NOVEL MISCANTHUS-BASED VALUE CHAINS

CHE 650 Hazardous Waste Engineering Seminar:
Phytotechnology with Biomass Production

Moritz Wagner
Biobased Products and Energy Crops
Institute of Crop Science (340)
University of Hohenheim

Moritz.Wagner@uni-hohenheim.de

UNIVERSITY OF HOHENHEIM

Miscanthus as a biomass crop

- Tall perennial rhizomatous C4 grass
- Potential dry matter yield of up to 25 t ha^{-1} a^{-1} in Central Europe
- Low-input crop with a high nitrogen, land-use and energy efficiency
- Can be harvested annually (after a establishment phase) for up to 20 years

UNIVERSITY OF HOHENHEIM

Miscanthus research in Hohenheim

Expired Miscanthus projects:

- EMI
- OPTIMISC
- New miscanthus genotypes for lignocellulose-based value chains

Ongoing Miscanthus projects:

- MISCOMAR
- BioC4
- GRACE

UNIVERSITY OF HOHENHEIM

EMI – European Miscanthus Improvement

Time: 1997 – 2000

Funding: EU

Description:

- 15 Miscanthus genotypes were tested across Europe
- Propagation methods were developed and optimized

Start of miscanthus breeding in Europe (collection of germplasm in Asia)

UNIVERSITY OF HOHENHEIM

OPTIMISC – Optimizing Miscanthus Biomass Production

Time: 2011 – 2016

Funding: EU

Description:

- 15 novel Miscanthus hybrids tested across Europe
- Utilization options (e.g. bioethanol, biogas) analyzed
- Large scale establishment was demonstrated
- Life-Cycle Assessment of various conversion routes
- Follow-up of EMI project

The project is supported by funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement no.°289159.

UNIVERSITY OF HOHENHEIM

OPTIMISC – Optimizing Miscanthus Biomass Production

- Intermediate products from two European breeding programs (IBERS, WUR) were tested

The project is supported by funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement no.°289159.

UNIVERSITY OF HOHENHEIM

New miscanthus genotypes for lignocellulose-based value chains

Time: 2014 – 2017

Funding: Ministry of Science, Research and Arts Baden-Württemberg

Description:

- 5 novel seed-based hybrids tested at 3 sites in Baden-Württemberg
- Focus on rather marginal areas
- Development of seed-coating method for miscanthus seeds
- Assessment of environmental performance

BIO ECONOMY RESEARCH BADEN-WÜRTTEMBERG

UNIVERSITY OF HOHENHEIM 1818

New miscanthus genotypes for lignocellulose-based value chains

First tests with near-to-market hybrids on marginal areas

BIO ECONOMY RESEARCH
BADEN-WÜRTTEMBERG

UNIVERSITY OF HOHENHEIM
1818

New miscanthus genotypes for lignocellulose-based value chains

BIO ECONOMY RESEARCH
BADEN-WÜRTTEMBERG

UNIVERSITY OF HOHENHEIM
1818

MISCOMAR – Miscanthus biomass options for contaminated and marginal land

Time: 2016 – 2019

Funding: BMBF, FACCE SURPLUS

Description:

- Medium-scale test of novel seed-based hybrids
- Novel establishment method (biodegradable mulch film)
- Field test on heavy metal contaminated site in Poland
- Analysis of soil interactions/changes under miscanthus
- Utilization: Biogas (green harvest) and combustion (dry harvest)

FACCE SURPLUS
SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652615.

SPONSORED BY THE
Federal Ministry of Education and Research

MISCOMAR

Near-to-market hybrids tested on marginal and contaminated areas

FACCE SURPLUS
SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652615.

SPONSORED BY THE
Federal Ministry of Education and Research

MISCOMAR

FACCE SURPLUS
SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652615.

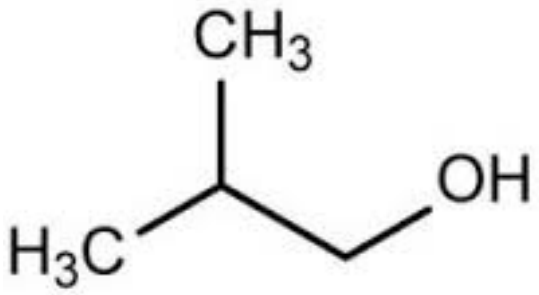
SPONSORED BY THE
Federal Ministry of Education and Research

BioC4

BioC4 – New integrative sustainable system from C4 photosyntetic miscanthus to biological synthesis of valuable C4 compounds

Time: 2016 – 2019

Funding: BMBF, FACCE SURPLUS



FACCE SURPLUS
SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652615.

SPONSORED BY THE
Federal Ministry of Education and Research

BioC4

Description:

- Development of new yeast stream which produces Isobutanol (aviation fuel, platform chemical)
- Miscanthus as raw material
- Biogas yield potential of residues
- Life-Cycle Assessment and concept study

Novel, high-value utilization option for miscanthus biomass

FACCE SURPLUS
SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652615.

SPONSORED BY THE
Federal Ministry of Education and Research

BBI Annual Work Plan 2016 – Call D2

BBI 2016.D2 – Improvement and adaptation of industrial crop varieties and novel sources of biomass to diversify biomass feedstock for bio refineries

Scope: Demonstrate the techno-economic viability and sustainability of complete value chains based on utilization of dedicated, purposely developed biomass production systems as feedstock for the bio-based industries.

Specific focus on non-food-conflicting biomass production systems:

- that are suitable for cultivation on unused, marginal or contaminated land (optional: phytoremediation)
- that can be cultivated in novel and highly resource-efficient conditions

Sustainability (LCA) and sound business models of entire value chain need to be included!

UNIVERSITY OF HOHENHEIM

GRACE - GRowing Advanced industrial Crops on marginal lands for biorEfineries

BBI Demonstration project

Coordinated by: University of Hohenheim (340b)

Consortium: 22 partners from science, industry (incl. SME) and agricultural sector

Time: 2017 – 2022

Funding: BBI within EU H2020

Budget: 15 million €

GRACE

Bio-based Industries Consortium

BIO-BASED INDUSTRIES Public-Private Partnership

Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

GRACE - Partners

Bio-based Industries Consortium

BIO-BASED INDUSTRIES Public-Private Partnership

Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

GRACE

Description:

- Crops: Miscanthus and hemp
- Large scale demonstration of seed-based miscanthus hybrids
- Focus areas: marginal, contaminated and abandoned land
- Linking biomass production to industrial application
- Connecting all stakeholders along various value chains

  (from farmer to industry)
- Assessment of environmental, social and economic impacts

GRACE

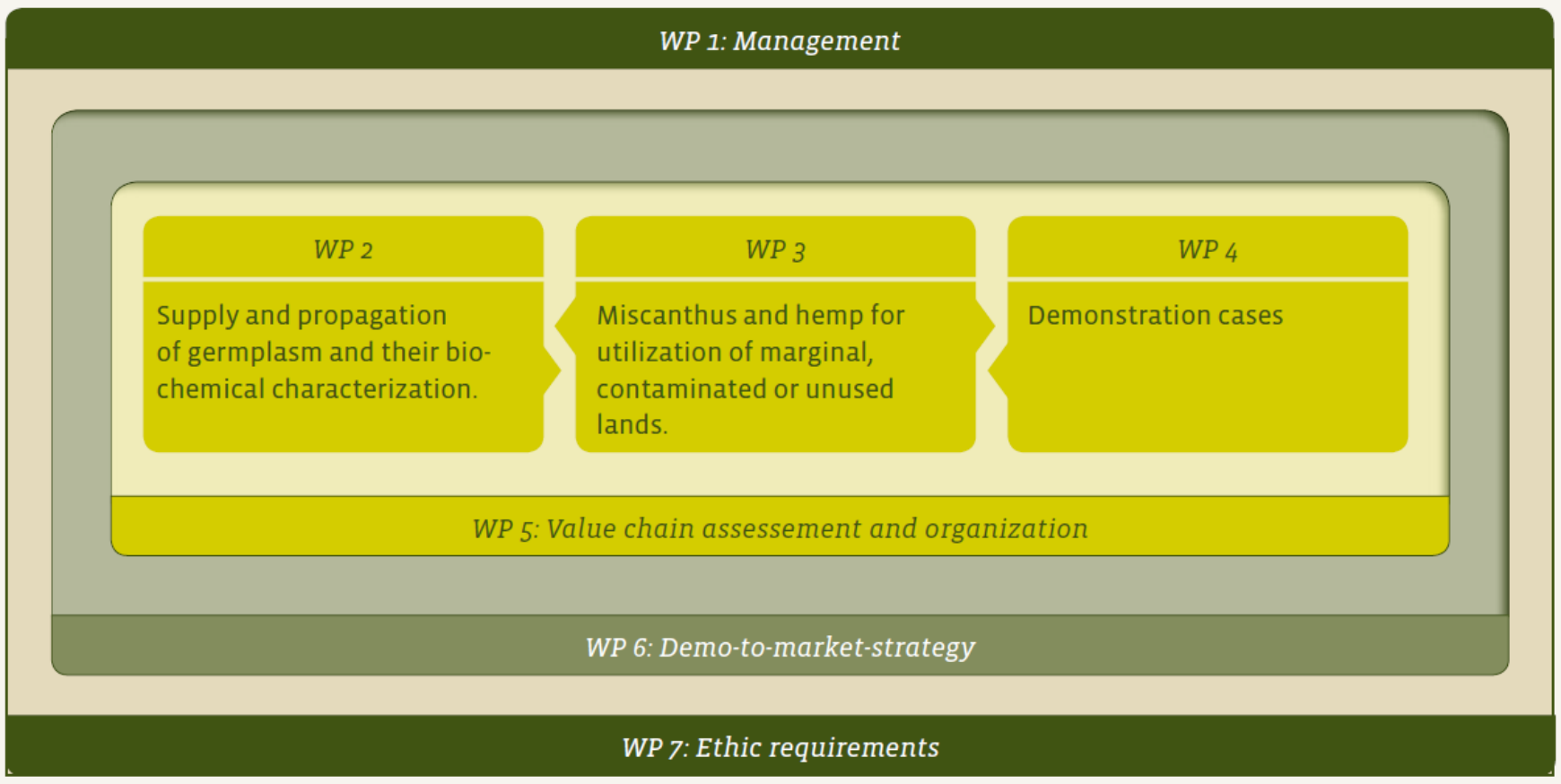
Bio-based Industries Consortium

BIO-BASED INDUSTRIES Public-Private Partnership

Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

GRACE



Bio-based Industries Consortium
BIO-BASED INDUSTRIES Public-Private Partnership
Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

GRACE – WP 2/3: Propagation and crop production

Demonstration of crop production (>80 ha):

- Suitability of hemp and miscanthus for marginal, abandoned and contaminated land


Source: S. Amaducci


Source: Uwe Kühn

GRACE

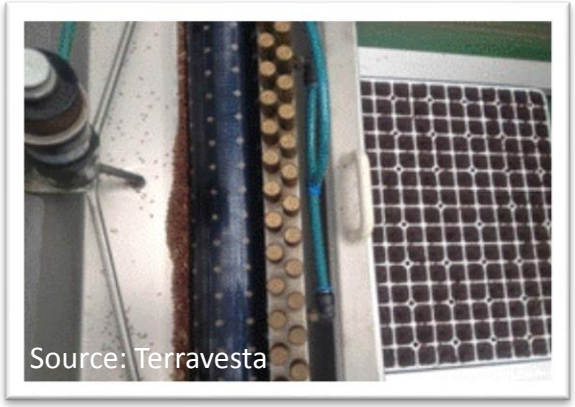
Bio-based Industries Consortium
BIO-BASED INDUSTRIES Public-Private Partnership
Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

GRACE – WP 2/3: Propagation and crop production

Demonstration of crop production (>80 ha):

- Upscaling of miscanthus seed production, seed-based propagation and crop production (Logistics!)



Bio-based Industries Consortium

BIO-BASED INDUSTRIES Public-Private Partnership

Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

GRACE – WP 4: Demonstration Cases

Ten Demonstration Cases

- **Green Building**
- **Green Agriculture**
- **Green Medicine and Cosmetics**
- **Green Chemistry**
- **Green Composites**

GRACE

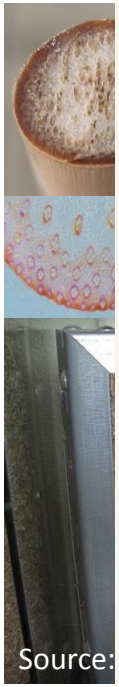
Bio-based Industries Consortium

BIO-BASED INDUSTRIES Public-Private Partnership

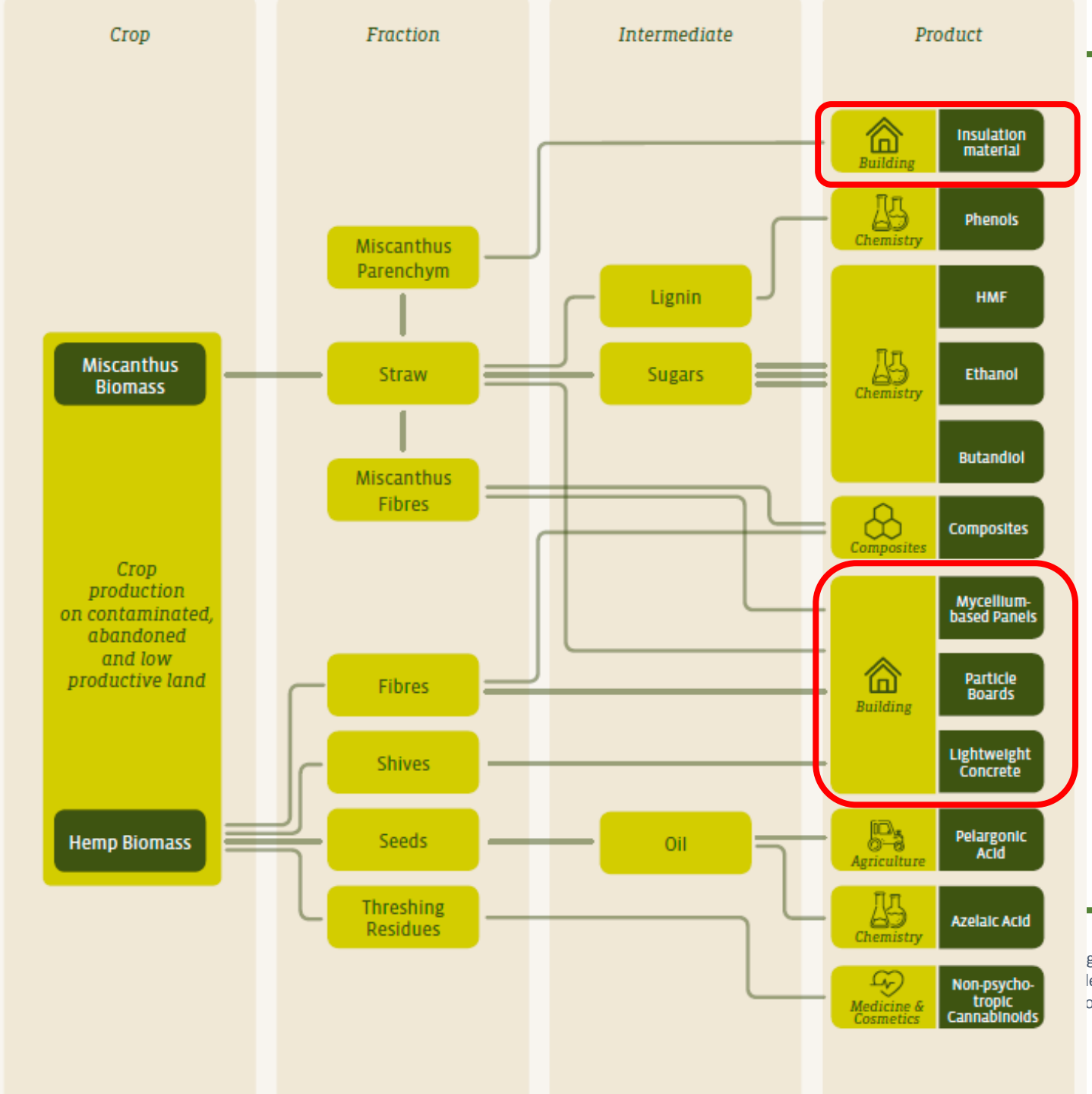
Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

Gree
misc



Source:



Bio-based

g from the Bio-
ler the European
ovation programme

Green Building: Utilizing miscanthus parenchym as insulation material

- Fractionate parenchym from stem fragments and utilize as insulation material in building bricks

Bio-based Industries Consortium

BIO-BASED INDUSTRIES Public-Private Partnership

Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

Green Building: Mycelium-based panels from hemp and miscanthus


Source: MOGU s.r.L.


Source: MOGU s.r.L.


Source: MOGU s.r.L.

- Fungal biomass as glue for lignocellulosic substrates

Bio-based Industries Consortium
BIO-BASED INDUSTRIES Public-Private Partnership
Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

Green Building: Formaldehyde-free bio-building material

Biomass

Preparation and mixing with biomass

Pressing

Formaldehyde-free biobuilding panel

- Hemp- and miscanthus-based building panels, patented technology by CMF Greentech

Bio-based Industries Consortium

BIO-BASED INDUSTRIES Public-Private Partnership

Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

Green Building: Lightweight Concrete

Source: Schiphol Trade Park

- Schiphol refinery
- Lightweight concretes, paper and paper-based products
- Based on miscanthus biomass

Source: http://acroniq.nl/

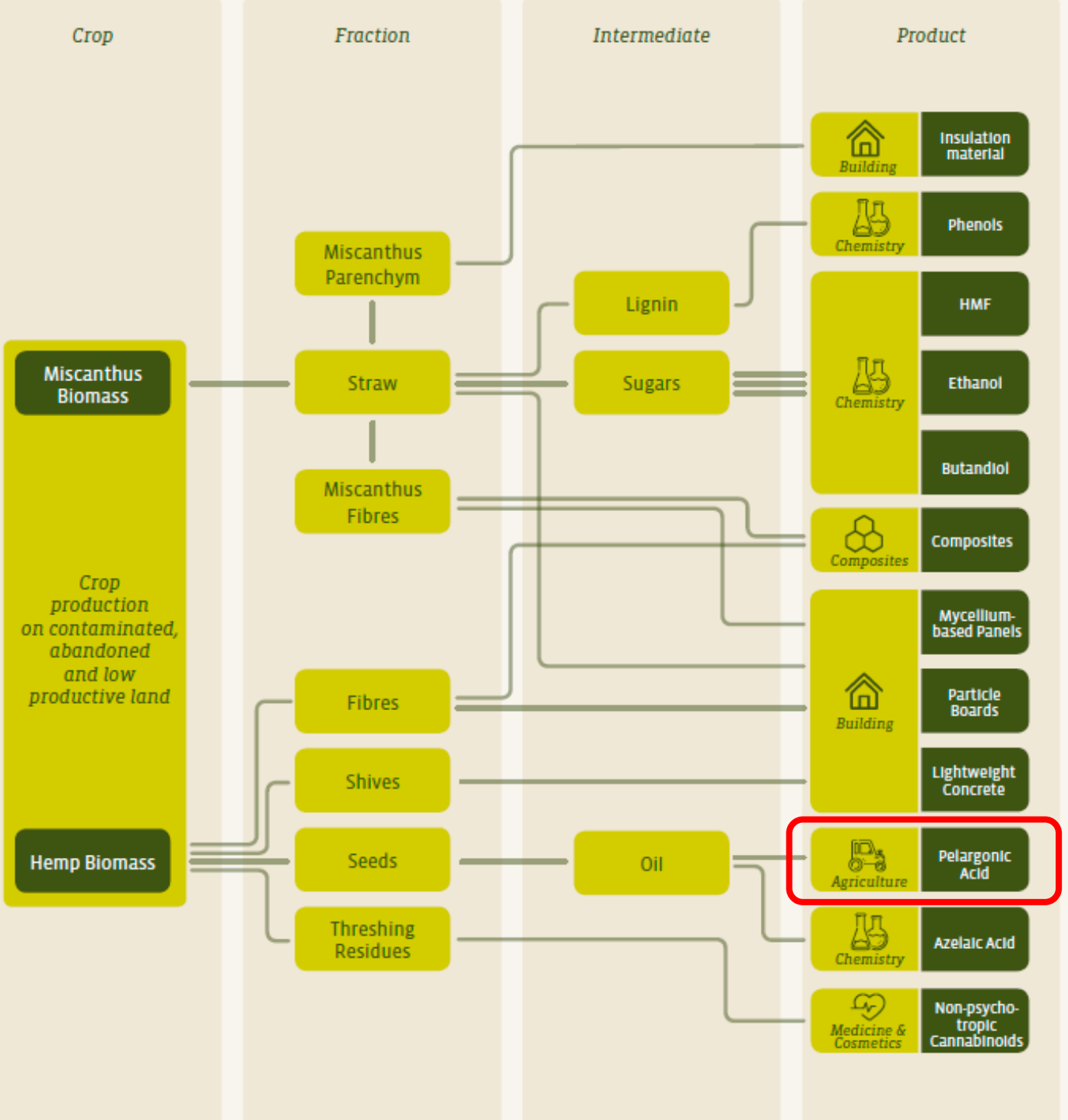
Bio-based Industries Consortium

BIO-BASED INDUSTRIES Public-Private Partnership

Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

Gree


Crop
Fraction
Intermediate
Product
Miscanthus Biomass
Crop production on contaminated, abandoned and low productive land
Hemp Biomass
Miscanthus Parenchym
Straw
Miscanthus Fibres
Fibres
Shives
Seeds
Threshing Residues
Lignin
Sugars
Oil
Building
Insulation material
Chemistry
Phenols
HMF
Ethanol
Butandiol
Composites
Mycellium-based Panels
Particle Boards
Lightweight Concrete
Agriculture
Pelargonic Acid
Azelaic Acid
Medicine & Cosmetics
Non-psycho-tropic Cannabinoids

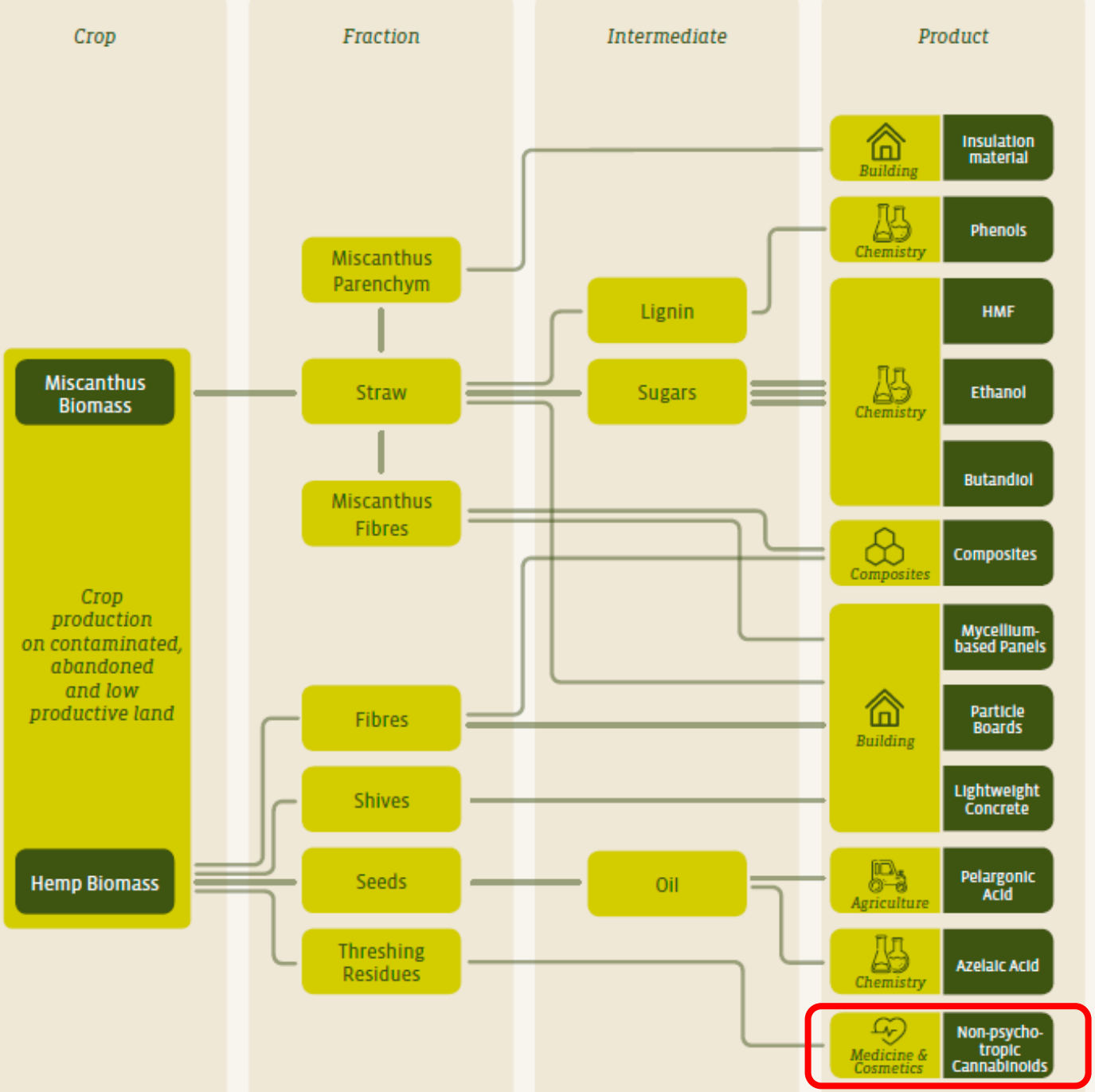
Green Agriculture: Bio-herbicide refinery

- Hemp oil-based pelargonic acid as herbicide
- Pelargonic acid causes rapid and non-selective burn-down of green tissues
- Possible substitute of glyphosate

Bio-based Industries Consortium
BIO-BASED INDUSTRIES Public-Private Partnership
Horizon 2020 European Union Funding for Research & Innovation

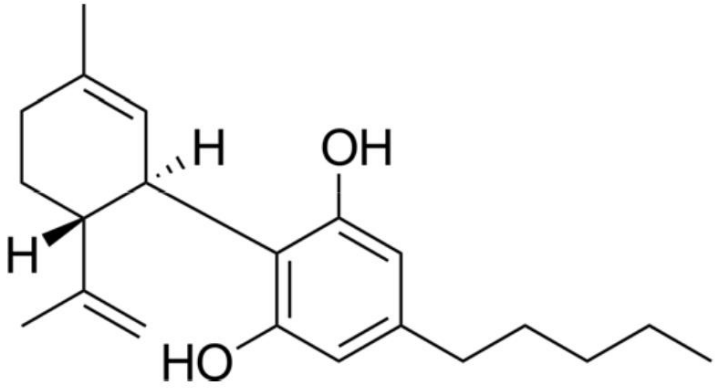
The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

Gree



g from the Bio-
ler the European
ovation programme

Green Medicines and Cosmetics:

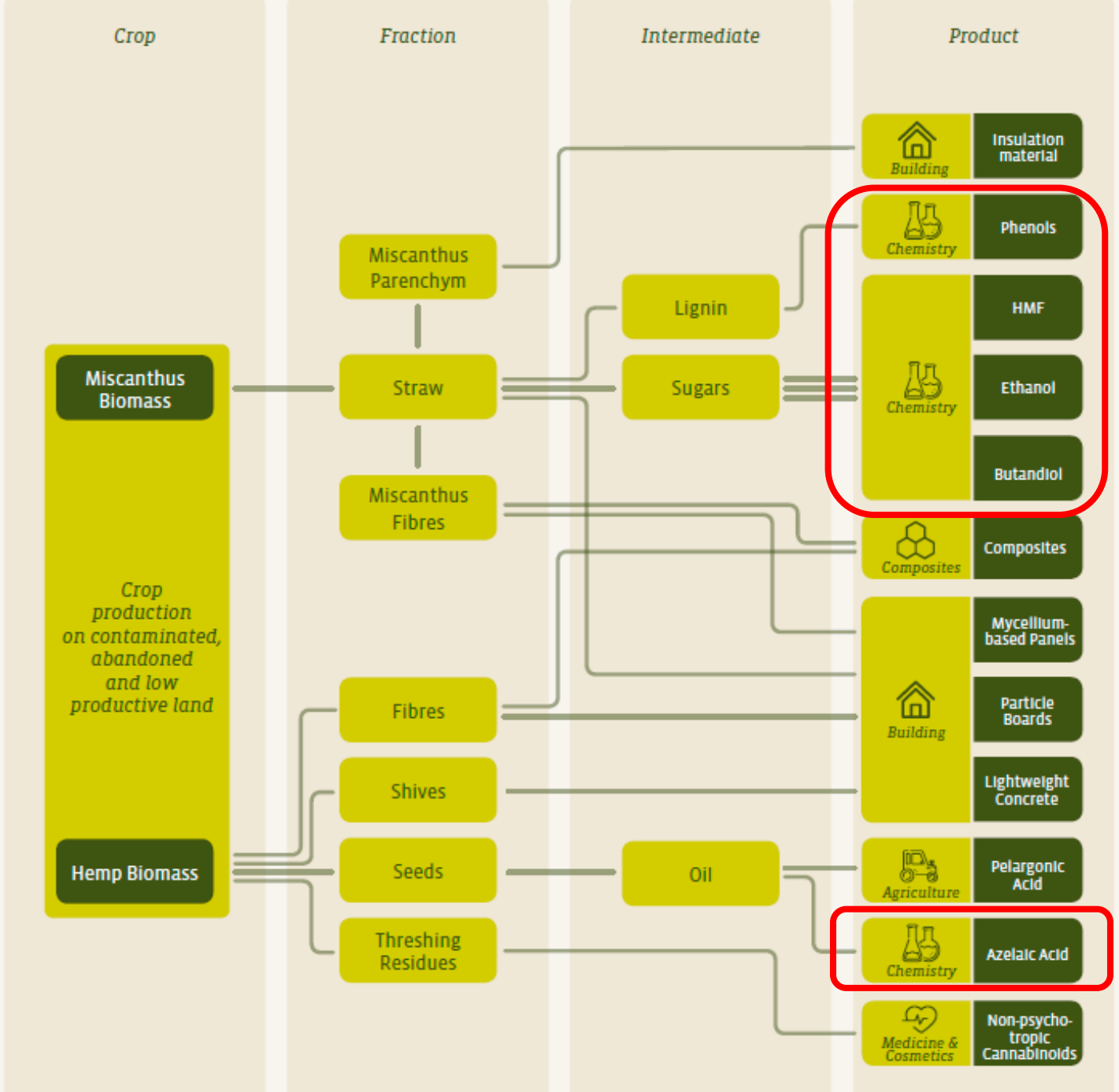


- Extraction of non psychotropic cannabinoids from hemp threshing residues for medicinal and cosmetic application

Bio-based Industries Consortium
BIO-BASED INDUSTRIES Public-Private Partnership
Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

Gree
chei



g from the Bio-
ler the European
ovation programme

Green Chemistry: Production of platform chemicals as building blocks for polymers

Lignin-rich fraction → Phenols

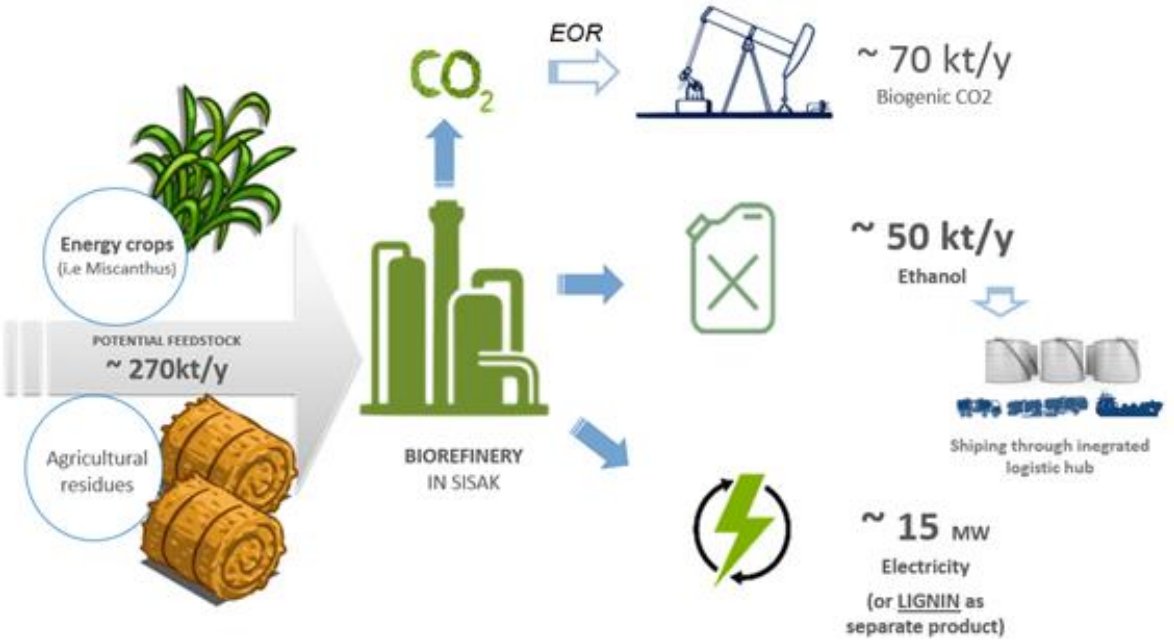
Cellulose and hemicellulose → Sugars → HMF

- HMF for example can be used to produce Polyethylenfuranoat (PEF) which can replace PET

Bio-based Industries Consortium
BIO-BASED INDUSTRIES Public-Private Partnership
Horizon 2020 European Union Funding for Research & Innovation

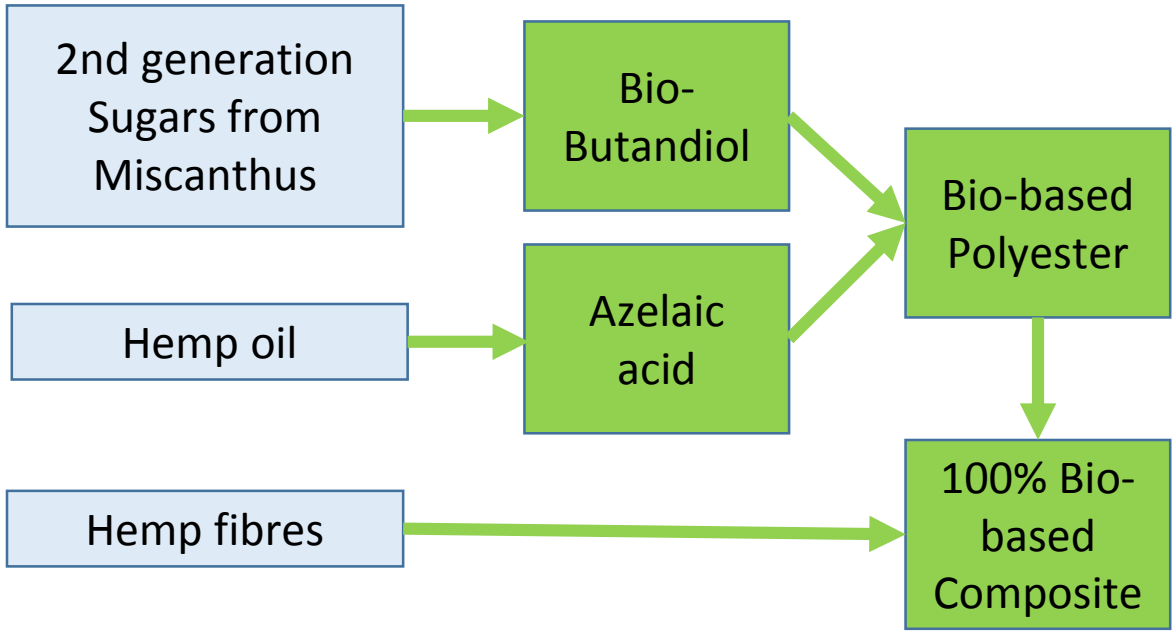
The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

Green Chemistry: INA Ethanol refinery - Fuel/chemicals from abandoned land



The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

Green Chemistry: Platform chemicals for bioplastic and 100% biocompounds

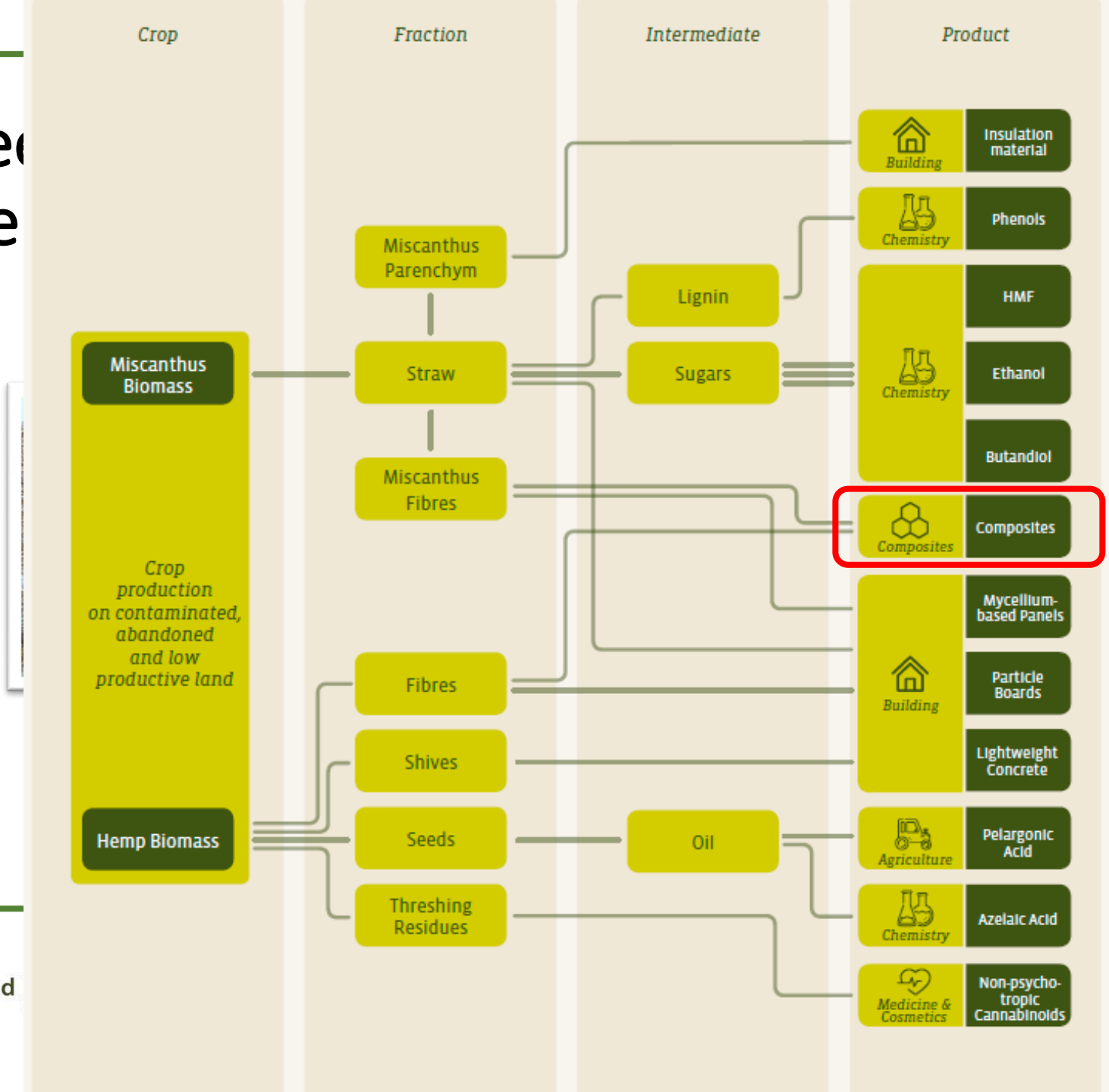


- Bio-Butandiol (BDO) is an 1:1 replacement of fossil BDO
- Azelaic acid platform chemical for various chemical applications

Bio-based Industries Consortium
BIO-BASED INDUSTRIES Public-Private Partnership
Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

Gree… fibe… …al



g from the Bio-
ler the European
ovation programme

Green Composites: Reinforced with natural fibers

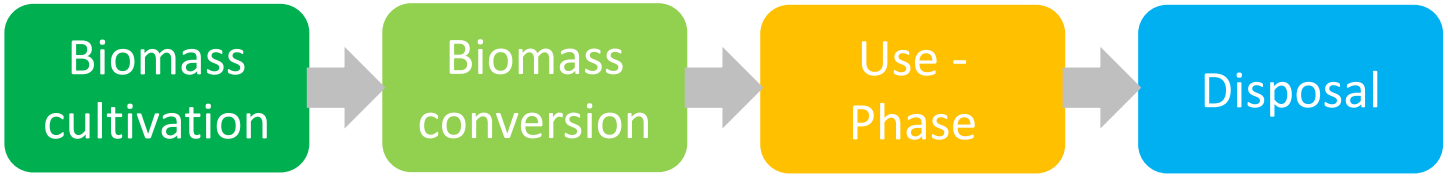
- Polypropylene composites reinforced with miscanthus and hemp fibers

Bio-based Industries Consortium
BIO-BASED INDUSTRIES Public-Private Partnership
Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

GRACE – WP 5: Value Chain Assessment and Organization

- Assessment of **environmental**, **social** and **economic** sustainability, identification of hot spots and potential for optimization



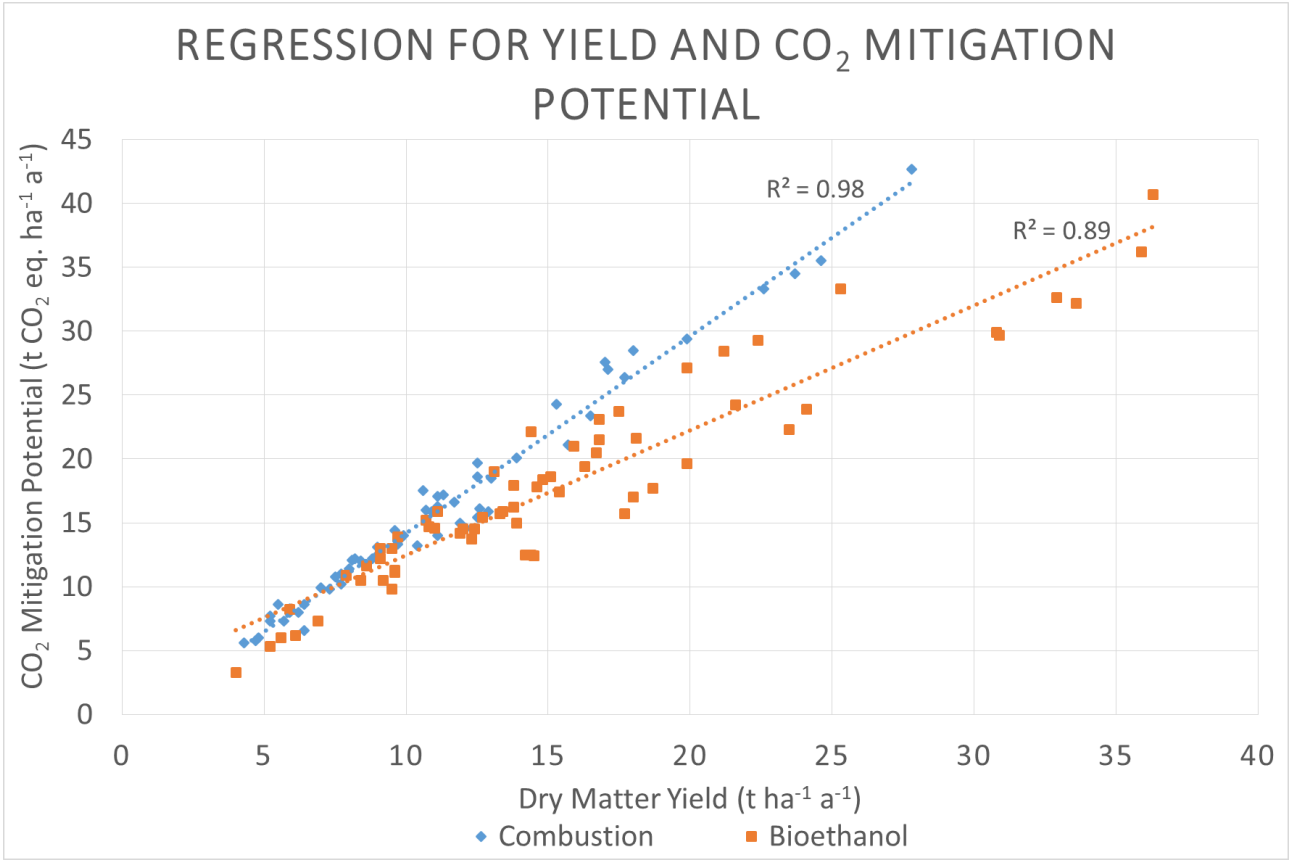
Value Chain

GRACE

Bio-based Industries Consortium
BIO-BASED INDUSTRIES Public-Private Partnership
Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

GRACE – Value Chain Assessment



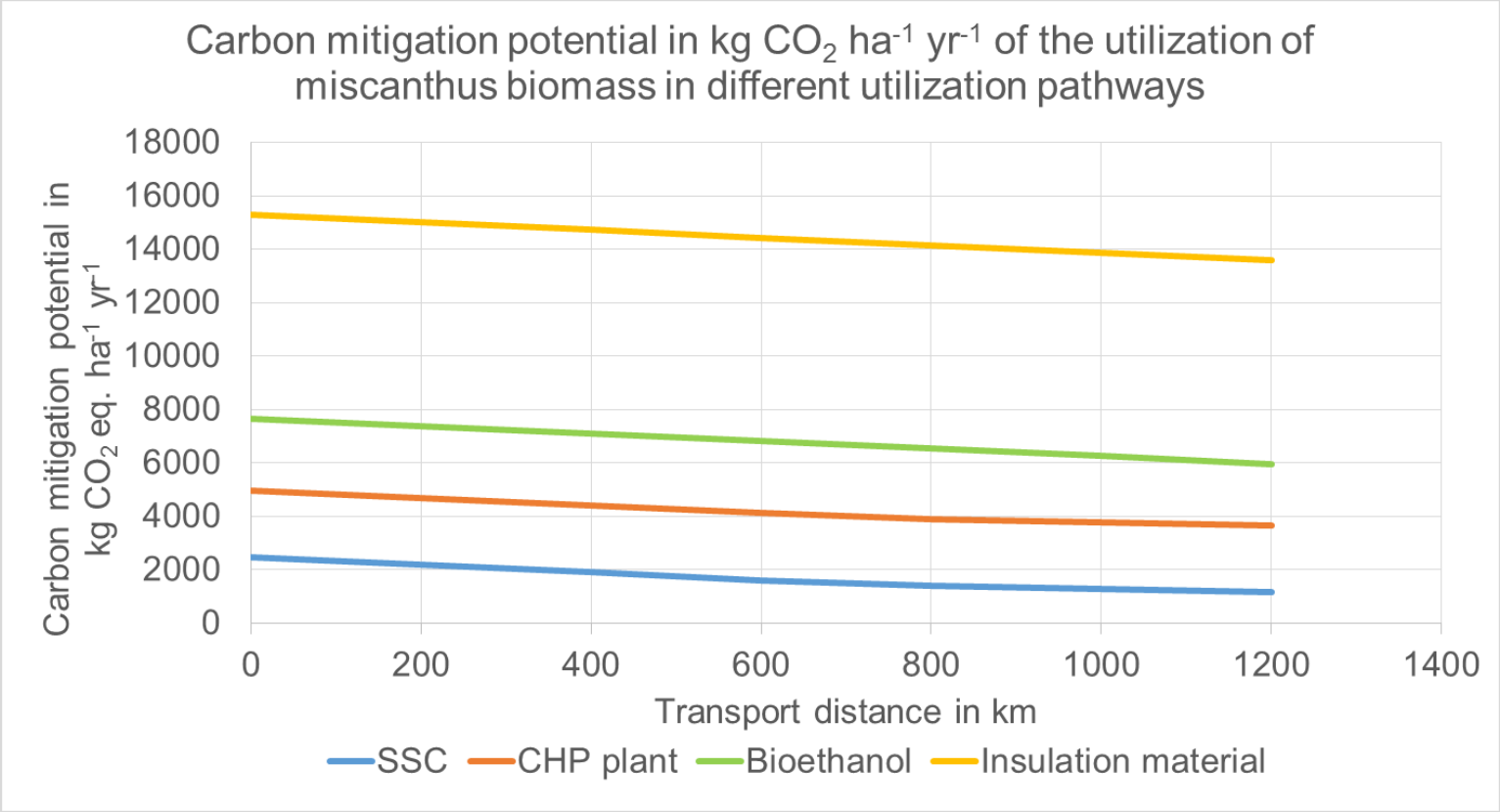
Bio-based Industries Consortium

BIO-BASED INDUSTRIES Public-Private Partnership

Horizon 2020 European Union Funding for Research & Innovation

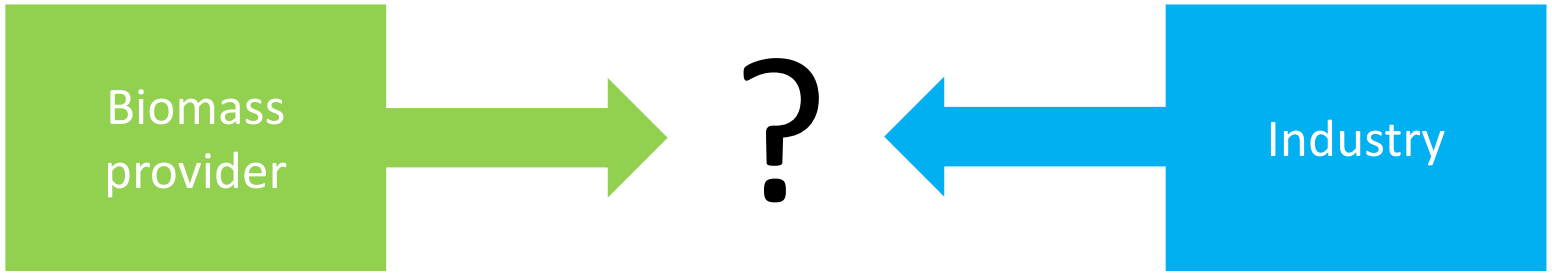
The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

GRACE – Value Chain Assessment



The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

GRACE – Value Chain Organization



Why grow miscanthus when there is no demand?

Why develop miscanthus-based products/processes when there is no sufficient biomass supply?

Problem: Missing market for miscanthus!

Bio-based Industries Consortium
BIO-BASED INDUSTRIES Public-Private Partnership
Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

GRACE – WP 6: Demo-to-market strategy

Industry Panel:

- ✓ Interested Industry, SME and farmers can join
- ✓ Access to biomass for own tests (novel miscanthus varieties, hemp)
- ✓ „to bring together the actors (e.g. industry and farmers) along value chains“
- ✓ Create markets for biomass and bio-based products
- ✓ Increase the outreach of the project

Interested?

GRACE

Bio-based Industries Consortium
BIO-BASED INDUSTRIES Public-Private Partnership
Horizon 2020 European Union Funding for Research & Innovation

The GRACE project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 745012.

Thank you for your attention!

UNIVERSITY OF HOHENHEIM