IEA T 42 : BIOREFINERY

Meeting March 3rd 2010 - Lestrem

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AGENDA

14h - 14h30 : Roquette Introduction : general, innovation strategy

14h30 - 16h30 : Tour plant (maize starch, glucose, sorbitol)

16h30 - 17h00 : Conclusion

THE ROQUETTE GROUP TODAY

One of the leading global producers of starch products :

- **Number 2 in Europe ; In the Top 4 in the world**
- **World leading producer of polyols and gluconates**
- **18 factories around the world including the most important cereal based biorefinery in Europe located in Lestrem (F)**

6 000 salaried staff

Turnover of 2.5 billion €

4 Agricultural Raw Materials :

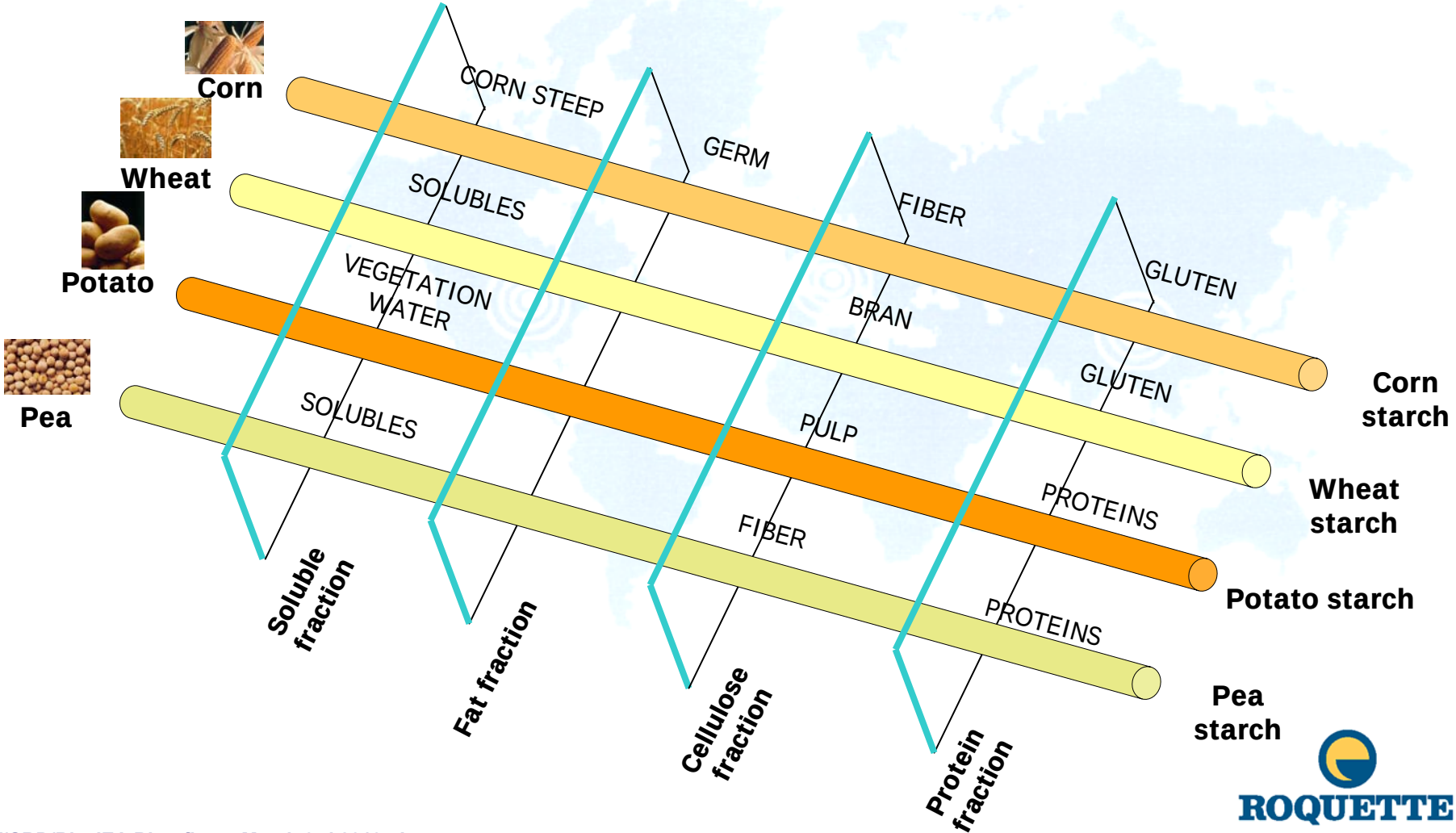
- Corn
- Wheat
- Starch potatoes
- Pea

Our business from harvest to starch and starch derivatives

250 research contracts by year with universities and private partners worldwide. An active portfolio of more than 150 patents

From raw materials ...
...to Roquette products

- **Production of starches**

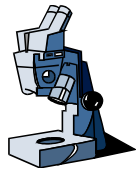


Our mission

- **Corn starch plant**

Corn

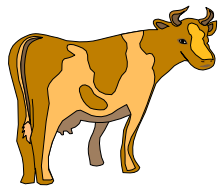
Steeping → **Corn Steep (solubles)**



Grinding → **Germ**

Corn germ meal

Screening → **Corn Feed (fiber)**



Separation → **Gluten (protein)**

Refining

STARCH

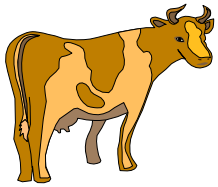
Raw material for our complete range of products

ROQUETTE

Our mission

- **Wheat starch plant**

Wheat

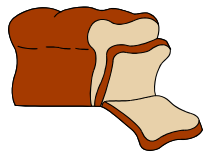


Bran

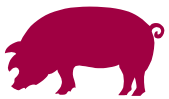
Milling

Kneading

Gluten



Washing



Fibers and gums

Solubles

Screening
Refining

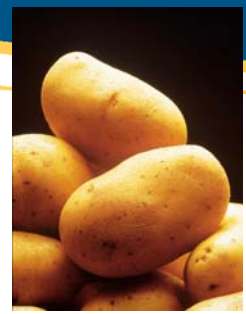
STARCH

Raw material for our complete range of products

ROQUETTE

Our mission

- **Potato starch plant**



Potato

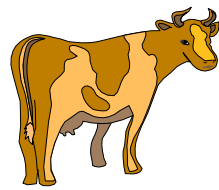
Rasping

Separation

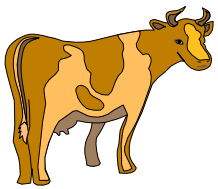
Vegetation water

Solubles

Proteins



Screening Refining



Pulp

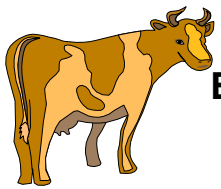
STARCH

Raw material for our complete range of products

ROQUETTE

- **Pea starch plant**

PEAS

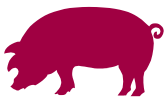


External fibers

Mill

Separation/ Refining

STARCH



Internal fibers

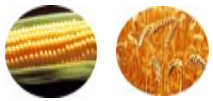
Separation

Solubles

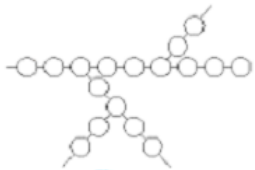
PROTEIN

ROQUETTE

CURRENT INTEGRATED PROCESSES - GLOBAL SYNOPTIC



STARCH



Starch molecule = thousands of linked glucose molecules

Native starch

Drying

Modification

Modified starches :
Dextrins, Pregelatinized, Ethers-esters, Cationics, others

Hydrolysis

Enzymes

Hydrolized products :
Malto-dextrins
Glucose syrups
Hydrolysates
Dextrose

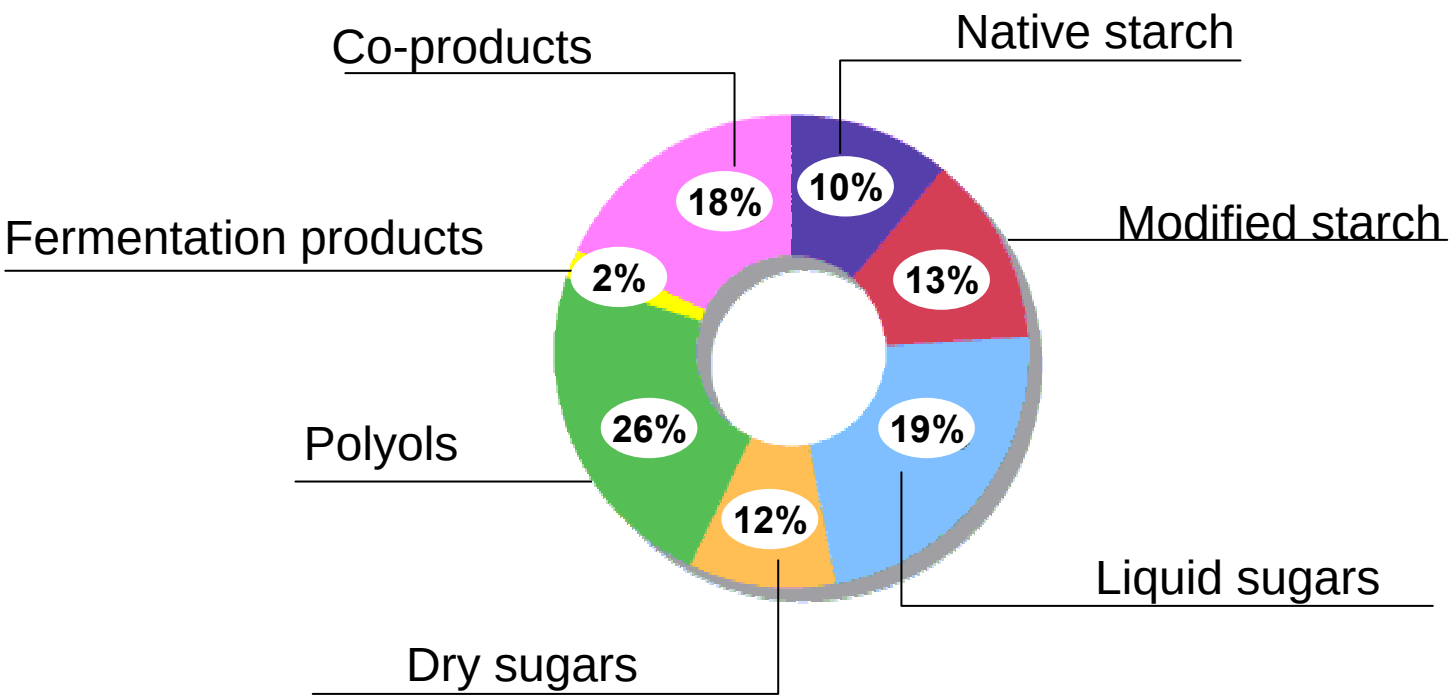
Biotechnology

Hydrogenation

Fermentation & Biocatalysis products :
New building blocks, organic acids…

Hydrogenated products :
Hydrogenated Glucose syrups
Polyols : Sorbitol, Mannitol, Isosorbide, Maltitol, Xylitol,

Sales by product line



Processing nature's products…

ROQUETTE

Our applications

- **Alimentation Humaine**

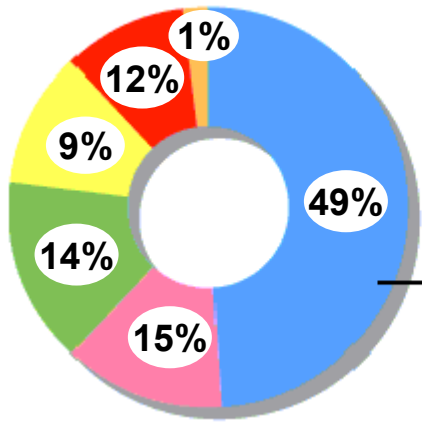












Alimentation Humaine

in volume

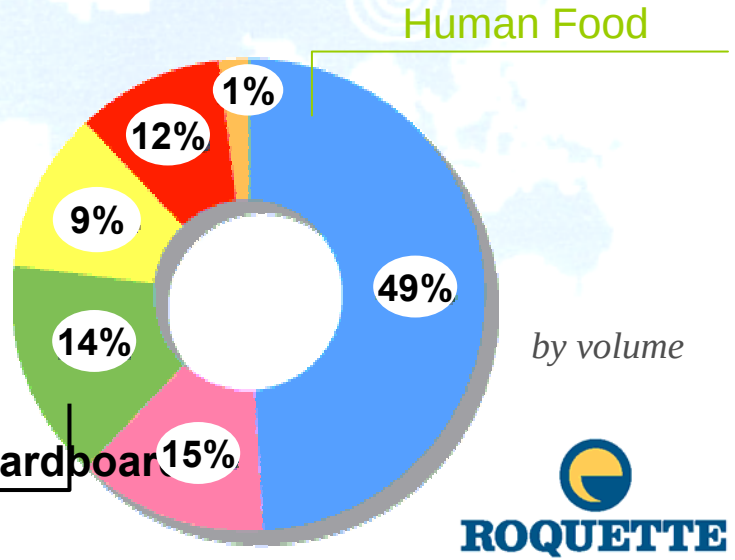
… adapted to the needs of industry

ROQUETTE

Our applications

- **Paper – Corrugated cardboard**

Paper - Corrugated cardboard



ROQUETTE

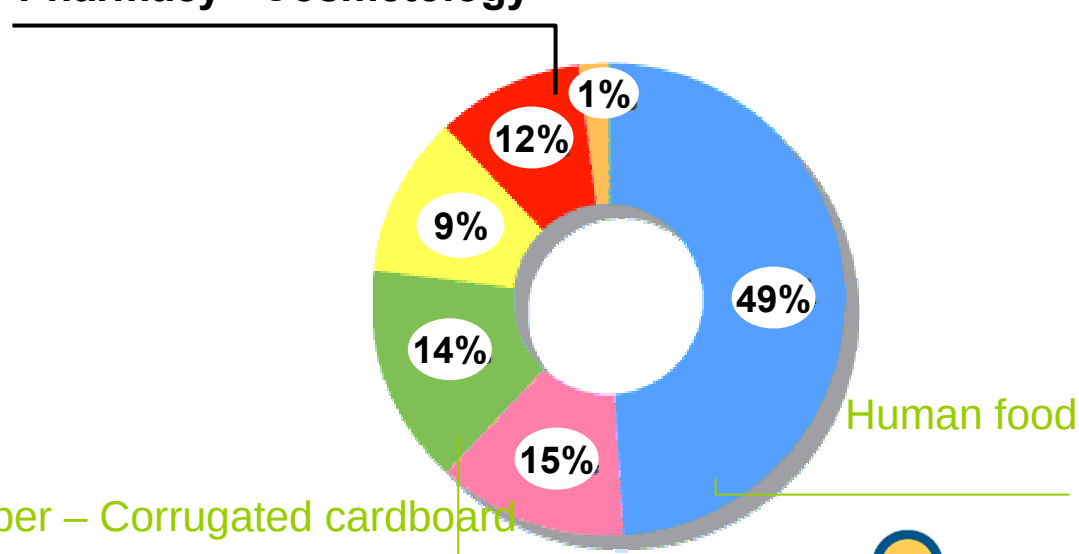
Our applications

- **Pharmacy - Cosmetology**



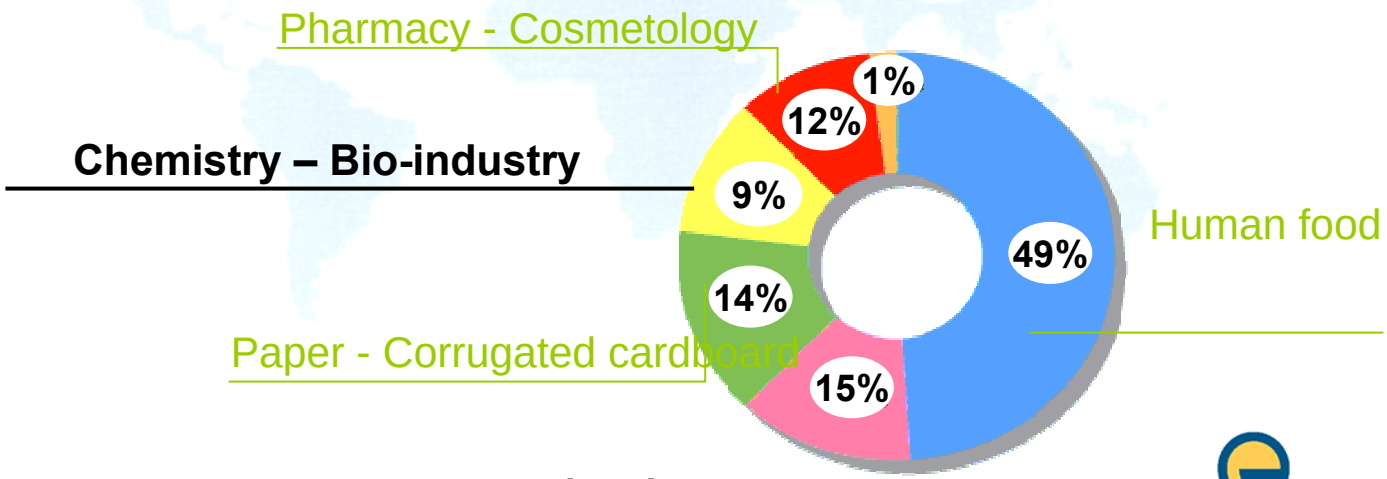






Our applications

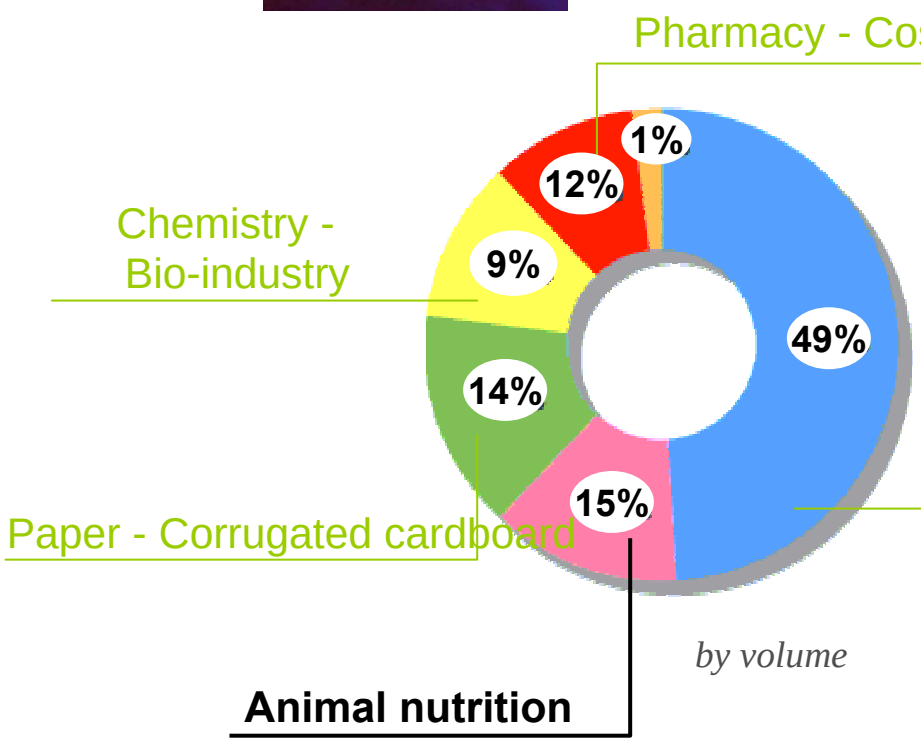
- **Chemistry – Bio-Industry**



by volume

Our applications

- **Animal nutrition**



by volume

Roquette Frères
France

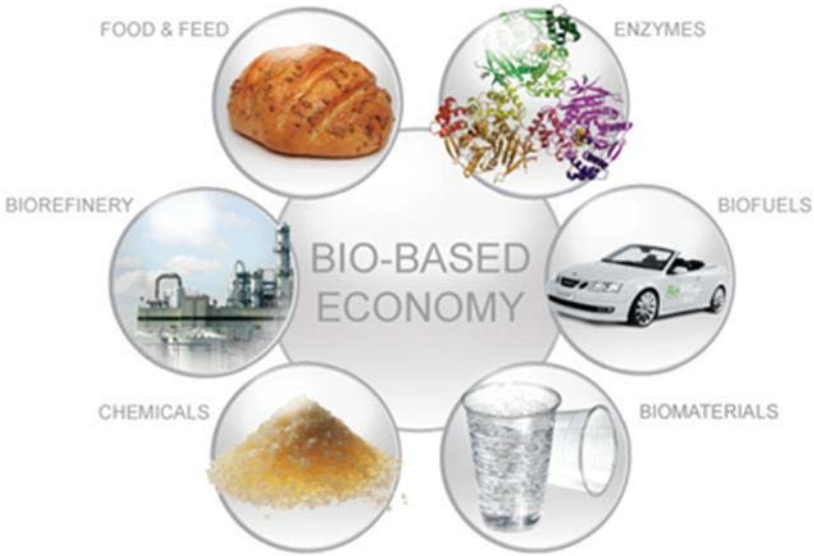
- Corn starch (native and modified)
- Wheat starch (native and modified)
- Sugars (liquid and dry)
- Polyols

Lestrem

Head office of the group and main production site

Innovation at ROQUETTE

➔ **Transforming innovative ideas into new, sustainable and competitive products**



TARGET : being a major leader in the future bio-based economy with integrated biorefineries

Two Axes for the Programs of Innovation

VEGETAL BASED CHEMISTRY

From integrated biorefineries to generate new business with partners

NUTRITION and HEALTH

BIOHUB

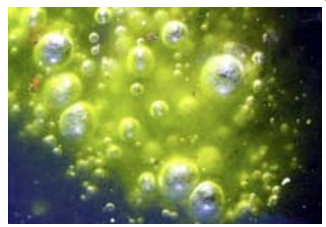
New monomers and new Ind. Biotech processes.

GaïaHub

New functionalized natural polymers

Nutrahub

Functional ingredients



algohub

Microalgae

Pea

Hubs for Innovation

Dedicated task-force to speed up the time to market for innovative new products

BIOHUB

GaïaHub

New Industrial Biotechnology & Hubs Center

Nutrahub

algohub

Illustration of new expertises :

New WB processes

Agro-materials

Microalgae

Nutrahub

Nutrition Health Wellness

Developing functional ingredients
- Sustainable innovation
- Friendly for environment
- Targeting countries and people

✔ Overnutrition
✔ Undernutrition

✔ Development
✔ Ageing

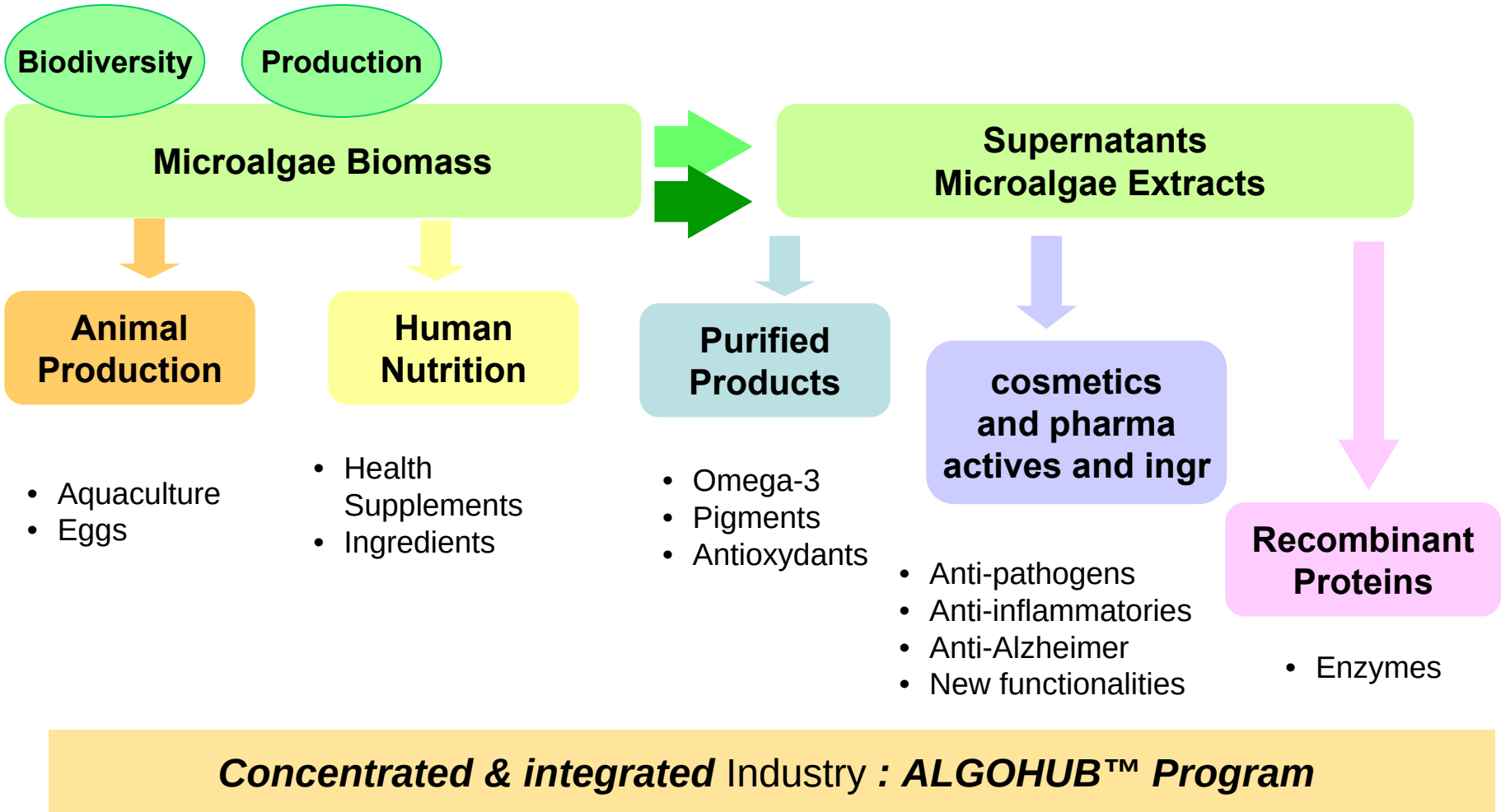
Leguminous industry

algohub
Microalgae industry

Cereal industry

ROQUETTE

ALGOHUB™ Program



Concentrated & integrated Industry ***: ALGOHUB™ Program***

ALGOHUB™ Program

Biorefinery : A New Example For Sustainable Development

The refinery based on fossil resources

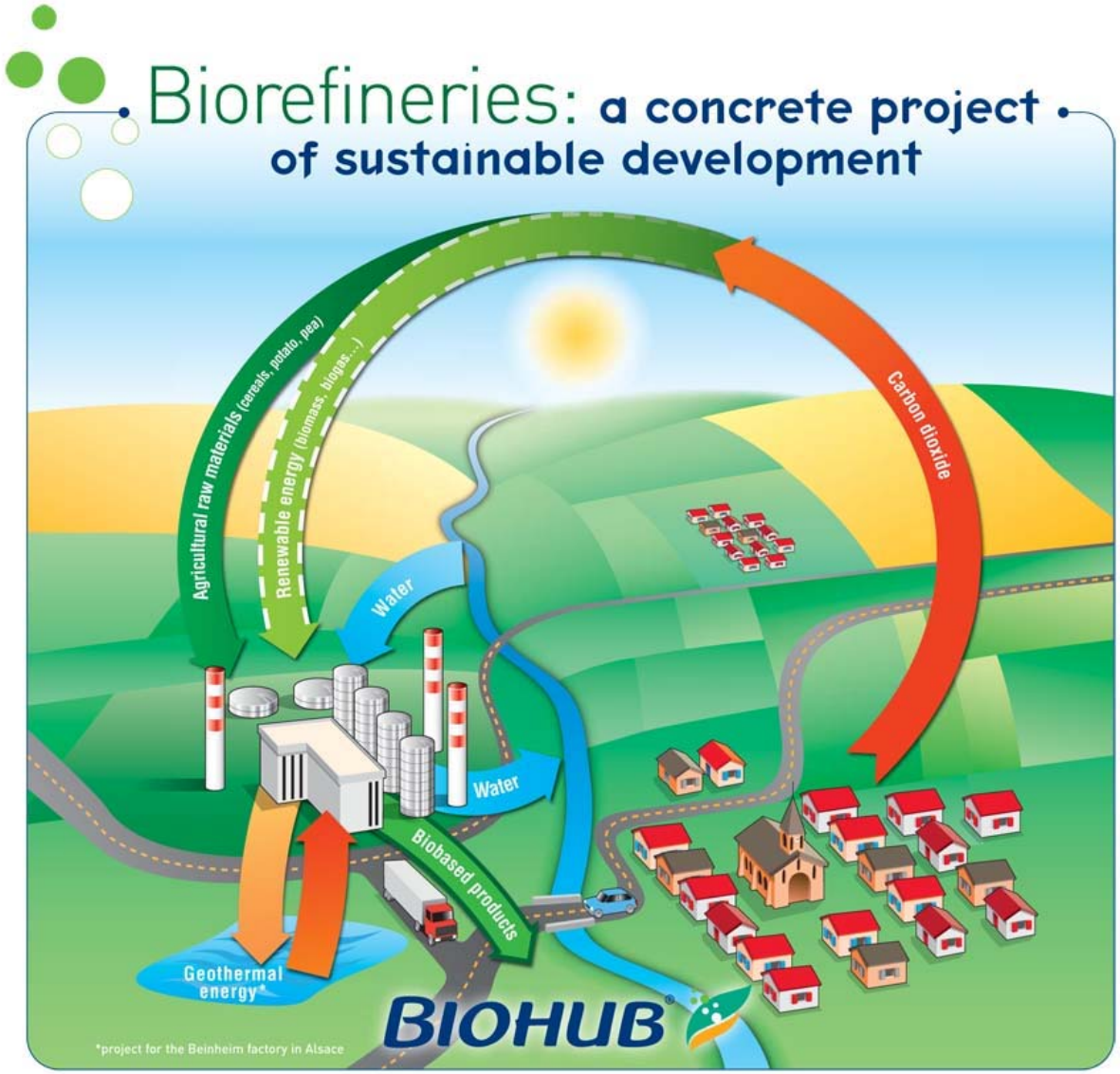
Source	Transformation	Products	Downstream process
Oilfields	Refining & Cracking	Chemical Transformation	Formulation
Native Oil	Naphta	Monomers & polymers	End Product

The biorefinery based on renewable resources (cereals)

Source	Transformation	Products	Upstream process
Agricultural fields	Starch production	Biotech Trans-formation	Chemical Trans-formation	Formulation
Maize/Wheat	Glucose	Monomers & polymers	End Product

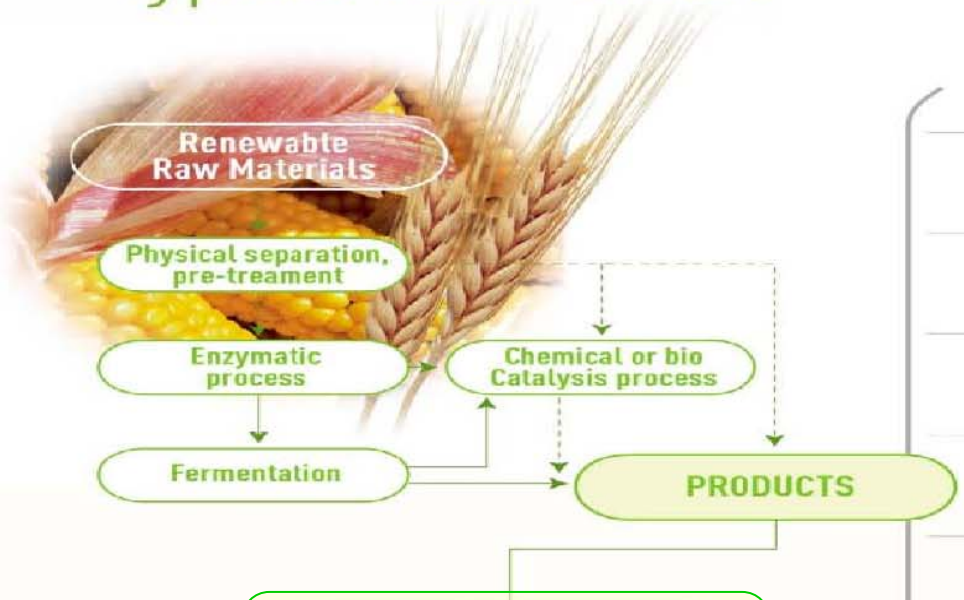
Leading role of biotechnology
Shared role between biotechnology and chemistry
Leading role of chemistry

New Biorefineries : An Example of the Circular Economy



The New Cereal Based Biorefinery

Typical flow-sheet



New platform chemicals

BIOHUB® PROGRAM

Main outlets

Family	Example	Application
Hydrocolloids	Cationic starches	
Polymers	Thermoplastic starches	
Vitamines	Vitamine C	
Amino acids	Lysine	
Organic acids	Gluconate	
Polyols	Sorbitol	
Fine chemicals	Cyclodextrins	
Biofuels	Bioethanol	

BIOHUB® PROGRAM

The Concept

Sustainable development

Starch based biorefinery

Products with new W.B. processes

New Chemical Products for Commodities, Specialties and Fine Chemical Markets

Biopolymers

Definitions

Meeting the needs of the present without compromising the ability of future generations to meet their own needs.

Processing starch and using chemical, biological and physical means to refined value added end-products for use in food and non-food applications.

PROCESSES :

- White Biotech (W.B.)
- Plant Based Chemistry

The BioHub ® PROGRAM

BIOHUB®

Substitutes for petchem

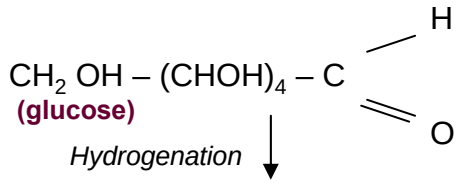
New products

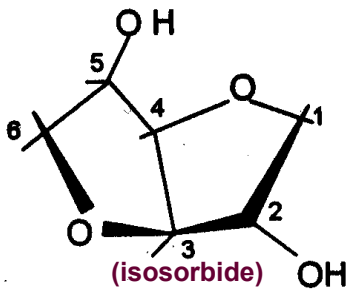
- ⇨ Biosolvents : Dimethyl Isosorbide
- ⇨ Bioplasticisers : Isosorbide diesters
- ⇨ Biolubricants : Isosorbide diesters
- ⇨ Biofluxing agents : Dimethyl Isosorbide
- ⇨ Biopolymers : Isosorbide
- ⇨ Biocomplexing agents

Current products with new WB processes

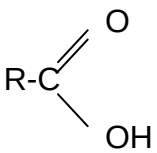
- ⇨ Active ingredients :
  - L-Methionine
- ⇨ Chemical intermediates :
  - Bio Succinic Acid (Succinium)
  - Bio Glycolic Acid

An Example of a Biohub® Platform : Isosorbide a Sustainable Diol For Chemicals And Polymers

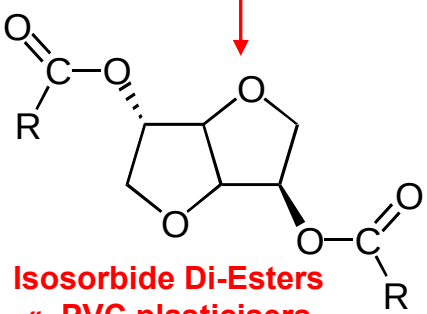




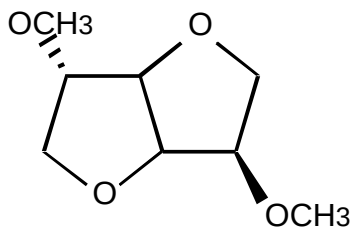
Isosorbide Derivatives



Fatty Acids



Isosorbide Di-Esters « PVC plasticisers Personal & Oral care»



Di Methyl Isosorbide « sustainable co-solvent and fluxing agent»

Isosorbide for polymers

$COOH – (CH_2)_n – COOH$

Diacids or other chemicals

Polyesters

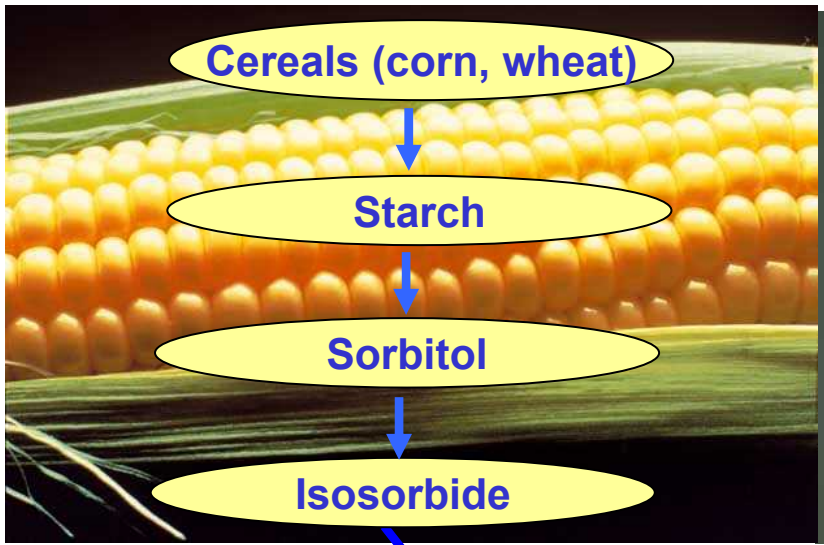
PEIT

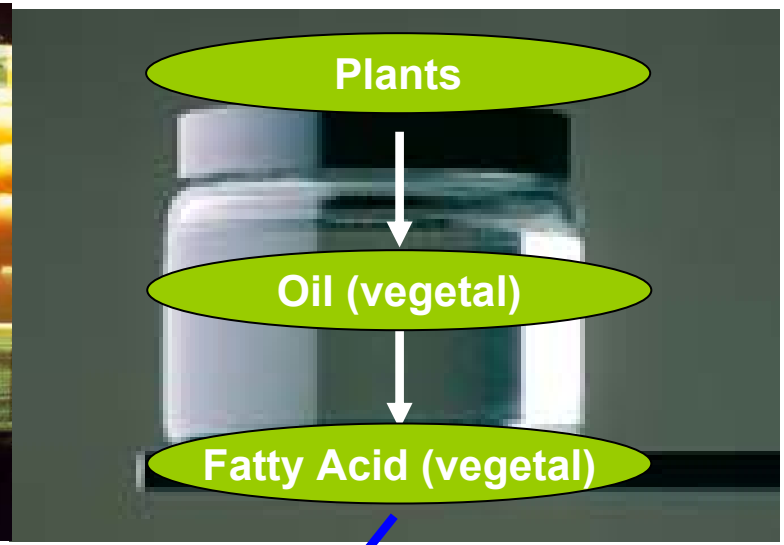
Polyurethanes
Polycarbonates
Others polymers

Illustration of the Isosorbide Platform : Polysorb® ID 37 - New 100 % Bio-Based Plasticizer

➔ Polysorb® ID 37 is a blend of diesters obtained from esterification of Isosorbide with fatty acid

➔ It's synthesized by
- ✓ fatty acid (vegetal based)
- ✓ and isosorbide coming from dehydratation of sorbitol





Isosorbide diester (IDE) : Polysorb® ID 37

► 100 % Bio-Based and Plasticizing Effect comparable to Phthalate Plasticizers

An Example of Bio-Based Building Block : Succinic Acid a Sustainable Di-acid for Chemicals And Polymers

Glucose $CH_2OH-(CHOH)_4-C$(H, O)

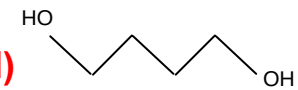
CO_2 → Fermentation

Succinic Acid

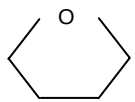
$COOH-(CH_2)_2-COOH$

Succinic Derivatives

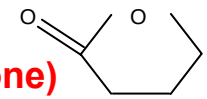
BDO (1,4 Butanediol)



THF (Tetrahydrofuran)



GBL (GammaButyrolactone)



Succinate esters

➔ Joint development with DSM

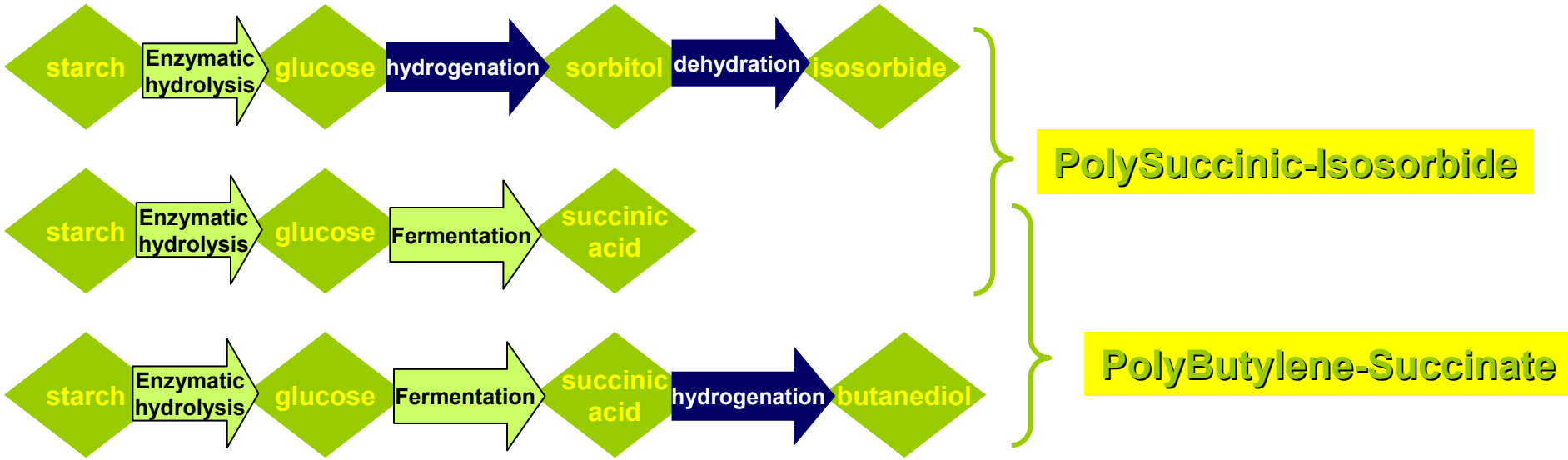
Succinic Acid for polymers

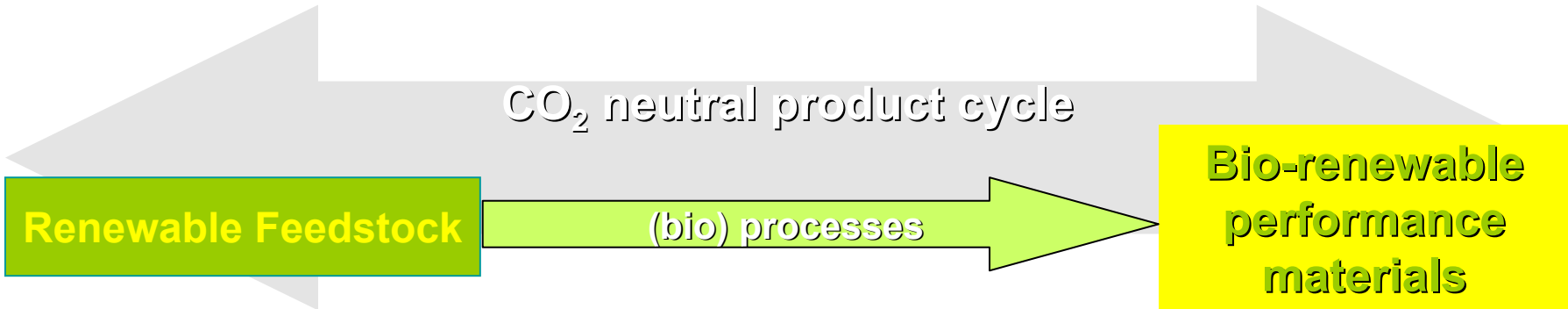
+ Isosorbide or BDO , …

Green Polyesters like PIS (Polyisosorbide succinate)

PBS (Polybutylene succinate)

Bio-Sucinnic Acid As Monomer for Renewable Materials / Products

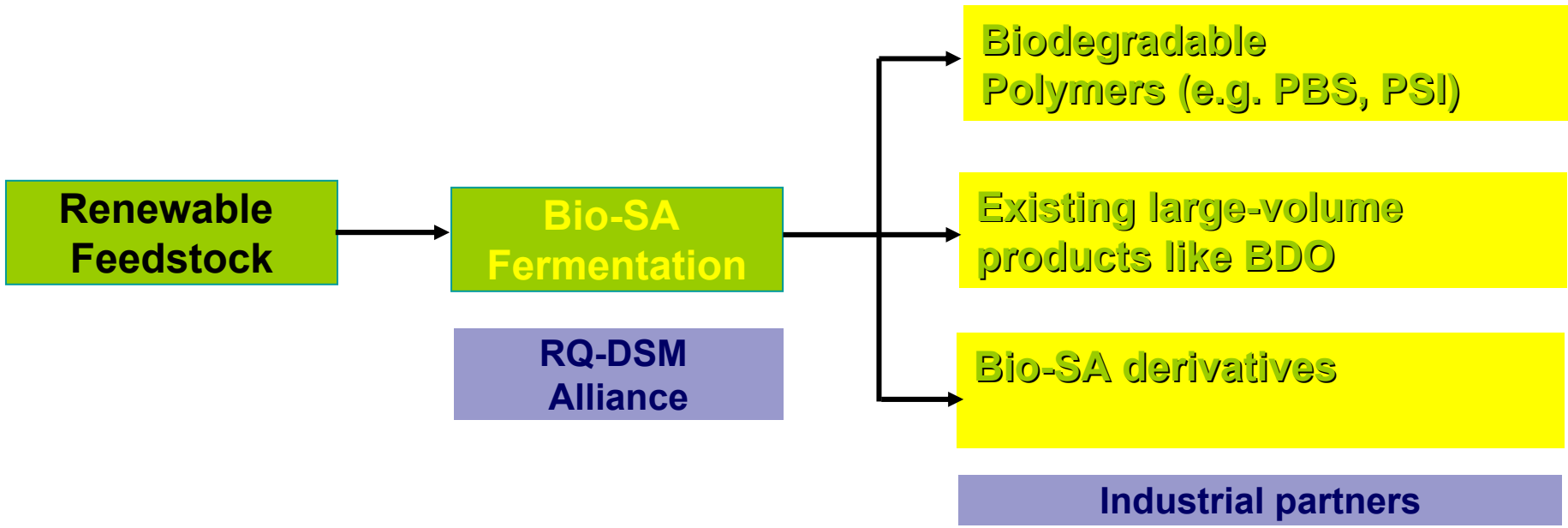




Unlimited. DSM

ROQUETTE

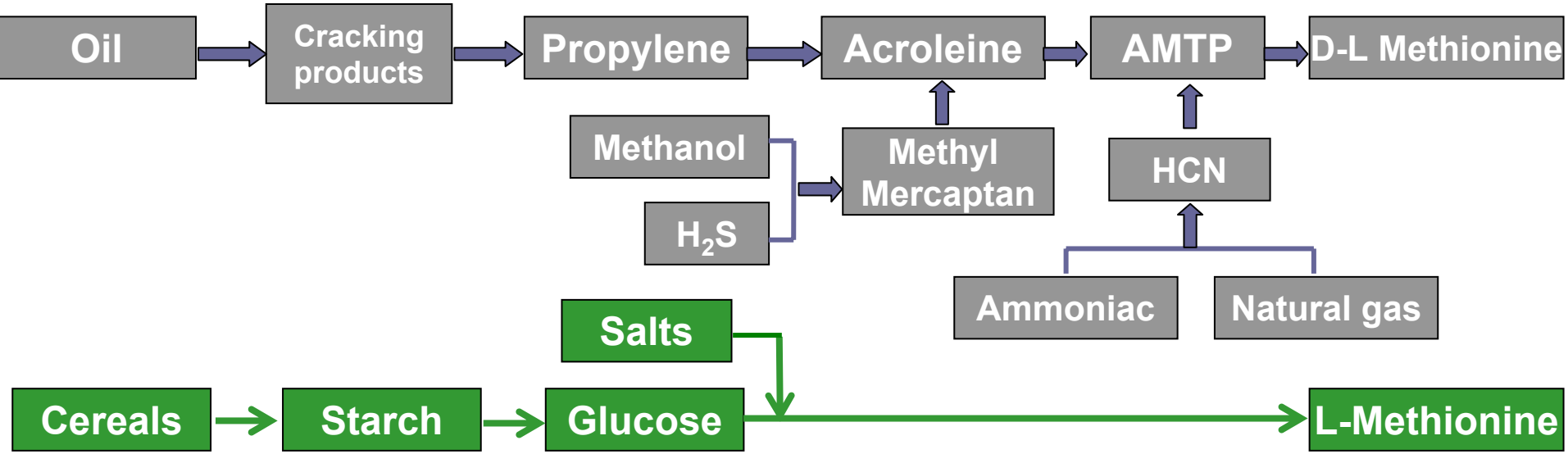
DSM – ROQUETTE Partnership for Bio-Succinic Acid



Unlimited. DSM

ROQUETTE

D,L and L-METHIONINE Project : Production Diagrams



World market 2008 price 2008 = 700 KT = 4 €/kg

Main Industrial and scientific partners

To create new value chains through industrial innovation !

BIOHUB® PROGRAM : Main Figures

➔ Global cost of the Programme = € 90 mio. (6 years)

➔ Aids from the French Industrial Innovation Agency : € 42 mio.

(€ 22 mio. as subsidy and € 20 mio. as reimbursable loans)

➔ Industrial investments = € 700 mio. (starting after 2010)

➔ Expected volumes and surfaces = 1.3 mio. tons corn or 150 000 ha

Many companies with very different backgrounds have started to engage in the biorefineries concept

NOT COMPLETE

- **Chemicals**

- **Agro Industries**

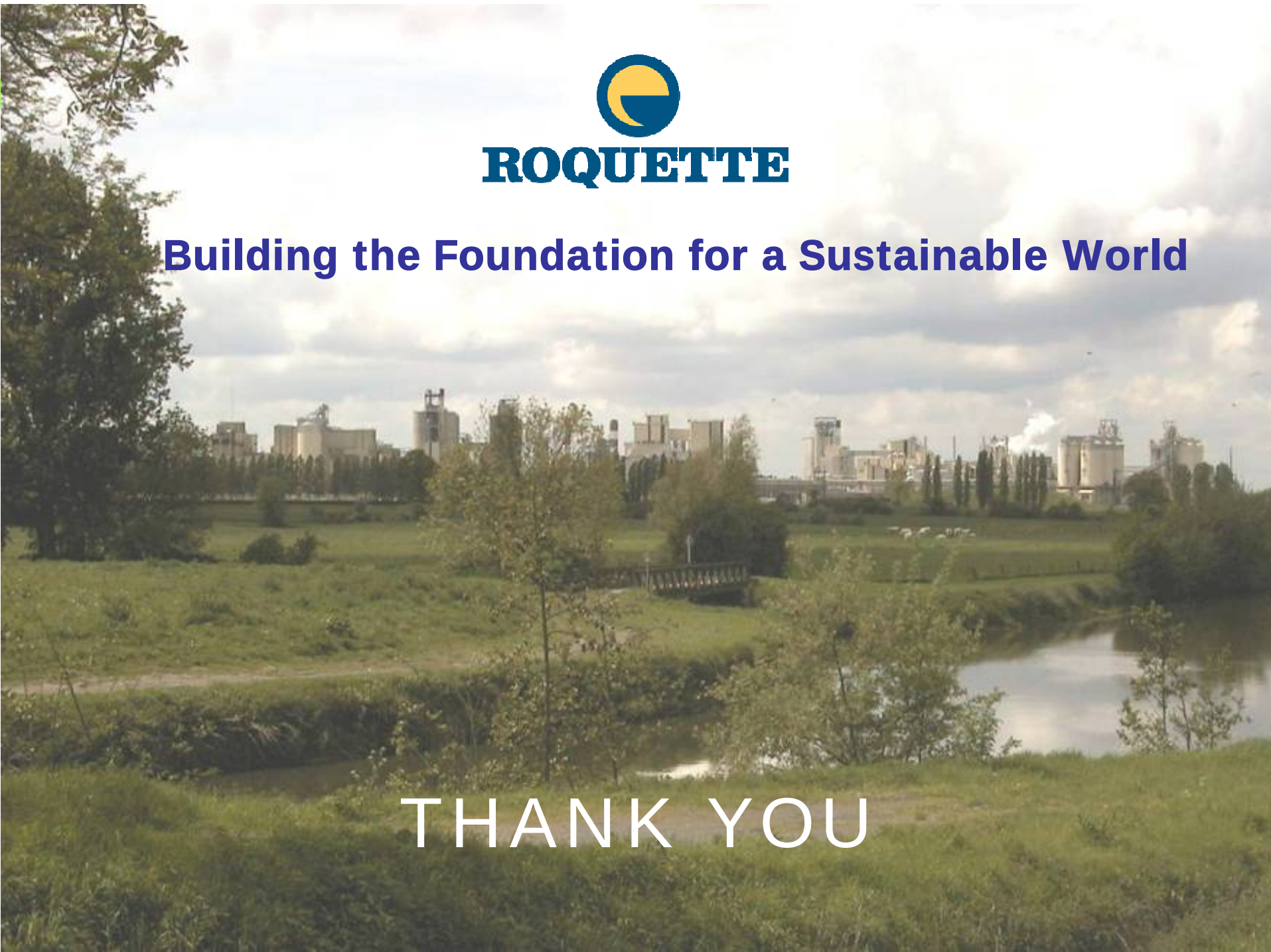
- **Biotech**

Source Mc Kinsey

Chemical and Agro Industrial players have started to form partnerships to build biorefineries

Some Emblematic Examples

	Product	Agro Industries	Chemicals	Volume kt	Announced Timeline
Brazil	Ethylene/VCM (from ethanol)	COPERSUCAR	SOLVAY	360 VCM	2010
	Ethylene (from ethanol)	SANTELISA VALE	DOW	350	2011
	Ethylene (from ethanol)	ETH	Braskem Petroquímica Brasileira de Classe Mundial	200	2009
Europe	Succinic acid (from starch)	ROQUETTE	DSM	Demo plant	End of 2009
USA	1,3-propanediol	Genencor International A Danisco Company / TATE & LYLE	DUPONT	45	Operational


ROQUETTE
Building the Foundation for a Sustainable World
THANK YOU