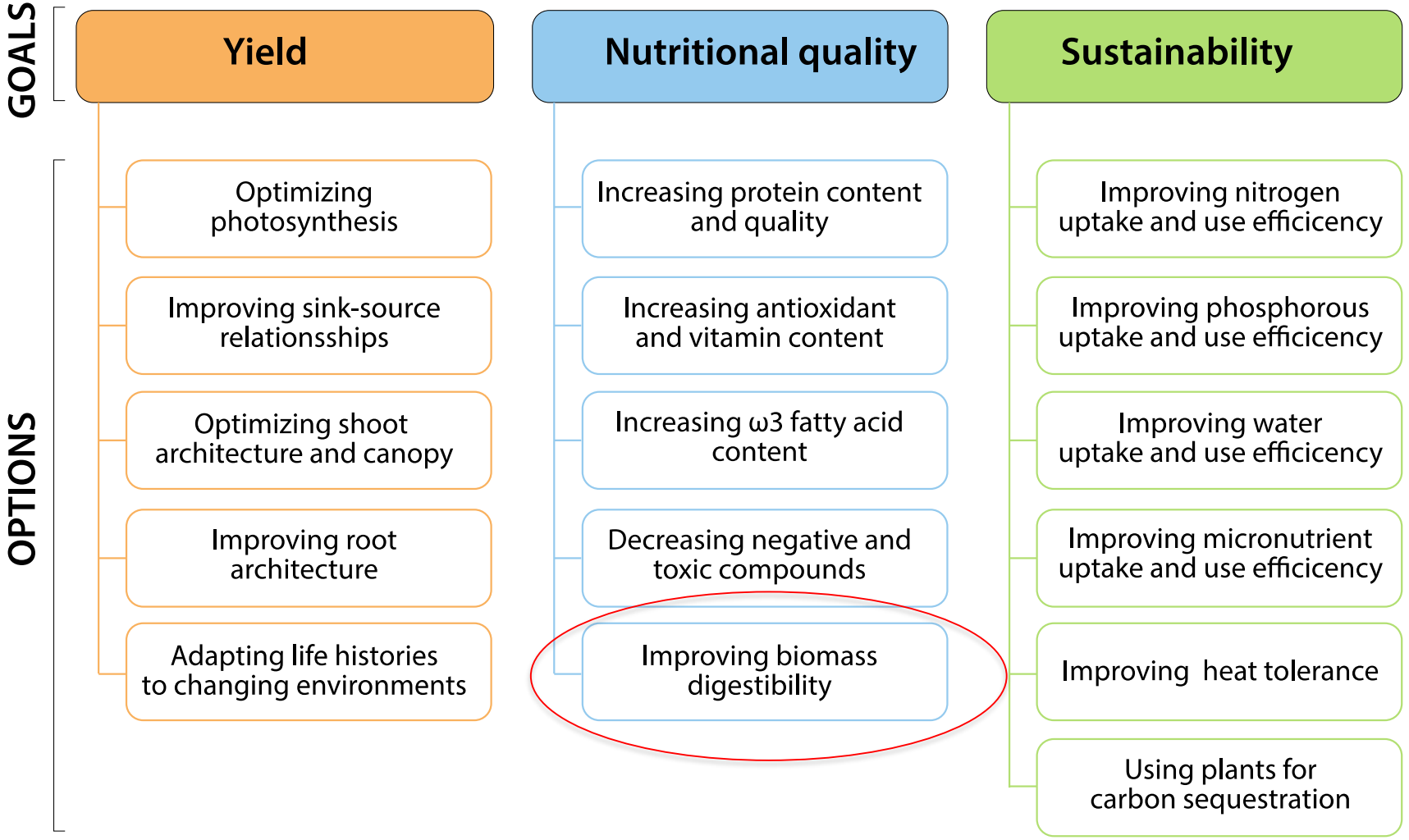
Cropbooster-P goals



CROPBOOSTER:
Lignocellulosic biomass research

Wout Boerjan: Plant Systems Biology, VIB, Ghent

Herman Höfte: IJPB, INRAE, Versailles

Iris Lewandowski: Dept Biobased Resources in the Bioeconomy, Univ. Hohenheim

Matthieu Reymond: IJPB, INRAE, Versailles

Henrik Vibe Scheller: Joint BioEnergy Inst., Berkeley

Luisa Trindade: Plant Breeding Dpt, Wageningen Univ

Context

- Green deal, carbon neutrality by 2050
- Replace fossil resources by biomass
- Opportunities for farming community to contribute to the development of advanced biorefineries: animal feed, fertilizers, chemicals, materials and energy
- How to avoid competition food production ?

Biorefineries:

biomass supply : different models

- Import of biomass (ex. Neste biorefinery in Rotterdam)

- Plantation surrounding bio-refinery (e.g. ethanol from sugarcane, Brazil)

- Small scale on-farm development and diversification (e.g. on-farm anaerobic digestion)

Limiting competition with food production ?

- Multipurpose food/feed crops
- Dedicated crops
  - Fast growing intermediate/catch crops
  - Perennials (C4-grasses, trees) on « marginal land »

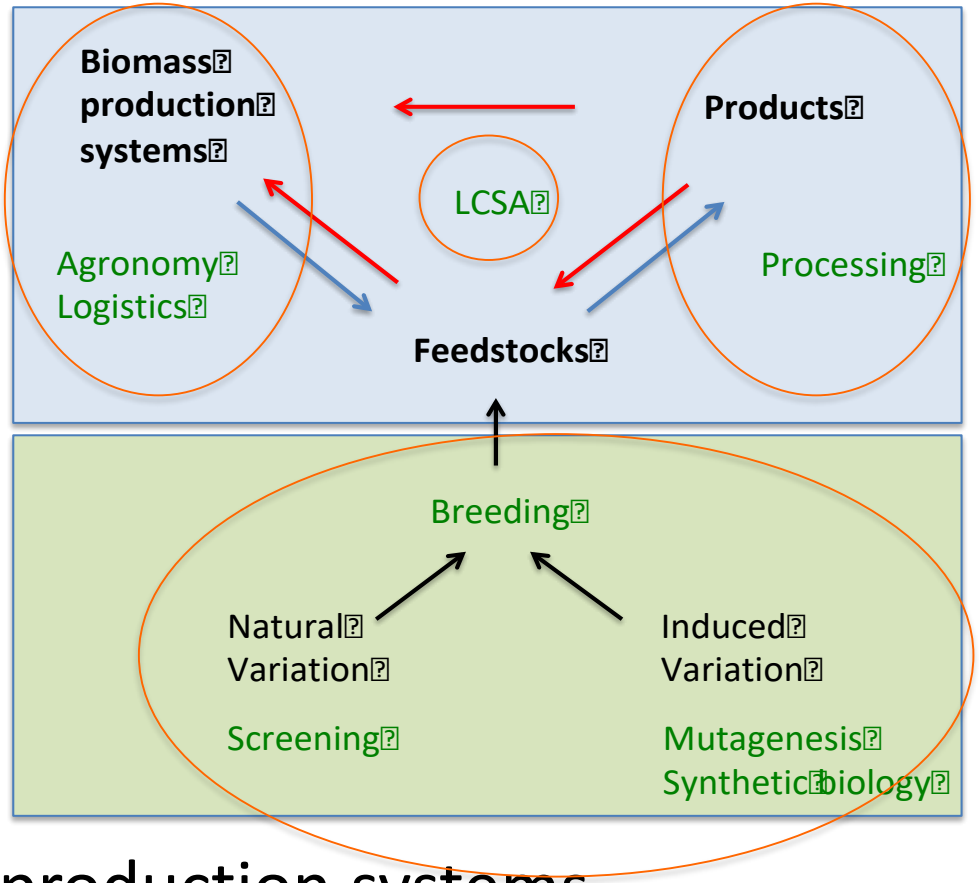

Sorghum intermediate crop, 2 months


Miscanthus

Perennials

- Minimal soil disturbance, soil coverage
  - limited erosion,
  - long term microbial communities, soil fauna
  - no need for herbicides after establishment
- Water management:
  - early growth season
  - deep rooting
- Late harvest
  - nutrient recycling: less fertilizer and GHG emissions
  - low moisture content of biomass
- Reduced fuel consumption : one intervention/year

Bottlenecks addressed by plant research



- Biomass production systems
- Biomass products and processing
- Life Cycle Sustainability Assessment
- Breeding

Biomass production systems and LCSA

- Agronomy, LCSA, modeling
- Replacing vegetative propagation by seed-based varieties
- Evaluation nutrient fluxes during growth cycle
- Impact of water management on yield and biomass quality
- Impact of soil microbiote on performance
- Evaluation C-storage in soil, lodging
- Fate of pollutants, in soil and in biomass, when grown on polluted soil
- Evaluation invasiveness risk

Biomass products and processing

- Screen for high value fractions or molecules
- Design sustainable biomass deconstruction methods
  - Knowledge on structures and functional properties of PS, lignins and small molecules
  - Knowledge on polymer interactions, nano-meso-scale wall architecture
  - Histology of plant organs
- Study microbial enzyme repertoires and adaptation to industrial processes

Breeding tools

- Genetics of self-incompatibility
- Molecular breeding
  - molecular markers, genomic models and HT phenotyping
  - Decomposing traits e.g. with ecophysiological models and omics data
  - Integration data using AI
- Genome editing combined with comparative genomics
  - Efficient transformation/regeneration
  - Knowledge on wall biosynthesis and regulation , identification of favorable alleles
- Synthetic biology
  - Engineering biosynthetic pathways cell wall components and secondary metabolites, while limiting impact on agronomic performance

Breeding targets

Trait	Corresponding plant research
Optimized biomass yield and quality for a given latitude	Regulation time of flowering and senescence and how they influence crop establishment success, biomass yield, composition and harvestability
Optimized NUE	Nutrient cycle, control of senescence, the role of the rhizome in perennial grasses
Optimized WUE	Drought stress response, arbuscular mycorrhizae
Optimized photosynthesis	Optimizing photorespiratory cycles, faster non-photochemical quenching
Growth on "marginal land"	Temperature, salinity, heavy metal, drought stress tolerance. Optimized nutrient and water use efficiency
Creation of seed-propagated but non-invasive hybrids	Investigating causes of invasiveness in different crops (e.g. seed or vegetative dispersal) and corresponding mitigation strategies.
Direct sowing in the field	Critical factors controlling seed size and seedling vigor
Crop architecture and stem density adapted for optimal biomass yield and lodging resistance	Ecophysiological modeling of crop architecture; source sink relationships in biomass crops; regulation of secondary cell wall accumulation.

Breeding targets

Trait	Corresponding plant research
The accumulation of specific metabolites or polymers	Biodiversity, biosynthesis and functional properties of secondary metabolites, polysaccharides and lignins.
Downstream processing	Structure-function of cell wall polymers; nano- and mesoscale cell wall architectures. Biodiversity screens for cell wall modifying enzymes. Fiber formation and cell separation for improved retting of fiber crops.
Genetic modification of biomass composition	Understanding the relation between cell wall composition (cellulose/hemicellulose and lignin) and cell wall recalcitrance. Transcriptional and post-transcriptional regulation of secondary cell wall deposition. Identification of new genes involved in cell wall polymer biosynthesis. Functional testing of mutants in these genes for increased biomass digestibility. Biodiversity screens for enzymes synthesizing monolignol substitutes that can be incorporated in lignins. Understanding the relation between cell wall modification and plant development and yield.
Interactions of biomass composition with the environment	Impact of environmental factors on biomass histology and cell wall composition. Potential bioactivity of phenylpropanoids and the impact of biomass composition on growth-promoting rhizobacteria and endophytes.