# Biorefinery: chemicals and materials from biomass

Rob Bakker

SAHYOG Twinning workshop/session 3:  Biorefinery

FOOD & BIOBASED RESEARCH
WAGENINGEN UR

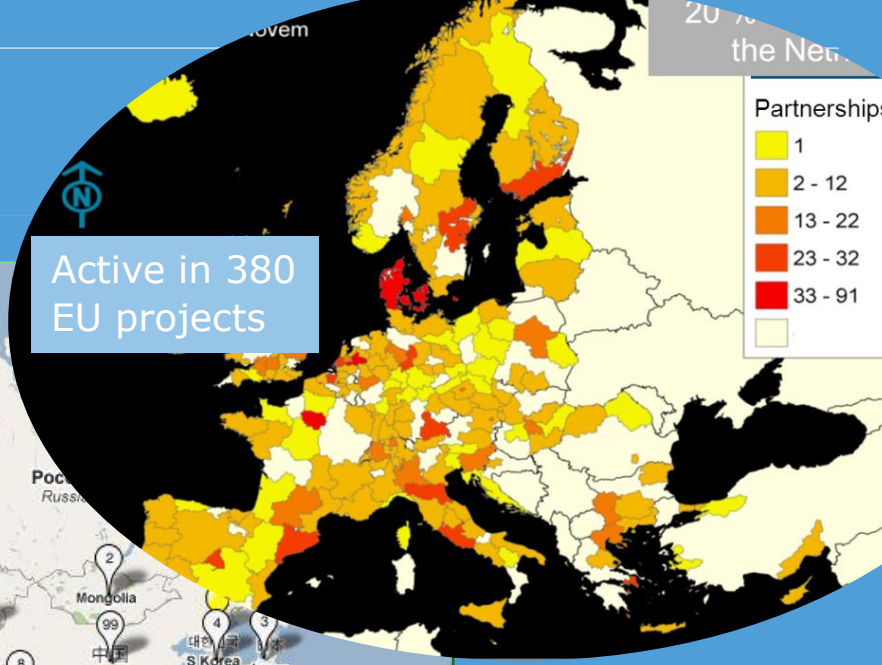
# Wageningen UR (University & Research centre)

- Two pillars:
  - Wageningen University
  - CRO (9 Specialized Contract Research Institutes)

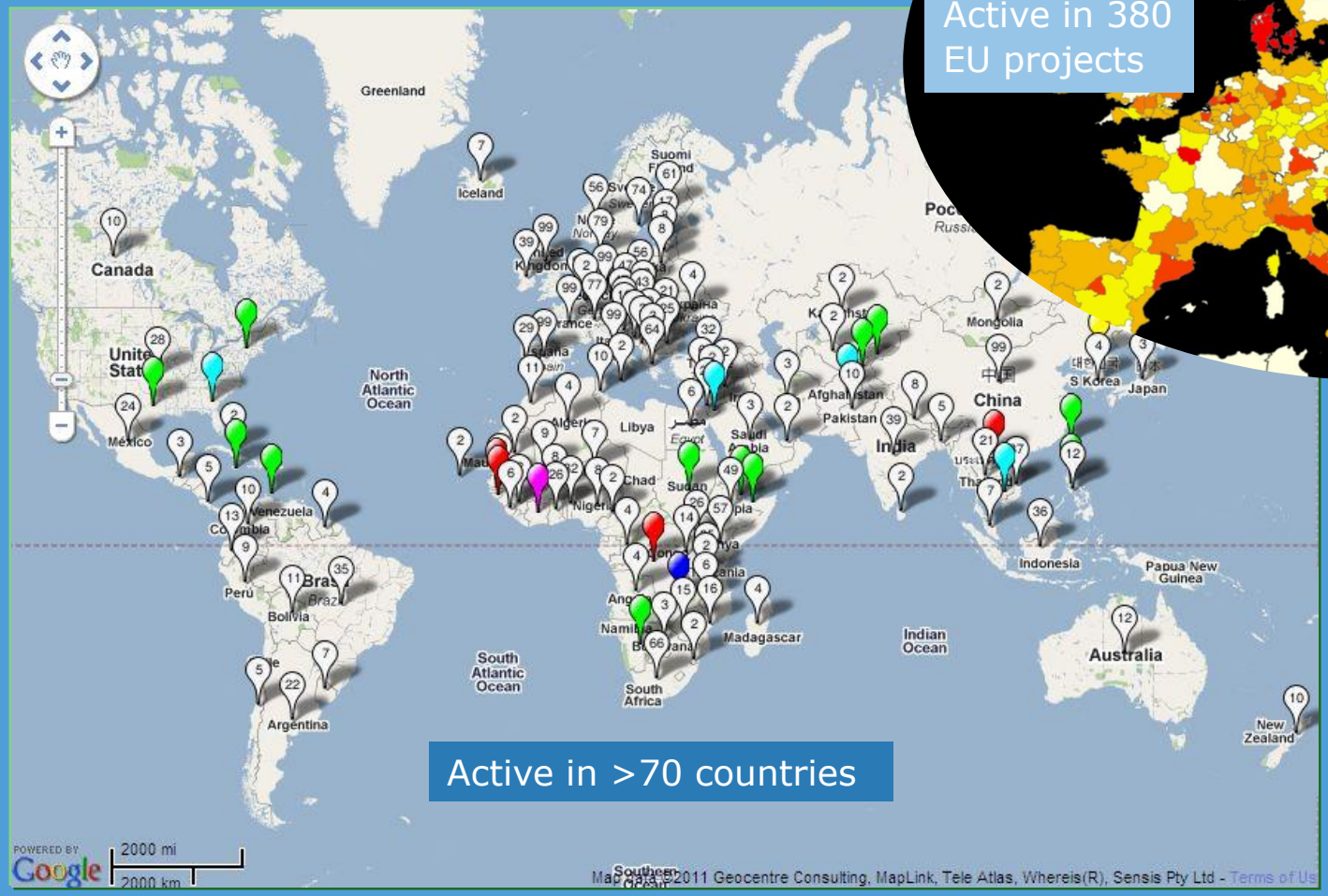
- Annual budget 2012:  650M€
- About 6500 employees (±50/50 WU en CRO)
- 9500 BSc/MSc students
- 1200 PhD (>125 countr.)


WAGENINGEN UR
For quality of life

# International projects




Active in 380 EU projects




Active in >70 countries

# BioRefinery @ Food & Biobased Research

Leading research group in the Netherlands

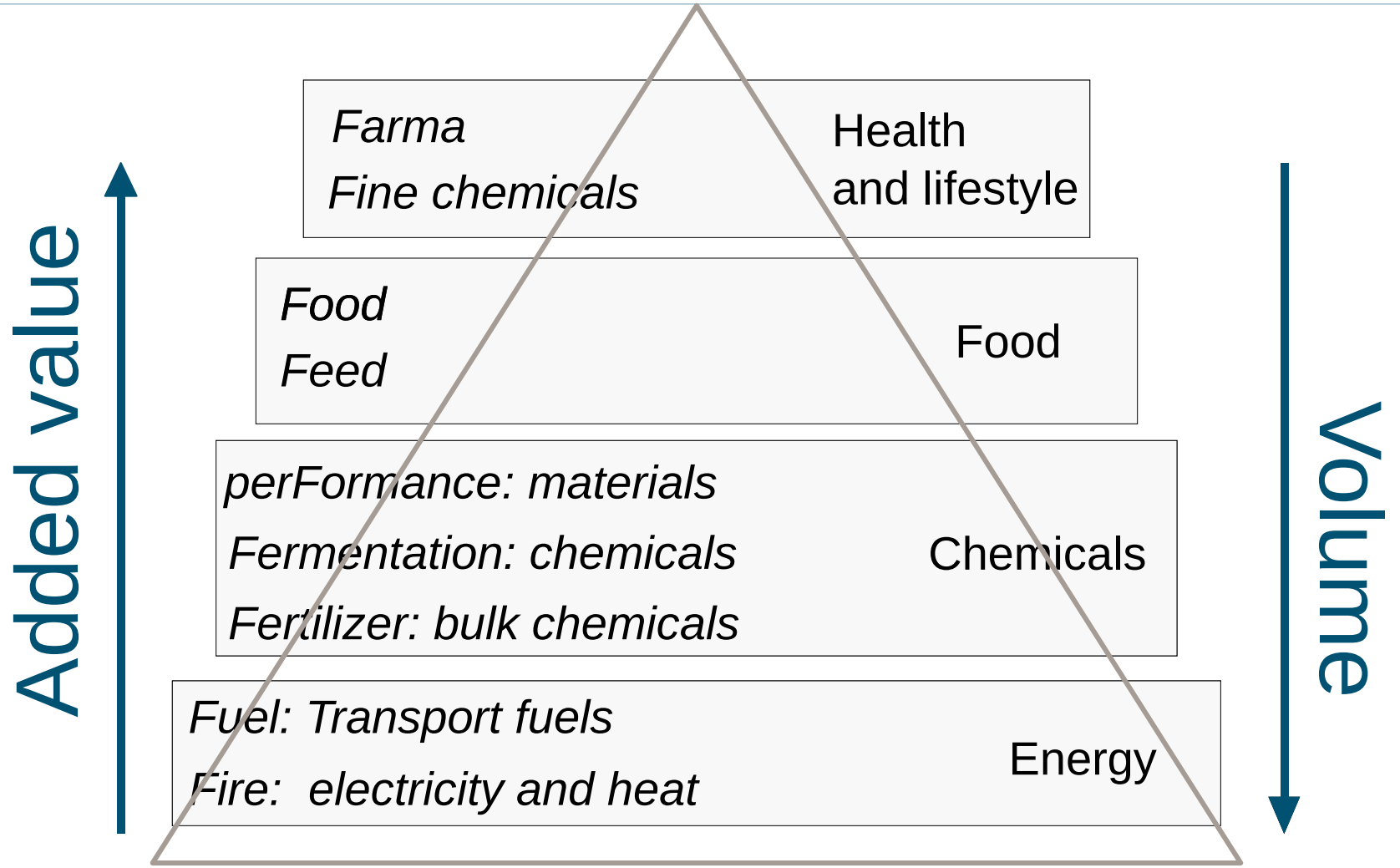
- 80+ fte, 12 M€ turnover
- Confidential bilateral projects with multinational SMEs
- Public-private sponsored projects

Three interconnected Programmes:

- Biorefinery
- Biobased Chemicals & Fuels
- Materials

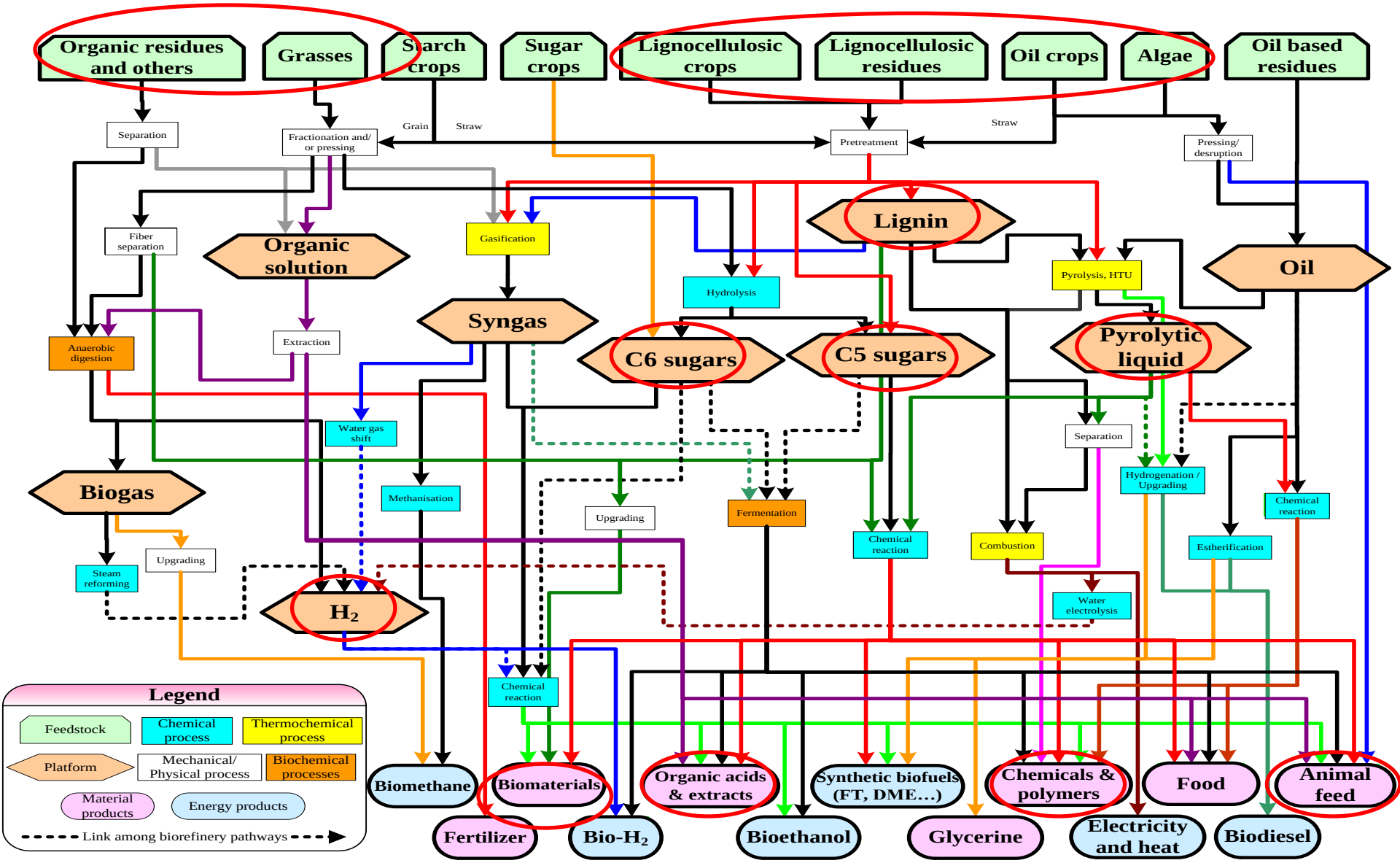
Close link with Food Technology Centre

# Value vs volume?

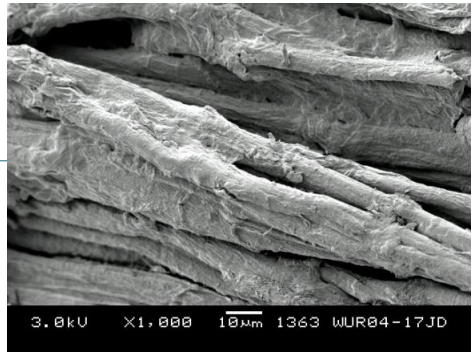


# Pathways around platforms:

Ref: IEA Task 42



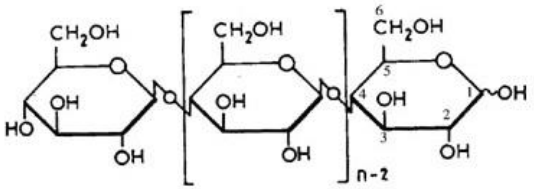
# Biomass Characterisation



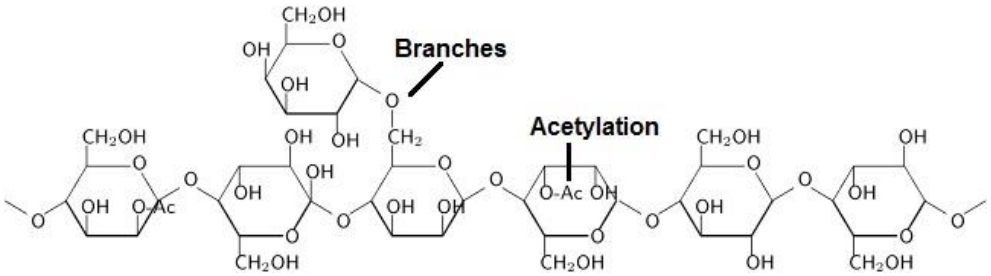

## Lignocellulose is a complex structure

- **chemical composition: structural carbohydrates, starch, lignin, proteins, extractives**
- **Many advanced analytical methods developed:** HPLC, GPC, GC-MS, UPLC, MALDI-TOF, TGA, etc.

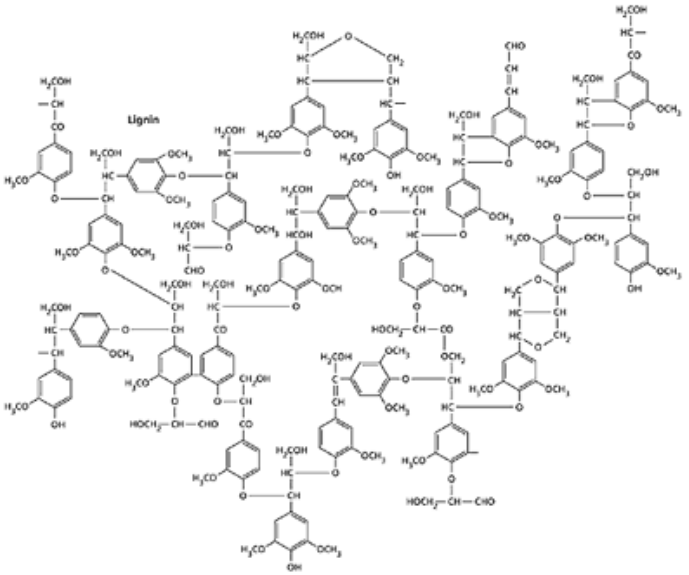
Cellulose



Hemicellulose



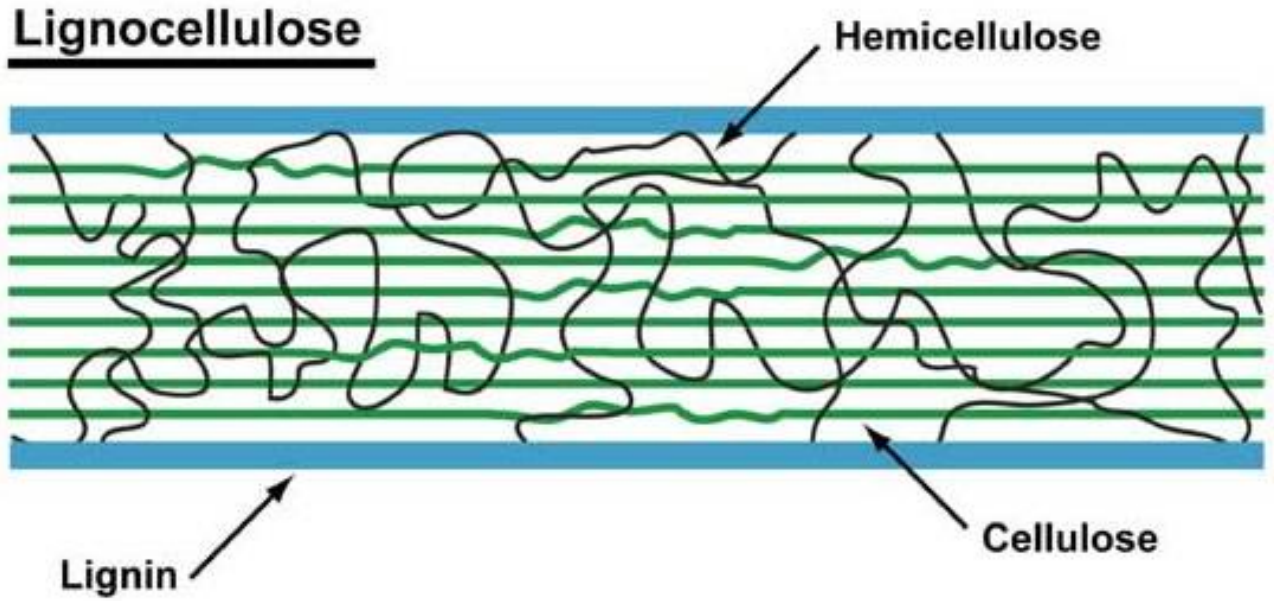

Lignin



# Lignocellulose pretreatment

Present in most plant material

- Part of secondary cell wall in plant cells
- adds resistance to degradation and pathogens



# Focus areas for pretreatment R&D

Mild pretreatment

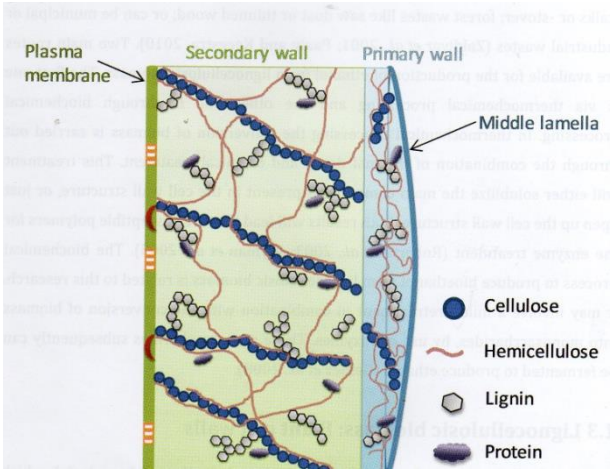
Selective extraction of lignin, C5 sugars, polyols, proteins, starch

Reduce water holding capacity of biomass

Process integration, reduce costs

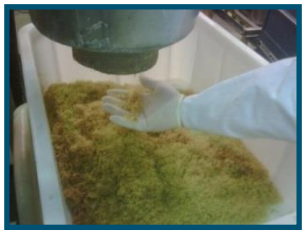
- Valorise all streams!

Gain more fundamental insights in pretreatment process in close collaboration with academic partners




Source; M.v. Gool; Wageningen University, 2012

# Straw to fermentable sugars, lignin

Wheat straw

Pretreatment

Lignin

Polymeric sugars

Enzymatic hydrolysis

Monomeric sugars

Fermentation

Ethanol

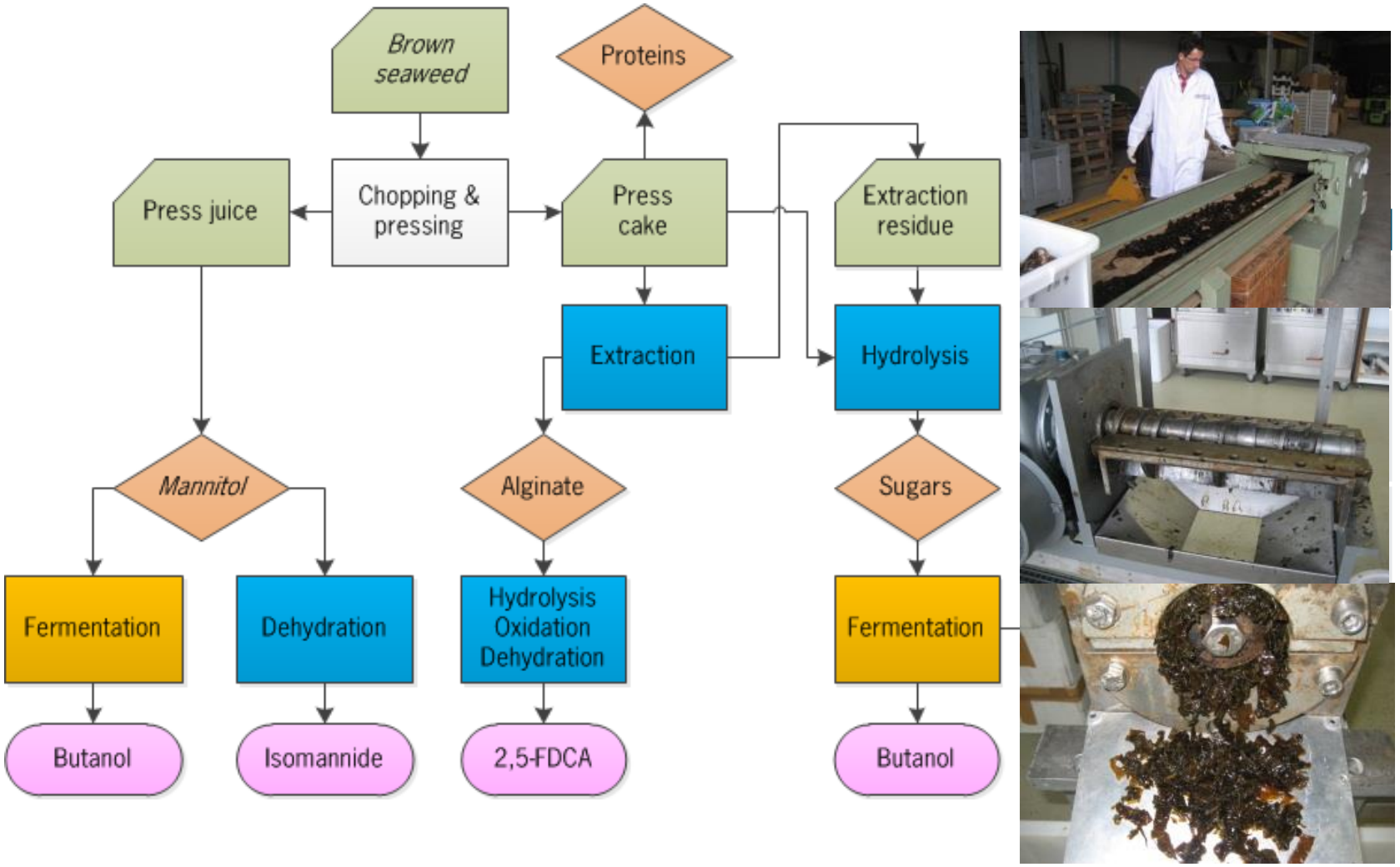
**Fractionation efficiency**

- Delignification up to 70 - 80%
- Improvement of enzymatic degradability

**Enzymatic hydrolysis**

Conversion of glucan and xylan to monomeric sugars, with low fermentation inhibitors

# Biorefinery of brown seaweed



# Biobased building blocks, chemicals

- Produce chemicals based on cellulose, monomeric sugars, lignin, fatty acids, and proteins from biomass

Two approaches:

- Conversion to existing chemicals: "drop –in"
  - Example: Aromatic platform chemicals (BTX) and phenols for resins from Lignin
- Conversion to new chemicals: new process development
  - Example: FDCA (furan dicarboxylic acid) from carbohydrates, for production of PEF

# Upscaling

- Pretreatment: 2 to 50 L batch; 5 - 10 kg/h continuous
- Hydrolysis and fermentation: 20 – 1000 L
- Downstream processing

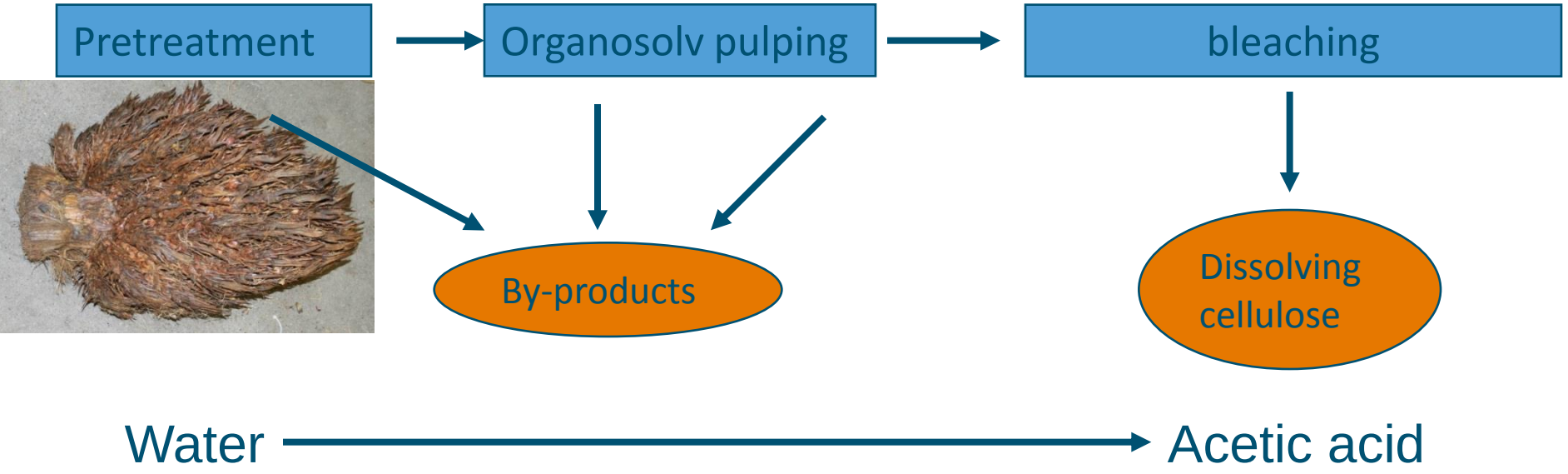
# Small Scale pretreatment of lignocellulose

- System size: 40 kton biomass per year (dry basis)
- Adapted to wet or dry biomass
- Fermentation of sugars to products
- Lignin conversion to electricity
  - Coupled to existing CHP facilities
  - Removal of unwanted elements (no ash fouling) prior to combustion

# Biorefinery concept

European Polysaccharide Network Of Excellence

Production of dissolving pulp from empty fruit bunches via acetic acid pulping process



# Interest and potential for collaboration

- Conversion of non-traditional feedstocks: oil palm byproducts, bamboo, sugar can trash, etc
- Mild pretreatment of agro-residues
- Small scale conversion concepts
- Lignin valorisation
- Sustainability and full biomass chain development

# Thank you

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