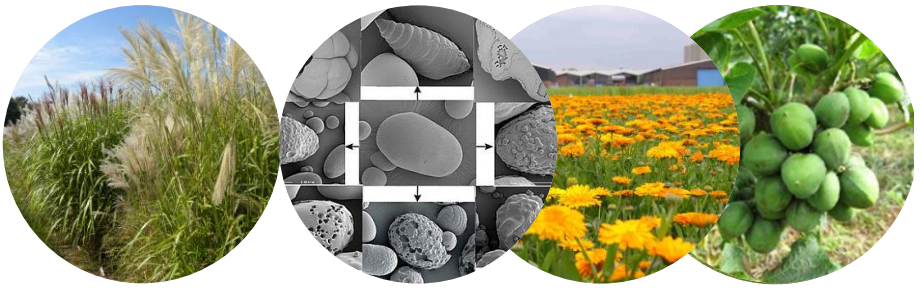
Plant Breeding for a Biobased Economy

Luisa Trindade

Wageningen UR Plant Breeding



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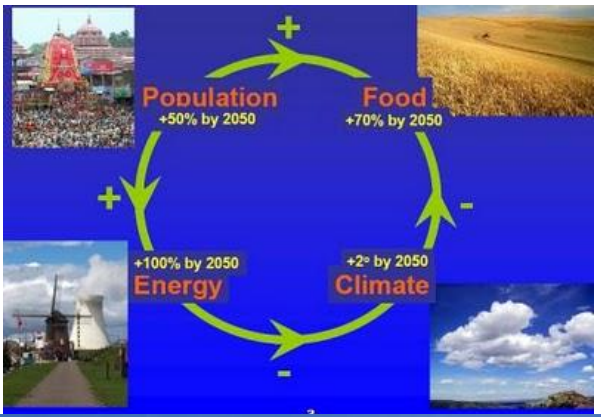
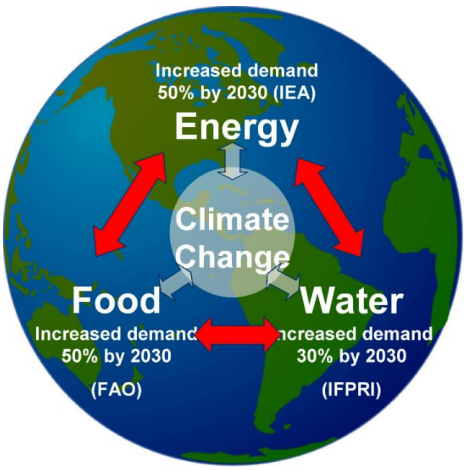
The world in 2050…



Main fossil oil reserves exhausted in 2050

Changing world – new challenges



1. Can nine billion people be **fed** equitably, healthily and sustainably?
2. Can we cope with the future demands on **water**?
3. Can we provide enough **energy** to supply the growing population coming out of poverty?
4. Can we mitigate and adapt to **climate change**?
5. Can we do all this in the context of redressing the decline in **biodiversity** and preserving ecosystems?

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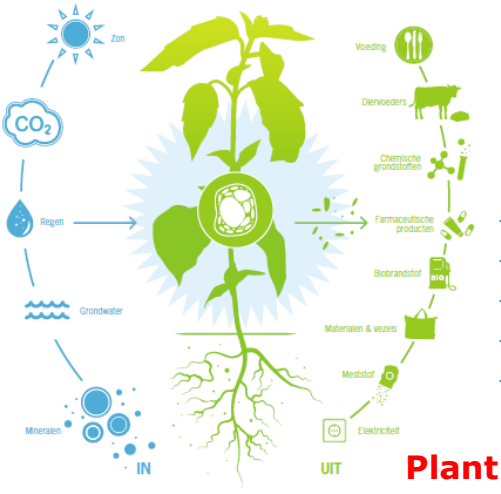
Sir John Beddington, 2012

Better plants for new demands

We need to produce more with less inputs

Require less

- Water
- Fertilizers
- Pesticides
- (sun) Light
- Energy



Produce more

- Food/Feed
- Bioenergy
- Biomaterials
- Biochemicals
- Pharmaceuticals

Plant Breeding

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Plant Breeding targets

- High yield and yield stability
- Biomass of good quality
  - Food/feed (ingredients)
  - Biobased applications – require different properties
- Crops able to grow on marginal lands
  - Salt, drought, cold, heat,...
- Sustainable crops
  - Efficient in use of water
  - Efficient in use of nutrients
- Resistance to pathogens

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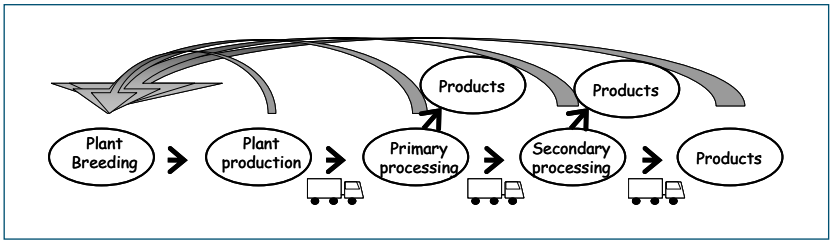
Breeding for biomass quality



- Right components with the required properties
- Facilitates the biorefining/extraction process
- Sustainability of the chain

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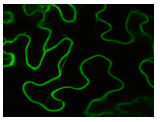
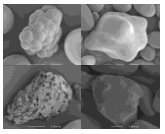
Breeding of Biobased crops

Plant = bio-factory

Primary metabolites

Secondary metabolites

Cell walls 	Oils 
Starch & Suc 	Rubber 

i) Understand the mechanism behind the synthesis and regulation

ii) Improve the quantity and quality in the plant (organ)

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Which crops to target?

The best crops and breeding targets will depend on the location, agro- and socio-economic environment

…but they have to fulfil the following demands:

- High yield
- Good quality (cell wall, oils, starch...)
- Fulfil sustainability criteria
- Adapted to local agro-economic situation
- Good position in breeding of the crop (plant material, breeding tools, expertise).
- Suitability for available production chains

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Biobased Production Chains with Potential

- Potato bio-refinery
- Sugar beet for the production of bio-chemicals
- Miscanthus bio-refinery
- Oil crops for biobased chemicals
- New grasses for bio-refinery
- New crops for natural rubber (guayule and dandelion)
- Maize bio-refinery: for feed and energy
- Microalgae

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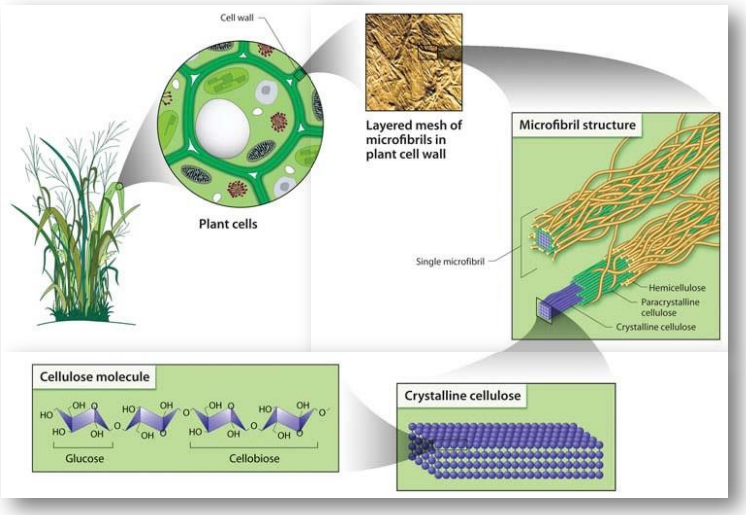
Koops and Trindade. Nov 2010. Research Vision on Plant Breeding for biobased production chains. Report 352. PRI - WUR

Breeding of Lignocellulosic crops



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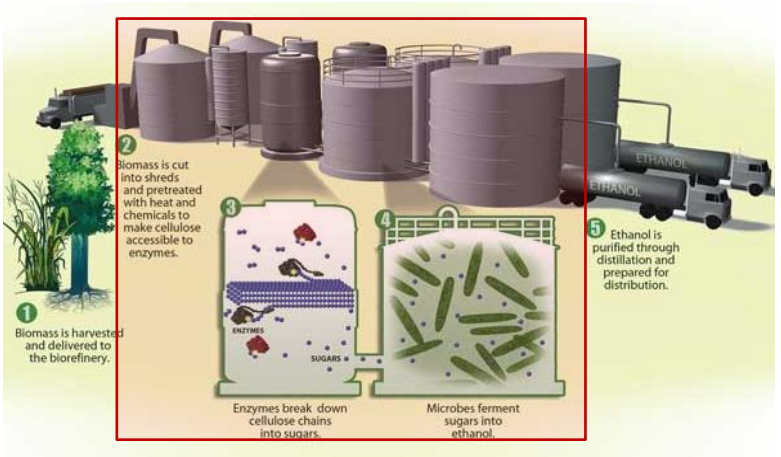
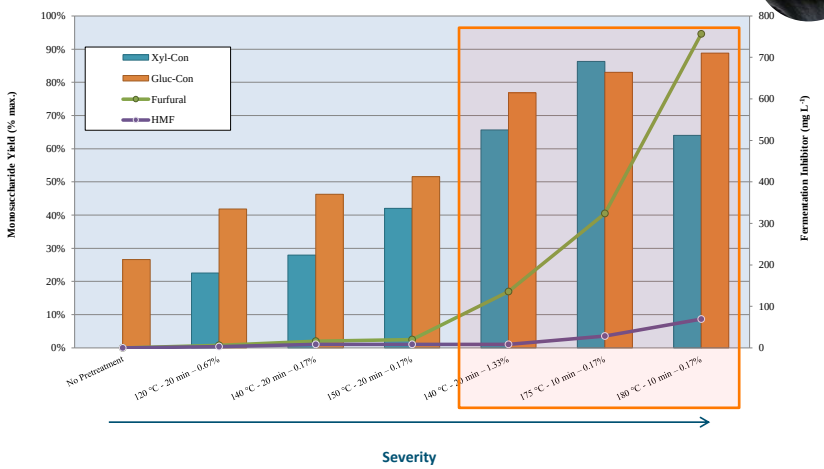
Cell walls for bioethanol



Is it possible to create lignocellulosic feedstocks that are more amenable to bioprocessing?

(Less Pretreatment, Less Enzyme, More Yields)

Trends in Bioconversion Efficiency



Higher severity pre-treatments → Release of more sugars
Increase formation of fermentation inhibitors

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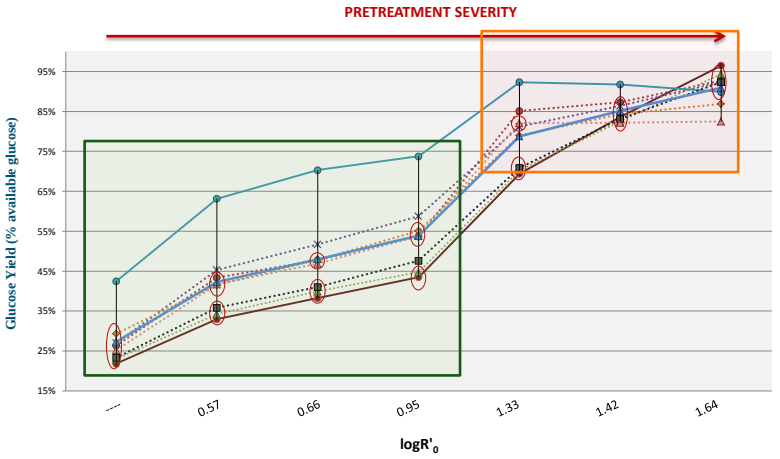
Torres *et al.* (2013). ***BioEnergy Research*** (Volume 6(3): 1038-1051)

Breeding of cell walls improves release of cell wall sugars



-Biomass quality plays a role in efficiency of pre-treatment at low severity
-At high severity pre-treatment the cellulose content is the most important factor

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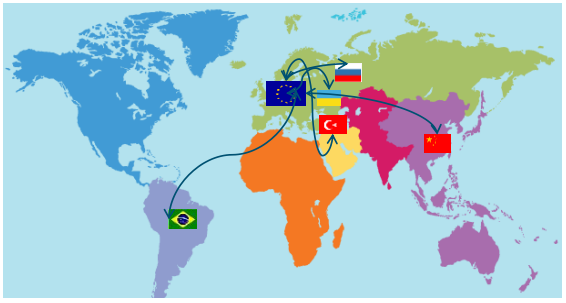
Torres *et al.* (2013). ***BioEnergy Research*** (Volume 6(3): 1038-1051)

Miscanthus sinensis: species of interest

- Sustainable crop with good agronomic characteristics for BBE (high biomass, mostly C)
- High biomass yield capacity (EU and US 40ton/ha)
- Perennial crop
- Low requirements in fertilizer (fixation atm N)
- Salinity tolerance
- Large genetic variation available (size, quality, …)
- Breeding possible

Miscanthus for energy, chemicals and materials

- NL has a leading position in breeding *Miscanthus sinensis*
- Area of *Miscanthus* cultivation is increasing rapidly (UK>15,000ha)
- Production chain being set up in NL: Breeding => Products
- R&D cooperation in EU-projects: participation NL companies



Opportunities with IP
* varieties
* biorefinery/processing
* products

European sugarcane

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SUNLIBB CCC CARBOHYDRATE COMPETENCE CENTER FP7 OPTIMISC FIBRA

Getting more out of potatoes

Now

Products:
- Starch
- Protein (for feed)
- Fiber (for feed)

After BBE Breeding

Products:
- Starch (improved properties)
- Protein
- Pectins
- Terpenes (for bio-plastics)
- Health compounds
- Fiber

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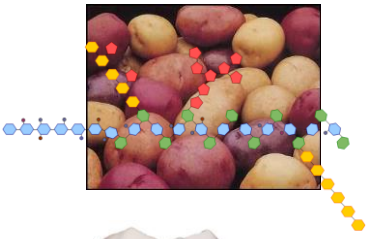
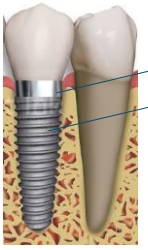
Pectins for medical applications

Potato modified Pectins
- Bone implants
- Vein implants (stents)
- Teeth implants





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STW project: WUR, HZPC, Aviko, Herbstreith &Fox

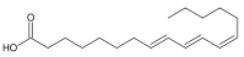
Plant oils for industrial applications

Calendula

Improvement of oil production

More filled-flowers

Medicinal properties



Calendic acid (63% of oil)

Paint without toxic solvents

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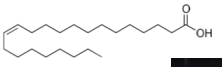
CALENDULA OIL

Improving oil composition in crambe

Crambe

Erucic acid



Lubricant
Bio-diesel

Erucamide:
-slip agent in plastics

Aim

Improve the yield and quality of Crambe oil:

1) Tilling population
2) Genetic modification

EU-project ICON

Biodiesel from Jatropha

Jatropha

12 different fatty acids

Very high quality bio-diesel!

Aim

Explore Jatropha natural biodiversity

Guayule for rubber and latex

Guayule

Rubber and latex

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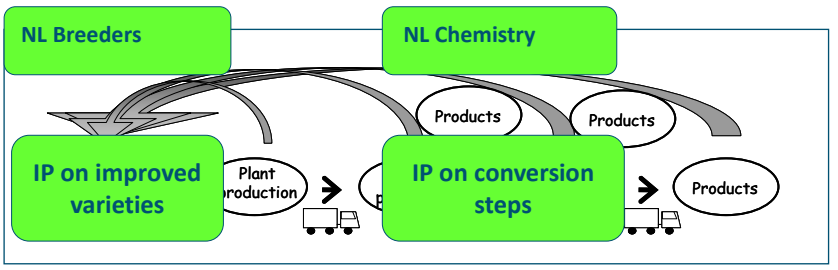
WUR - Whole chain approach

- Complementary expertise at the 5 science groups
  - Many (EU) collaborative projects
- Together we create unique opportunities for NL in biobased chains



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The Biobasers

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Thank you!