



Opportunities For Sustainable Feedstock Supply In Biobased Building Blocks

October 20, 2011

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Outline

- Purac company
- Sustainability driven innovation for succinic acid and lactic acid
- Sustainable feedstock supply for biobased building blocks



Purac Overview

- Subsidiary of CSM (Euronext listed)
- 80 years experience in **Lactic acid** Fermentation and Purification
- More than 20 years experience in **Lactides and PLA**
- Over **60%** Market share in Food, Pharma and Industrial Markets

2008 : 5,000 tpa **D- and L-Lactide** pilot-plant in Spain

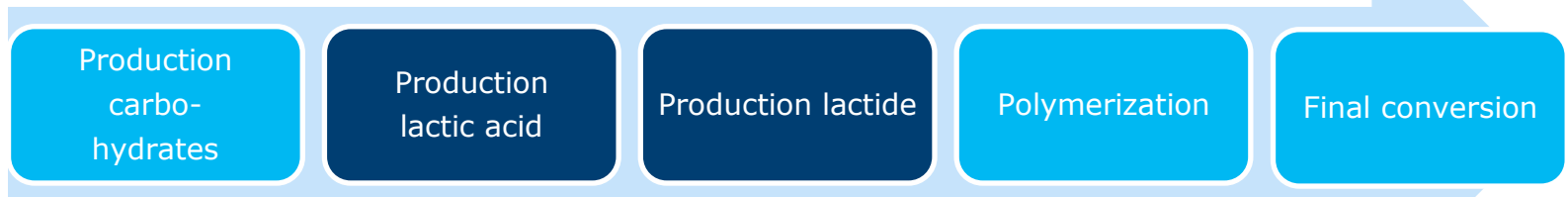
2009 : PLA Polymerization Process developed with **Sulzer Chemtech** (Switzerland)

: Start of Succinic Acid Development Collaboration with BASF

2010 : First commercial PLA plant installed at **Synbra** (Netherlands) for production of **BioFoam** (EPLA)

2011 : 75,000 t/a Lactide monomers plant in Thailand

: Purac and **BASF** announce intention to form Succinic Acid JV



Purac: Lactic acid Technology Leader

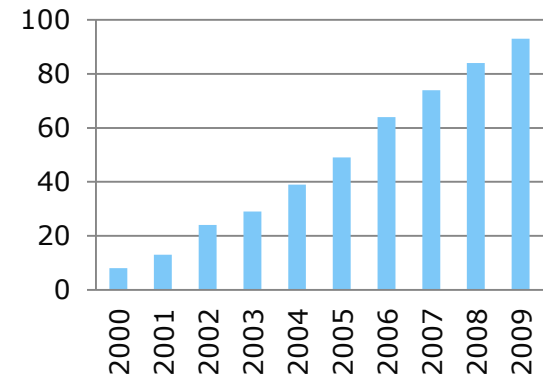
- **Lactic acid**

- Feedstock flexibility
- Purac world market leader
- High carbohydrate conversion rates
- High fermentation productivity
- Economic purification to polymer grade Lactic acid

- **Lactide**

- High isomeric purity
- Unique stable powdered product
- Enables production of high MW PLA
- Excellent starting material for polymerization
- Reactive form of Lactic acid for small molecule synthesis
- Purac 20 years experience in biomedical Lactides and PLA

Purac patent positions

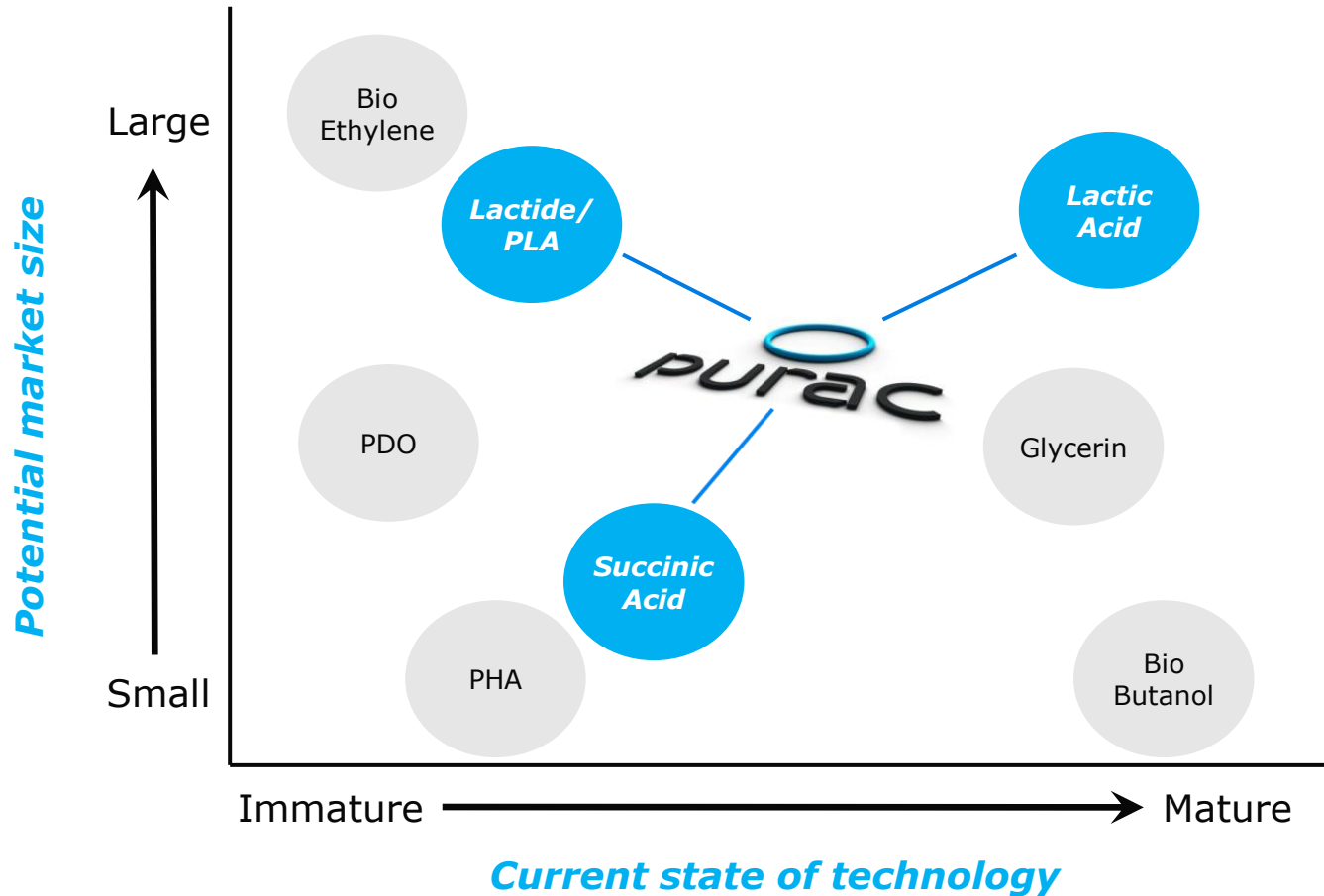


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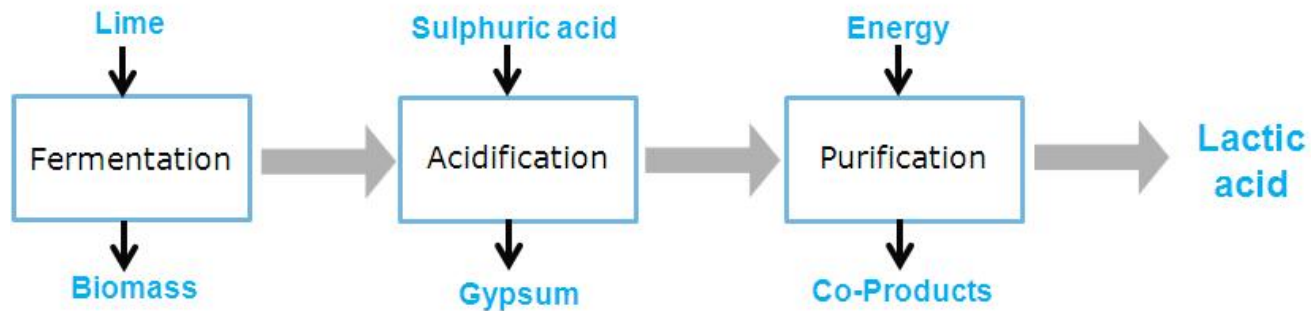


Lactic acid, Lactide/PLA and succinic acid amongst key Biobased Products

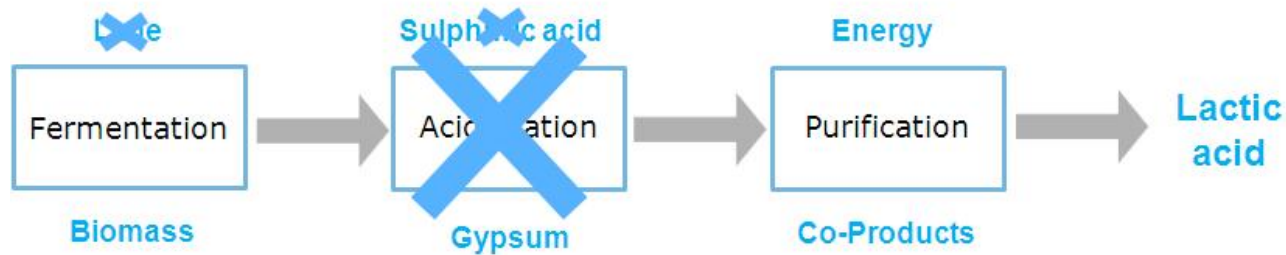


Source: SBI Energy

Lactic acid fermentation and purification process



Gypsum free lactic acid process technology now demonstrated



Gypsum free process demo plant Gorinchem, the Netherlands

Synbra – a Purac partner

Synbra products:

- PLA Biofoam®
 - Alternative for Expanded PS
- High-heat and specialty PLA resins
 - Alternative for PS, PP and ABS type resins



Bi
Foam



Plant at Synbra with 5,000 t/y capacity designed and delivered by Sulzer Chemtech.



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Sustainability Driven Innovation for PLA

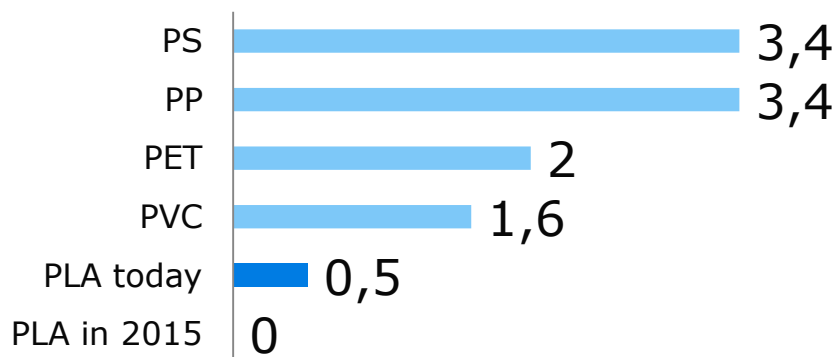
- 1st generation PLA: **Amorphous PLA** with low heat-deformation temperature
- 2nd generation PLA: **Crystalline PLA**
based on **stereocomplex technology** using D-lactide monomers and non-GMO feedstocks
- 3rd generation PLA: **Gypsum Free** Fermentation Technology for Lactic Acid
 - Less Chemicals
 - Lower environmental footprint
 - Significant improvement in LCA
- 4th Generation PLA: **Cellulose** based Lactic acid
 - Best social acceptance
 - Driven by sustainability needs of brand-owners



Carbon foot print

Emissions from production of common polymers *

kg CO₂ eq per kg of polymer – cradle to gate



- Huge differences between **carbon intensities** of feedstocks
- **GHG regulation** may make production based on emission-intensive feedstocks more costly
- **Environmental benefits** of biobased production (e.g., biodegradability, reduced fossil energy consumption)

*Source: Int. Journal Life Cycle Assessment, "LCA of the manufacture of lactide and PLA biopolymers..." published 3 Aug 2010 / accepted 10 July 2010.
PLA in 2015 is under development at Purac R&D*



Sustainability driven Innovation for Biobased Succinic Acid Production



Joint News Release

BASF and CSM explore a bio-based succinic acid joint venture

- **The two companies will intensify their collaboration with the aim to become the leading supplier in the succinic acid market**

LUDWIGSHAFEN, GERMANY and DIEMEN, NETHERLANDS, August 1, 2011 – BASF SE and Purac, a subsidiary of CSM nv, today announce the start of negotiations to form a joint venture for the production of bio-based succinic acid. The companies have been conducting research under a joint development agreement on bio-based succinic acid since 2009. The complementary strengths in fermentation and downstream processing led to the development of a sustainable and highly efficient manufacturing process based on a proprietary microorganism. The demand for succinic acid is anticipated to grow strongly in the next years. Main drivers are expected to be bioplastics, chemical intermediates, solvents, polyurethanes and plasticizers.

Empowering growth in Biobased Succinic Acid

MISSION

- Meet growing market demand with a **high quality** and **eco-efficient** Succinic Acid product

CHALLENGE

- Bringing together Chemistry, Life Sciences and Engineering to achieve **efficient production** of Biobased Succinic Acid

GOAL

- Become the **leading supplier** in a strongly growing Biobased Succinic Acid market



Bacterial Fermentation



Purification



Biobased Succinic Acid



Global Supply



Partnership

Empowering growth in Biobased Succinic Acid



Highest product quality
for Biobased Succinic Acid

Regional support to our
global customers

Competitiveness to
fossil based alternatives

Establish BBSA as
platform chemical

Use sustainable
feedstocks
for fermentation

**Purac / BASF partnering with customers to develop
strong growing market**

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Biobased Building Blocks Value Chain



Drivers:

- ❖ Expanding the Biobased Products market with new building blocks

Purac

Drivers:

- ❖ Demand for 'green' materials from retailers and brand-owners
- ❖ Adding value through material innovations and technology
- ❖ Framework conditions

Key issues

- ❖ Brand-owners demand decoupling from food-chain

Plastics and Chemical Industry

Drivers:

- ❖ Corporate Sustainability targets
- ❖ Consumer concern about environment
- ❖ Green image of retailers and brand-owners
- ❖ Adding value through "Sustainability Branding"
- ❖ NGO's, Policies and Regulations

Key issues:

- ❖ Cost versus fossil based polymers
- ❖ Need for Non-GMO carbohydrates (esp. Europe)

Retail chain



What feedstocks for bioplastics will be acceptable for brand-owners and NGO's?

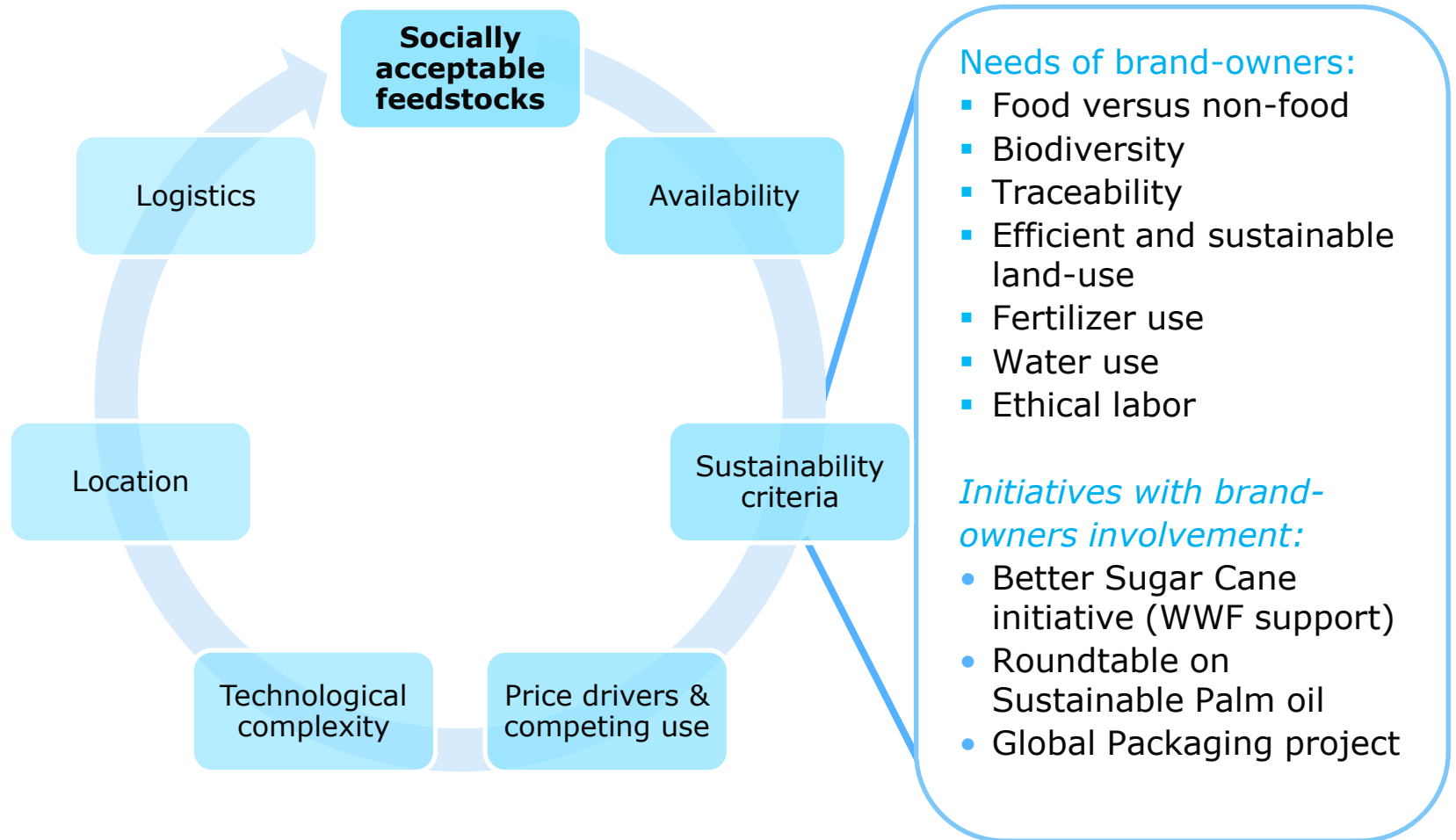


Key questions:

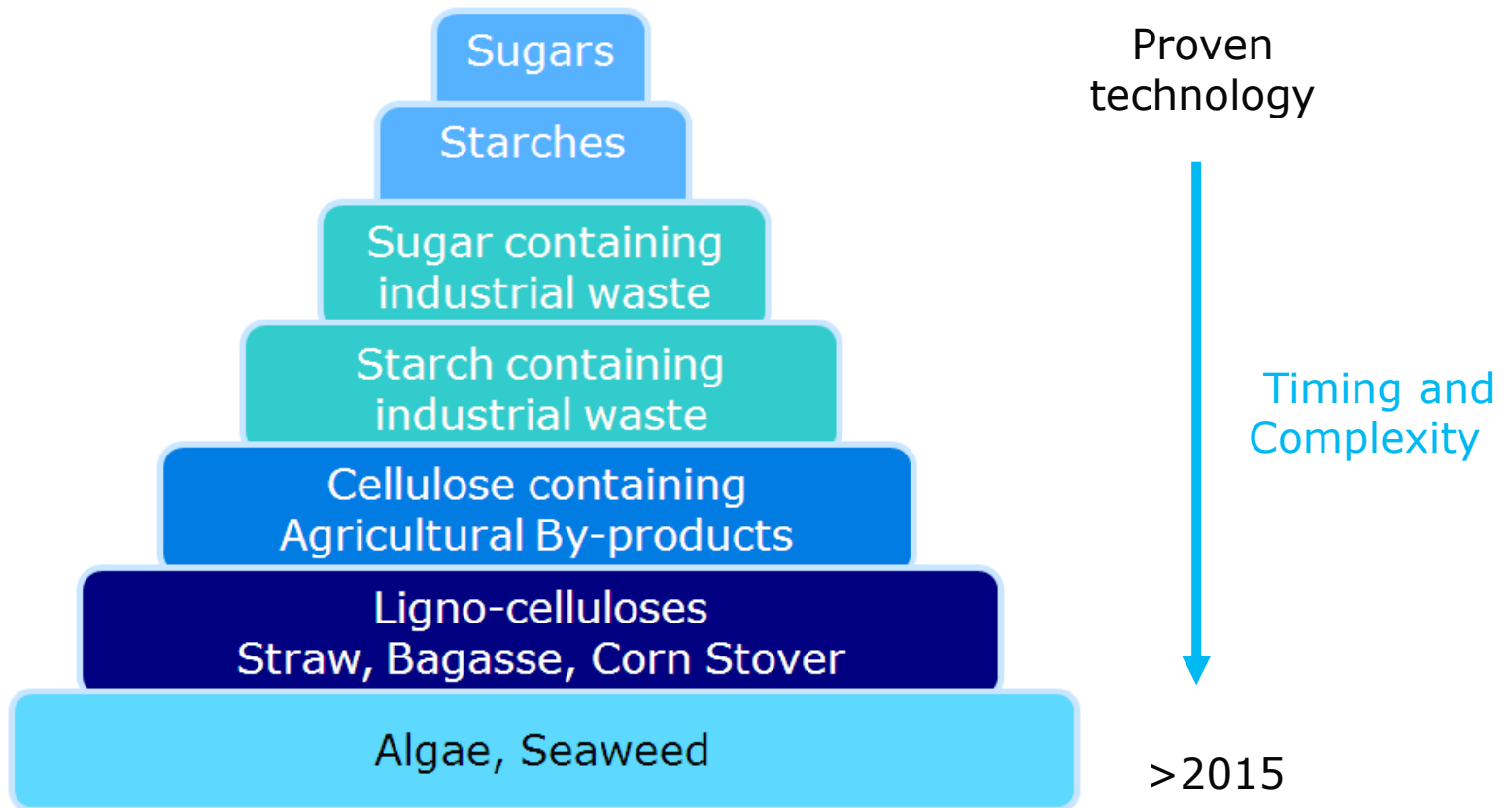
- Can we move to a *fact based* discussion?
- What is *the most efficient land-use*?
- How to compare *social and environmental impacts* of bio and fossil?



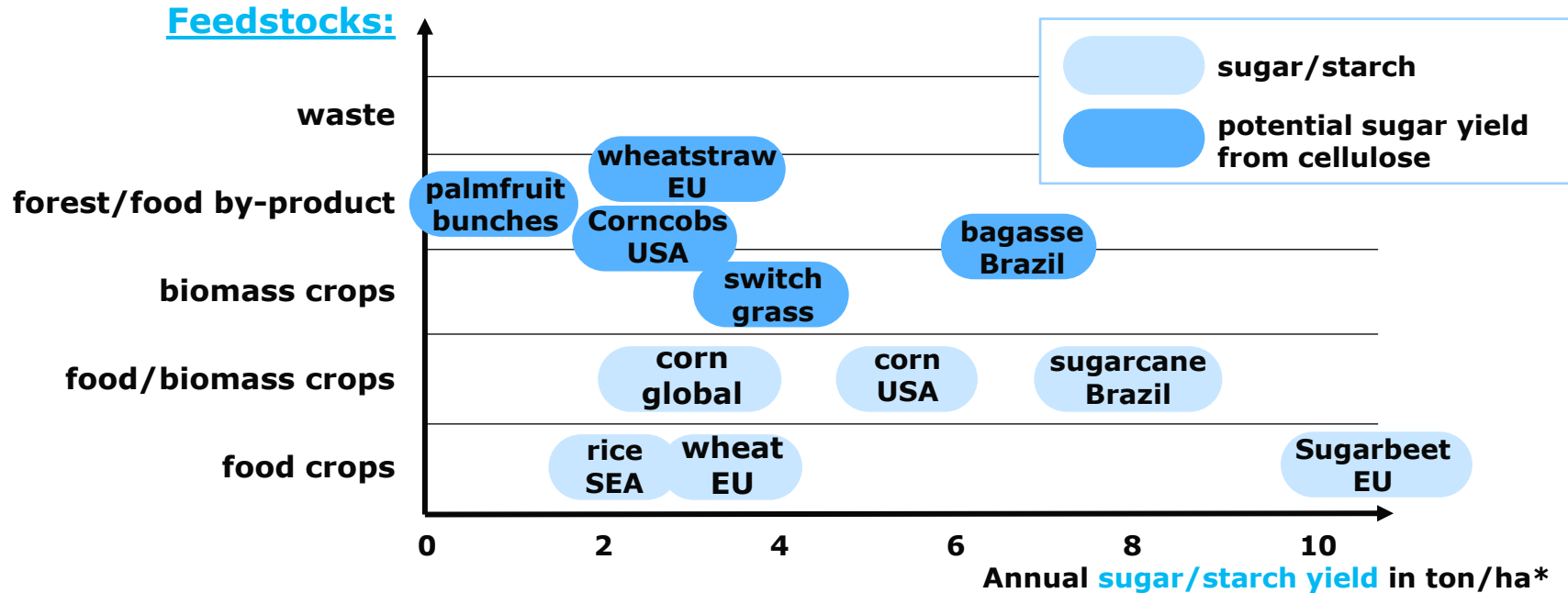
Selection criteria for next generation feedstocks



Increasing number of feedstock options becoming available



Selecting the right feedstock ...



Feedstock Sustainability Considerations:

- ✓ Agricultural sustainability – a must have !
- ✓ Brand-owners benefits for “socially acceptable feedstocks” ?

Today: Sugar is an effective feedstocks
Next generation feedstocks under development



Purac leading in Public Private Partnerships focused at Biorefinery research

- Purac is investing several million Euro in **next generation feedstock development** with various partners:

- BE-Basic R&D program : € 120 million

 - Global Industrial, Academic & Financial Partners

 - PURAC is Research Member

 - Bioprocess Pilot Facilities

- Kluyver Centre

- SenterNovem

- Bio Based Europe (BBE)

- Dutch Separation Technology Institute (DSTI)



Agentschap NL
Ministerie van Economische Zaken

Science Port Holland



Conclusions

- Purac **leading in Lactic Acid** based building blocks for biobased plastics:
 - **80 years** experience in lactic acid
 - **New investments** in Lactide and Succinic Acid
 - **Partnerships** with PLA producers
- Focus on **sustainability driven innovation**:
 - Second generation PLA
 - Gypsum free lactic acid technology
 - **Cellulosic feedstocks** for Lactic Acid and Succinic Acid
- Next generation **feedstocks**:
 - **Brand-owners** are key leverage in the value-chain
 - **Fact-based** discussions needed around acceptable feedstocks for brand-owners
 - Purac involved in Public-Private-Partnerships (PPP) around **biorefineries**



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a  **CSM** company