Belgian Biomass Workshop in the frame of BERA/EERA

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Chemical composition and biofuels potentials of various vegetal biomasses

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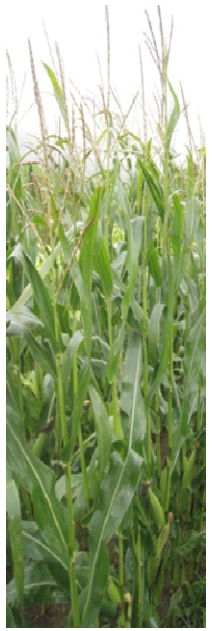

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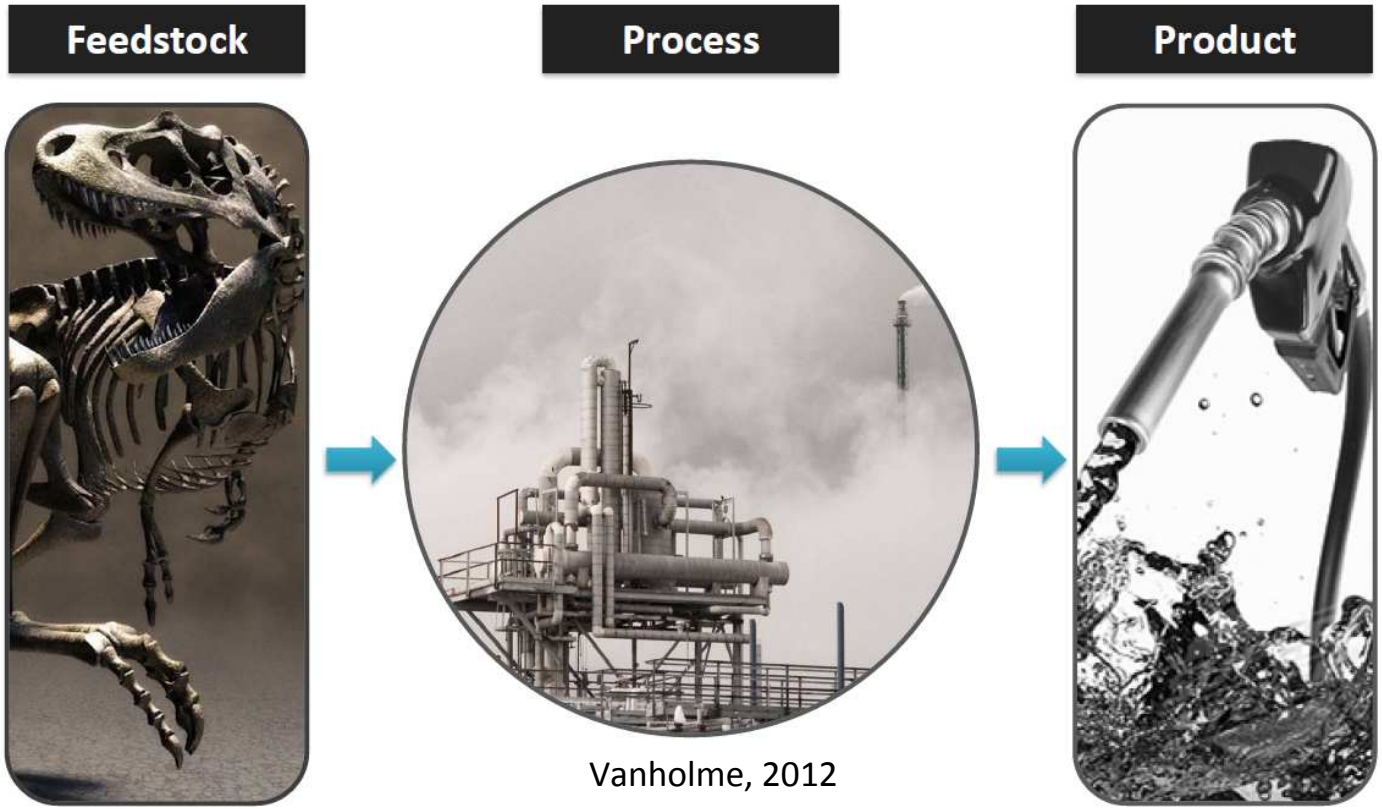
Context

Fossil fuels

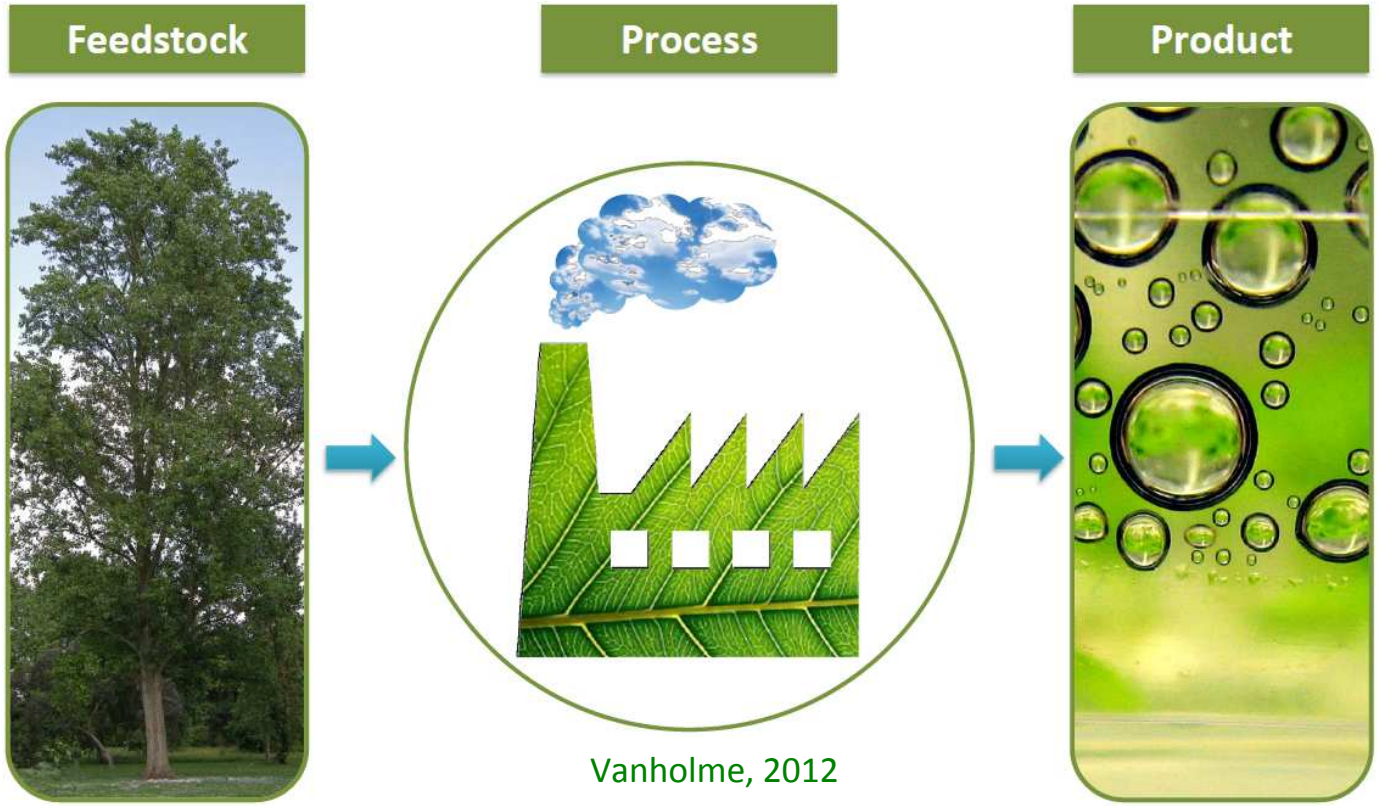


Vanholme, 2012

- High greenhouse gas production → Climate change
- High fossil fuel dependence → Price volatility and Uncertain availability

Context

Biofuels

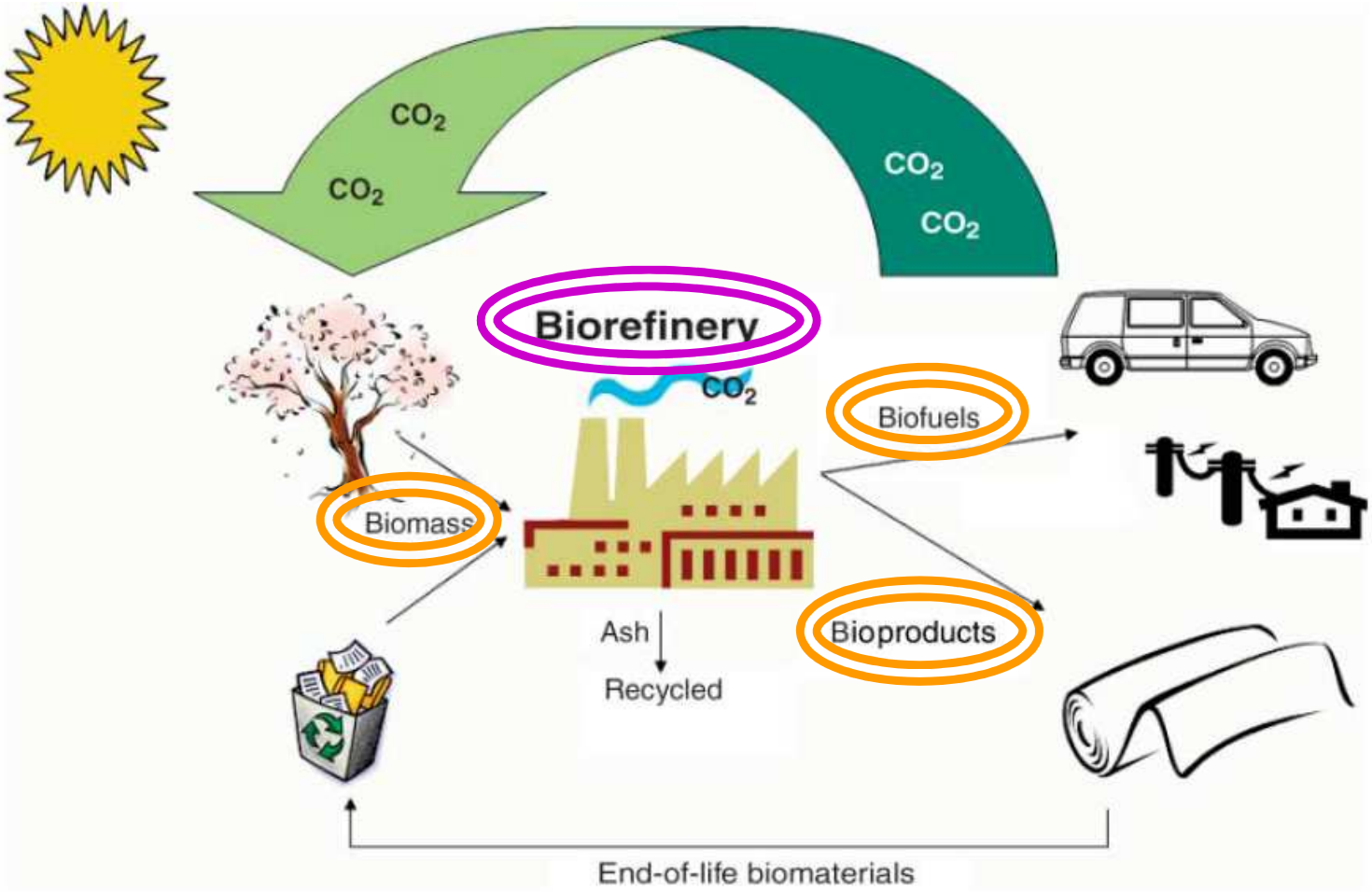


Vanholme, 2012

- Biomass → Renewable source of energy and products
- Development of a sustainable bio-based economy

Context

- **Development of a sustainable bio-based economy**
  - Requires a good knowledge of the contents and molecular composition of the chemical components of plant biomasses

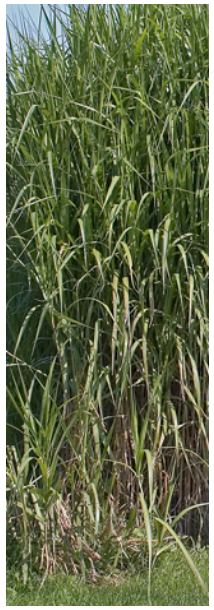


Adapted of Ragauskas et al., 2006

Context

- **Fibrous crop biomasses**
  - Non-food crops
  - Low input requirements → Low greenhouse gas production
  - Grow in tough pedoclimatic conditions → Acceptable dry matter yield per hectare

- **Examples**

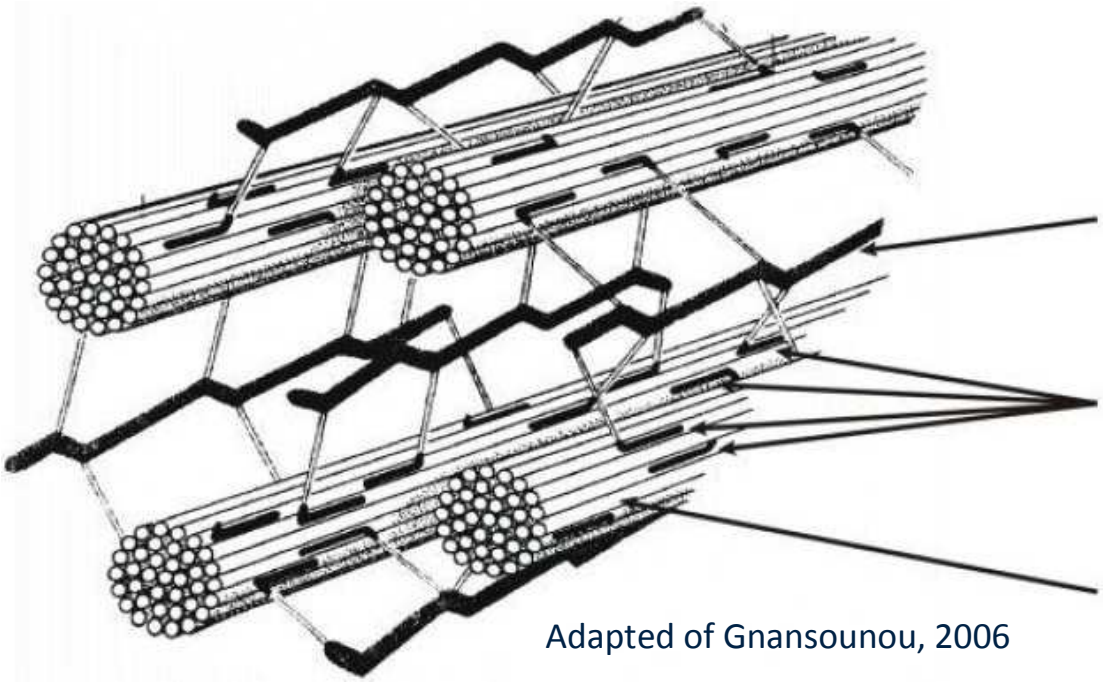
Perennial crops			Annual crops	Residues
				
Miscanthus	Switchgrass	Tall fescue	Hemp	Spelt straw

Adapted of ENERBIOM, 2012

Context

- **Chemical composition of biomasses**

Structural components of cell walls



Adapted of Gnansounou, 2006

- Cellulose → Linear polysaccharide homogeneously, glucose units
- Hemicelluloses → Ramified heterogeneous polysaccharides mainly, xylose units
- Lignin → Phenyl propanoid polymer, syringyl, guaiacyl and p-hydroxyphenyl units
- Other components → Pectins, soluble sugars, proteins, mineral compounds

Aim of this study

- **Relationship between chemical composition and biofuel potentials of plant biomasses**
  - On a wide diversity of plant biomasses
- **Fast biofuel potentials assessment**
  - Anaerobic digestion potential → Enzymatically digestible organic matter (DOM)
  - Bioethanol potential → Theoretical conversion of carbohydrates to ethanol
  - Combustion potential → Higher heating value (HHV) and Dry matter content
- **Chemical composition of plant biomasses**
  - Cellulose, Hemicelluloses, Lignin, Total soluble sugars, Starch, Proteins
  - Mineral compounds

Relationship between chemical composition and biofuel potentials of plant biomasses

- **Chemical composition of plant biomasses**
  - **A wide diversity of biomasses**

→ A wide diversity of chemical components contents

  - **8 distinctive biomass groups**
    - Phylogenetic origin

→ Commenlinids: A subgroup of monocotyledons (e.g. miscanthus, tall fescue, spelt, corn) → Higher hemicelluloses content

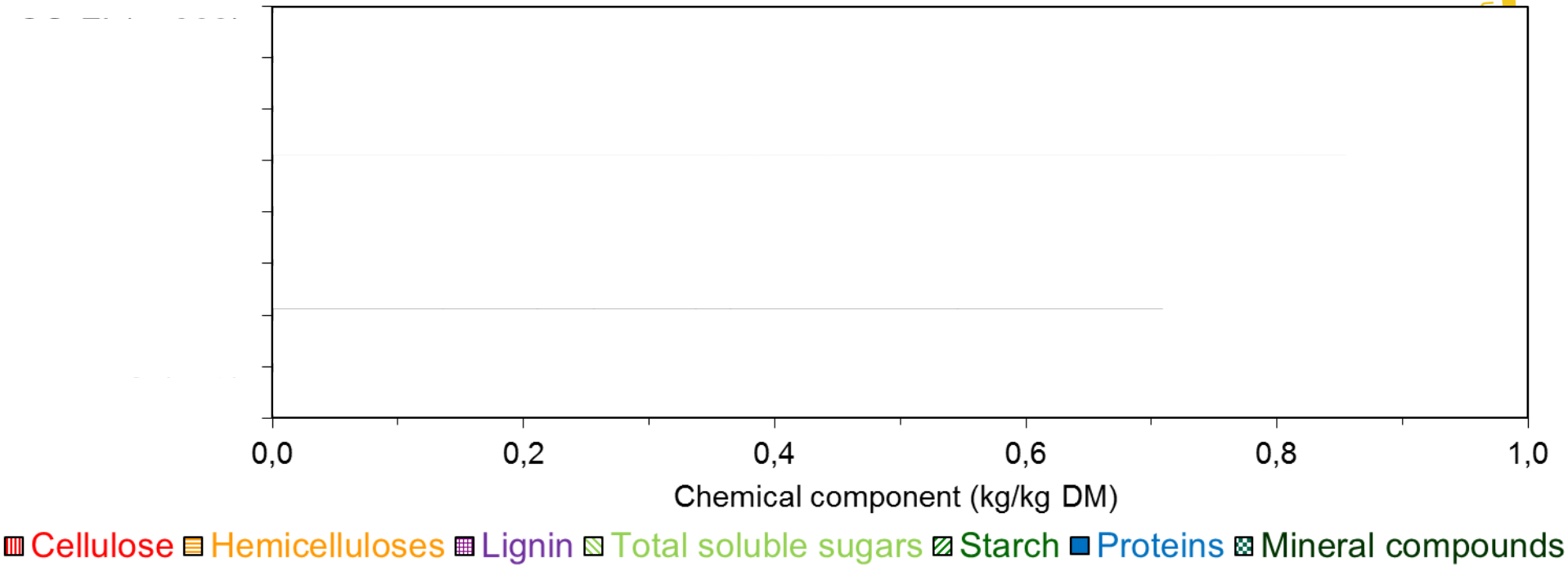
→ Non-commelinid magnoliophyta: Dicotyledons (e.g. hemp, potato, sunflower, chicory) and a subgroup of monocotyledons (e.g. onion) → Lower hemicelluloses content (substituted by pectins)

→ Pinophyta: Coniferous species (e.g. aspen) → Very high lignin content

    - Fiber content → Degree of cell wall lignification

Chemical composition of plant biomasses

- **8 distinctive biomass groups:**
  - **CO-FI**: Commelinid fibrous biomass (e.g. miscanthus, switchgrass, spelt straw)
  - **CO-LF**: Commelinid less fibrous biomass (e.g. fiber sorghum, fescue)
  - **CO-ST**: Commelinid high starch biomass (e.g. fiber corn)
  - **NC-WO**: Non-commelinid woody biomass (e.g. willow, aspen and oak wood)
  - **NC-FI**: Non-commelinid fibrous biomass (e.g. hemp, sunflower stalk, flax straw)
  - **NC-LF**: Non-commelinid less fibrous biomass (e.g. potato leaf, alfalfa, cabbage leaf)
  - **NC-SU**: Non-commelinid high sugars biomass (e.g. chicory tuber, onion bulb)
  - **PI-WO**: Pinophyta woody biomass (e.g. aspen, pine and larch wood)

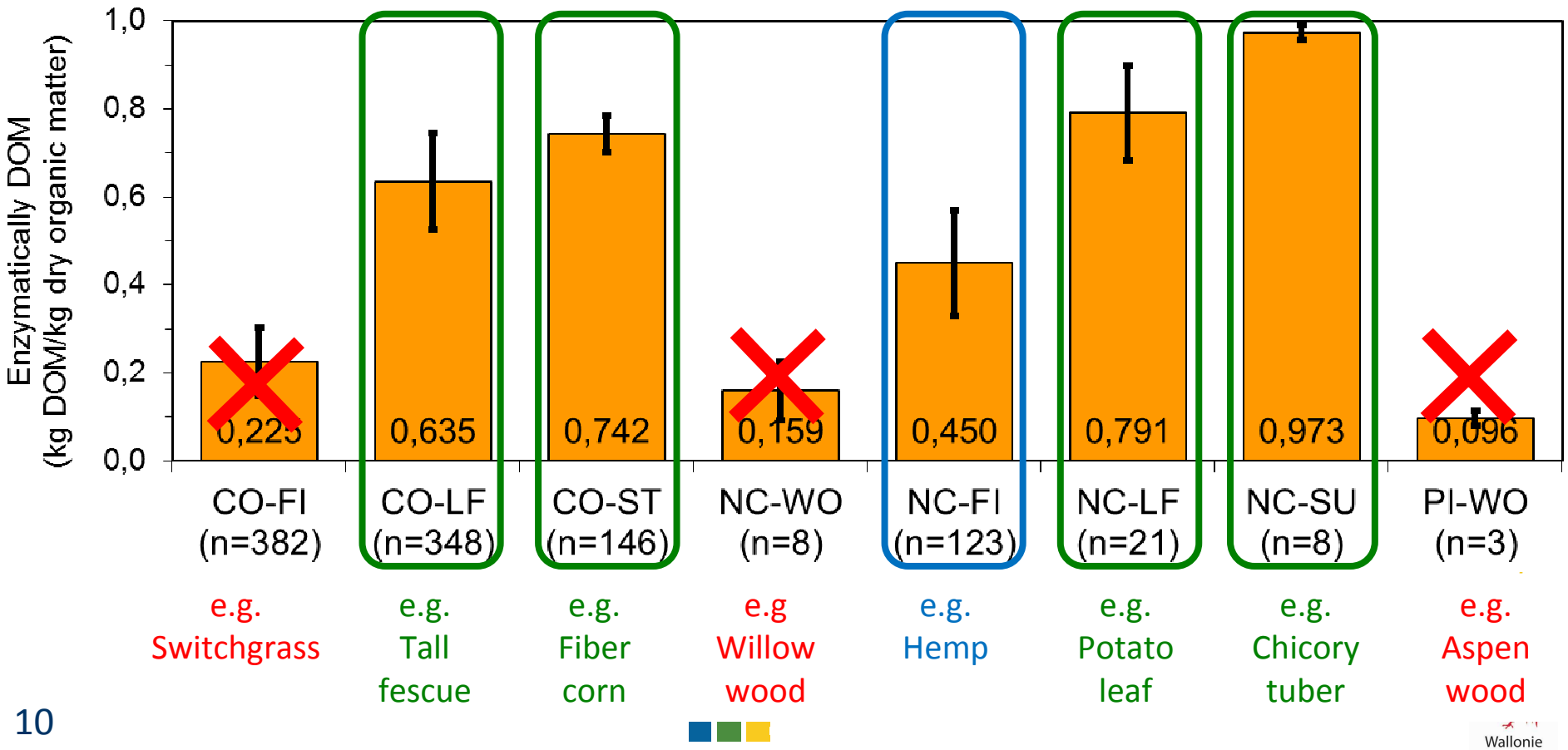


Rapid biofuel potentials assessment

- **Anaerobic digestion potential**

→ **Enzymatically digestible organic matter (DOM)**

- High suitability → Low degree lignification
- Cellulose and Lignin

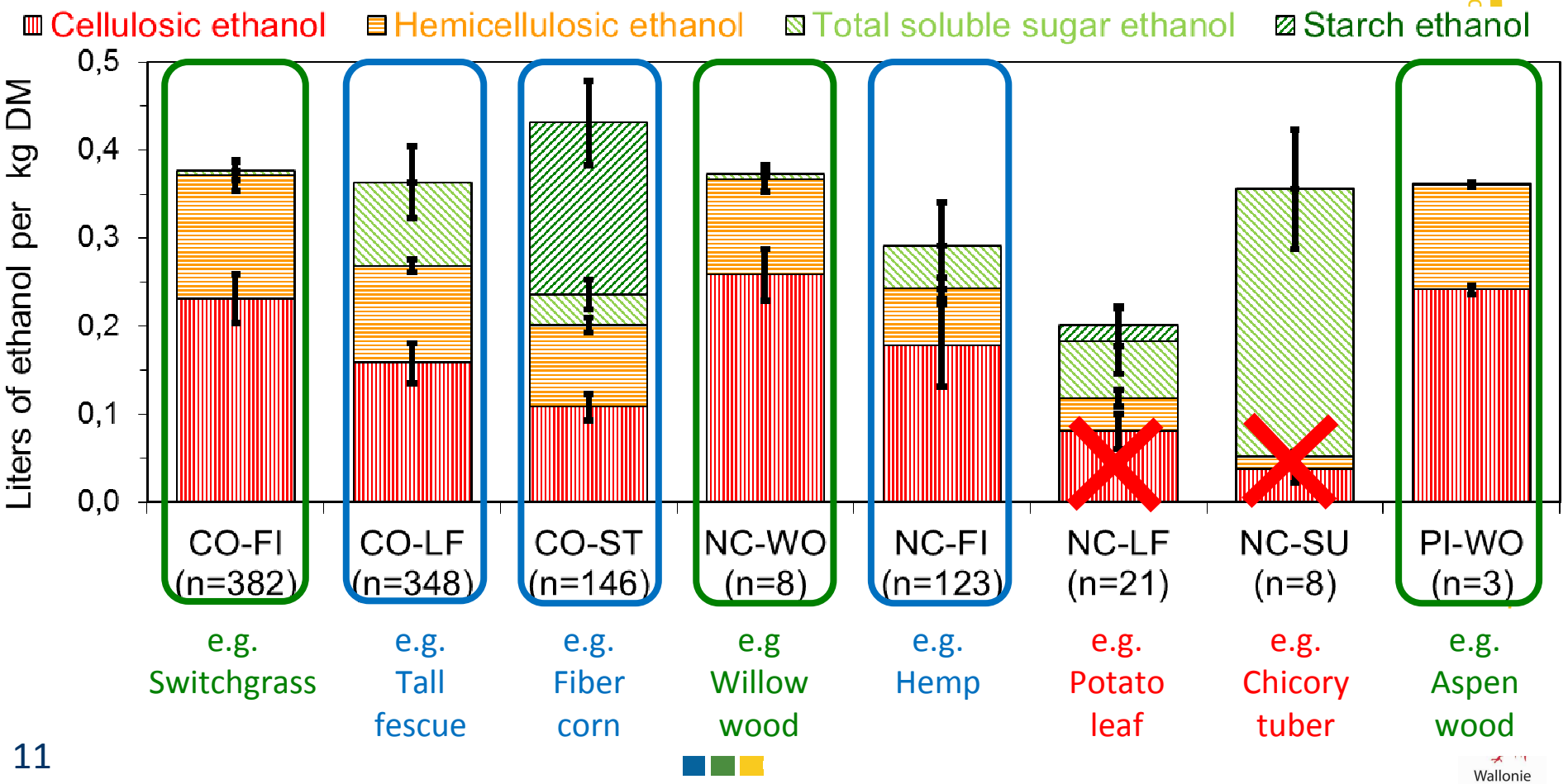


Rapid biofuel potentials assessment

- **Ethanol potential from structural carbohydrates**

→ **Structural carbohydrates**

- High suitability → Cellulose and/or Hemicelluloses
- Pretreatment severity → Lignin

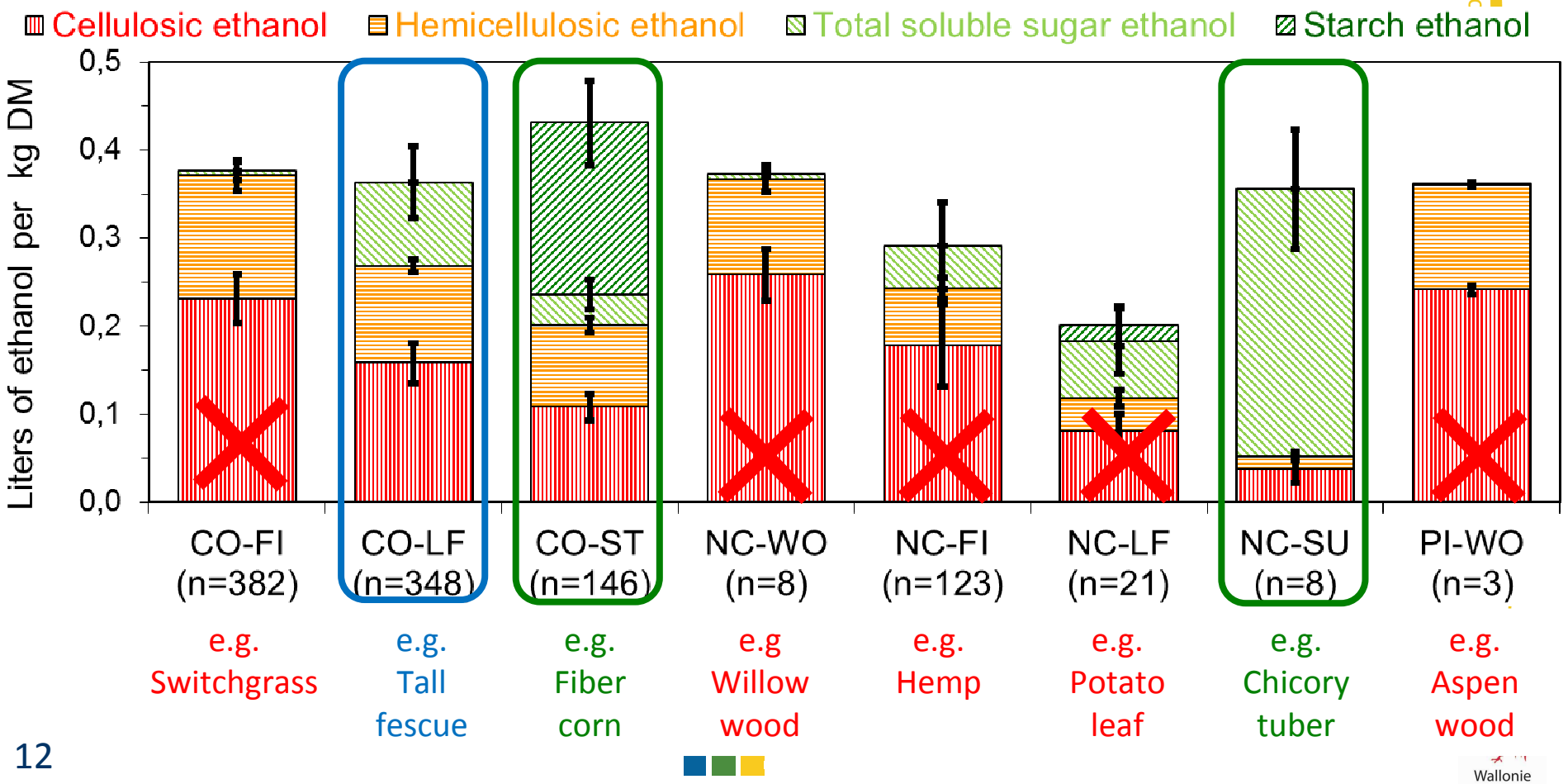


Rapid biofuel potentials assessment

- **Ethanol potential from non-structural carbohydrates**

→ **Non-structural carbohydrates**

- High suitability → Total soluble sugars and/or Starch



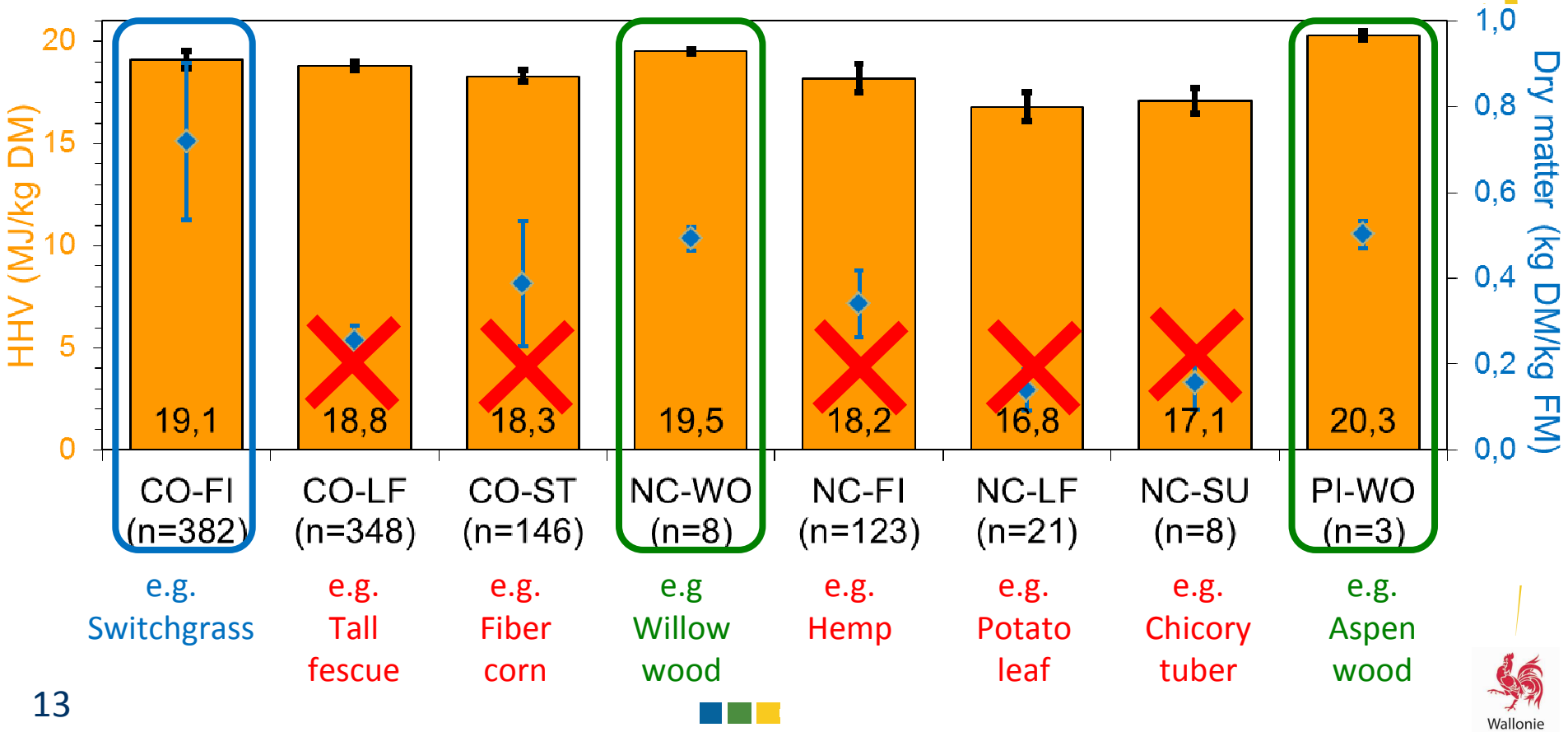
Rapid biofuel potentials assessment

- **Combustion potential**

→ **Higher heating value (HHV)**

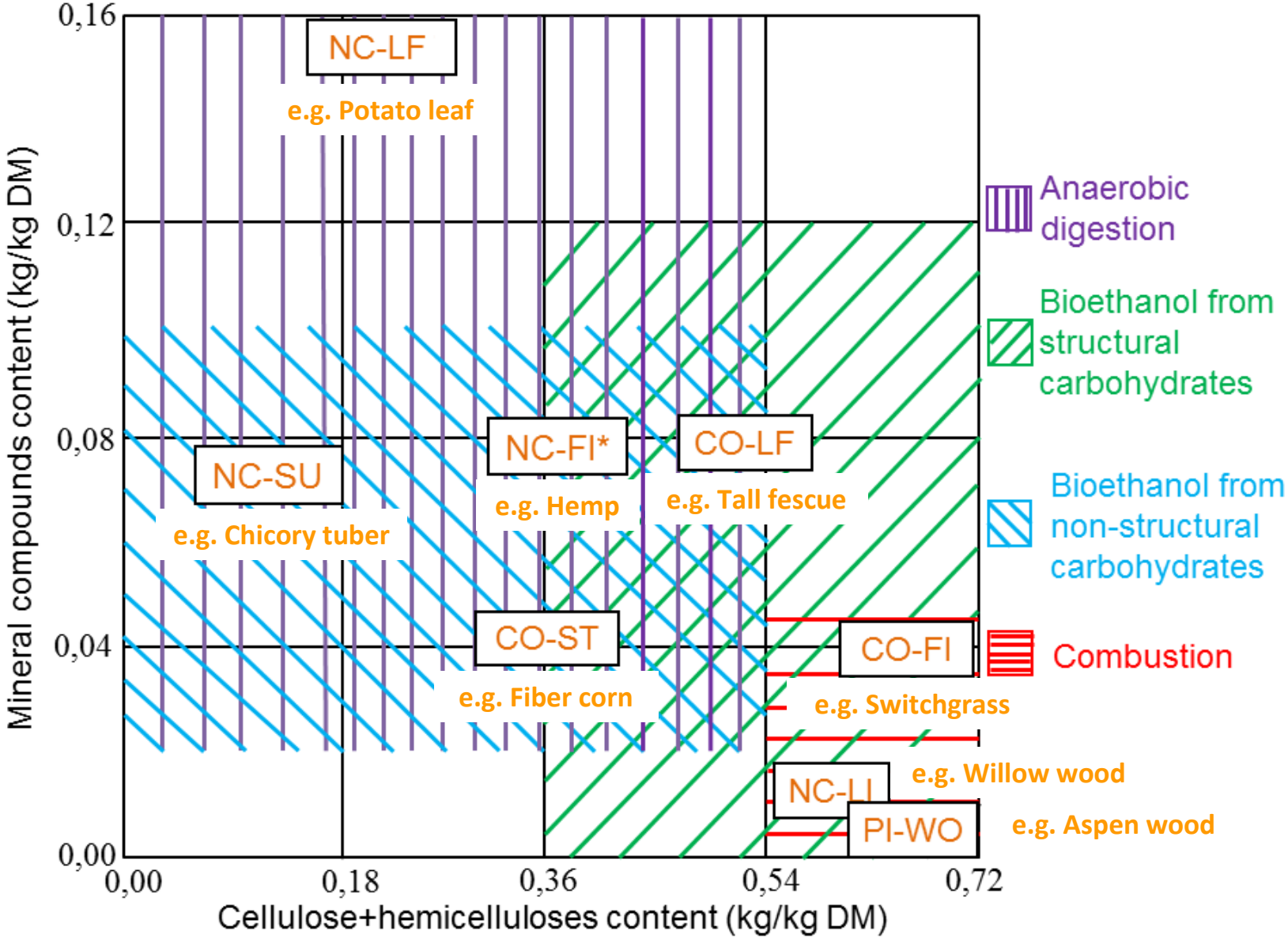
- High suitability → High degree lignification
- Organic matter and Lignin

→ **Dry matter content**



Relationship between chemical composition and biofuel potentials of plant biomasses

- **Essential variables → Cellulose, Hemicelluloses and Mineral compounds**

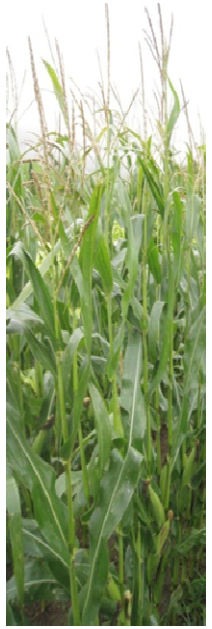


Conclusions

- **Each type of biomass generally suits to better to a given energy conversion processes**
  - Intrinsic chemical properties of the biomass
  - Specifity of each type of energy conversion process
- **Suitability assessement**
  - Chemical composition → Fast assessment method of each process
- **Most important chemical component to assess biofuel potential**
  - Cellulose
  - Hemicelluloses
  - Mineral compounds

Thank you for your attention

Questions ?



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