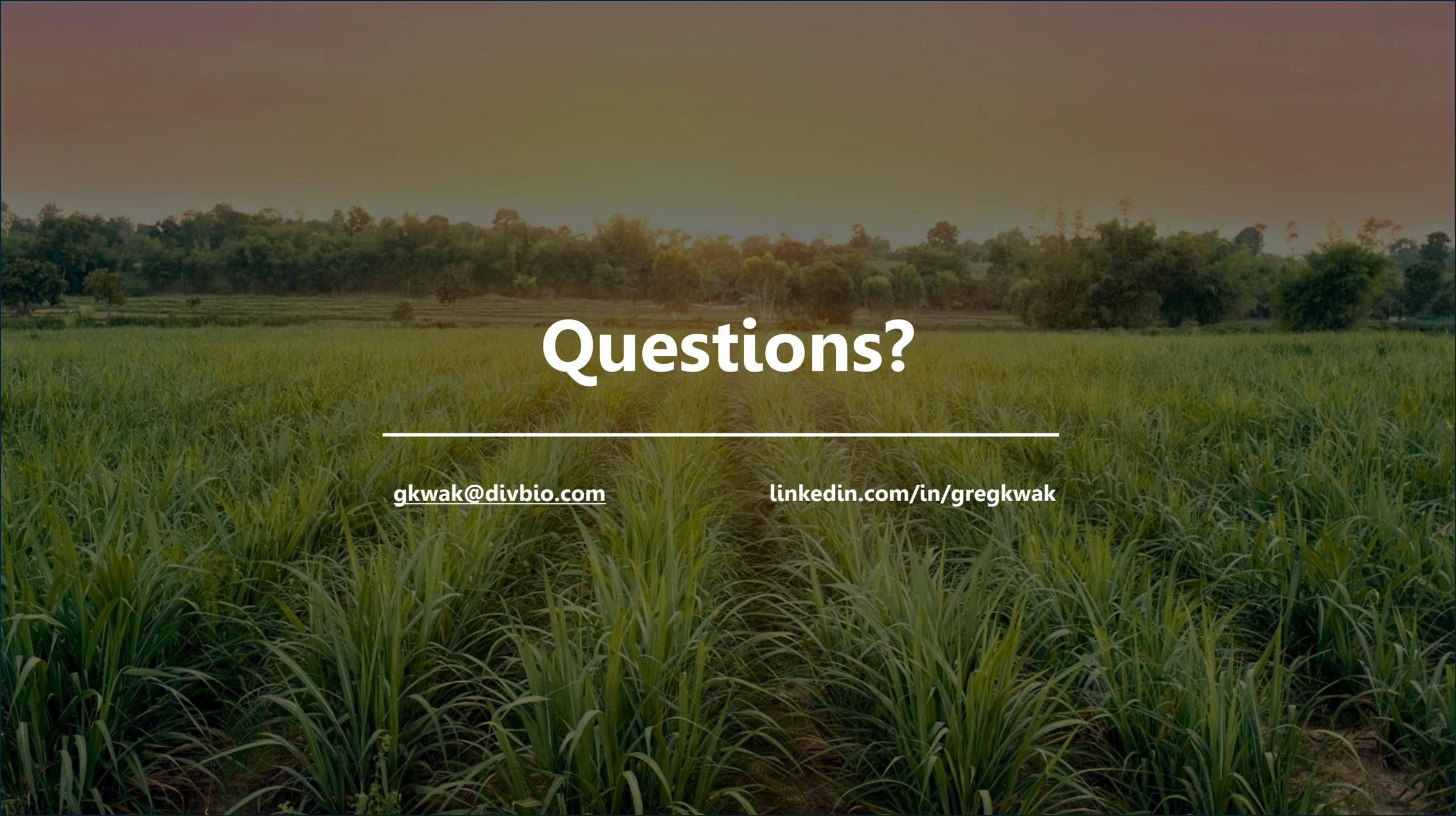


ASTM INTERNATIONAL

- D6400 – Industrial Compostability
- D6866 – Biobased Carbon
- D6400-23 – Total Fluorine
- D6400-21 – Heavy Metal Analysis
- D6002-02/OECD 208 - Phytotoxicity



Life Cycle Analysis



Questions?

gkwak@divbio.com

[linkedin.com/in/gregkwak](https://www.linkedin.com/in/gregkwak)