Sustainability issues regarding bamboo as a renewable feedstock for fuels and materials

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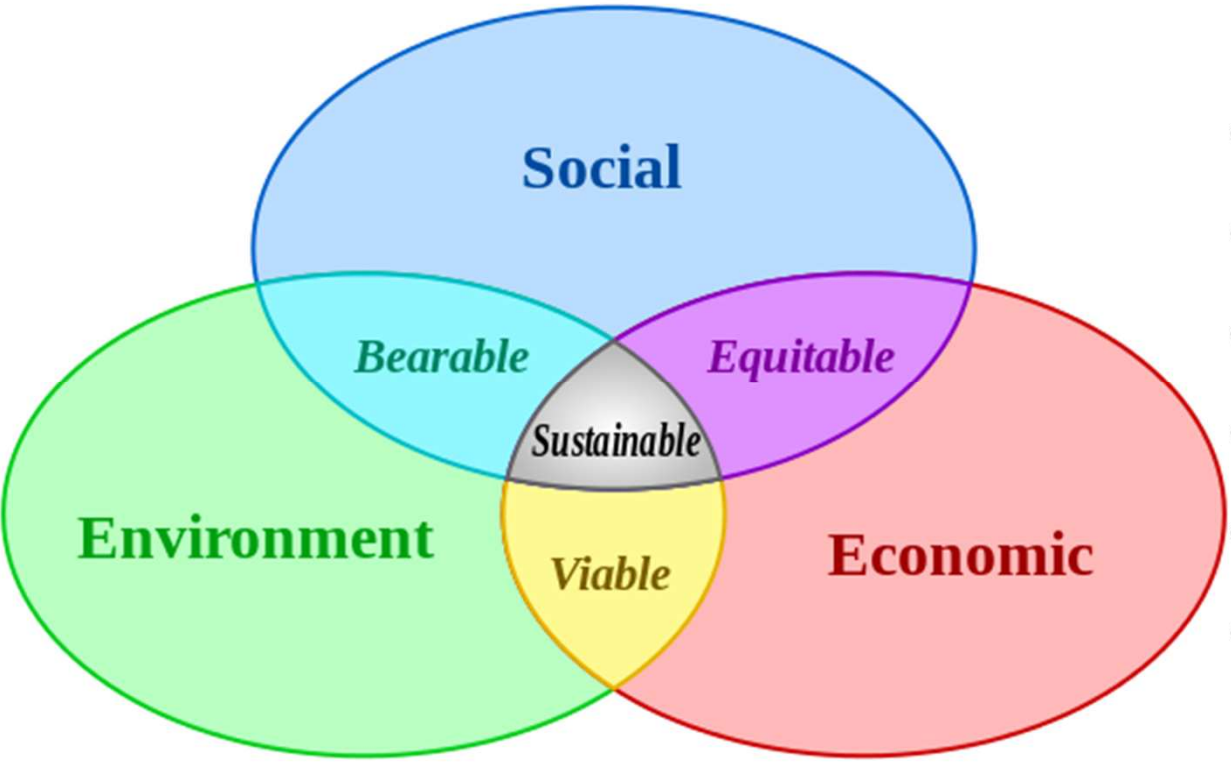
Sustainability

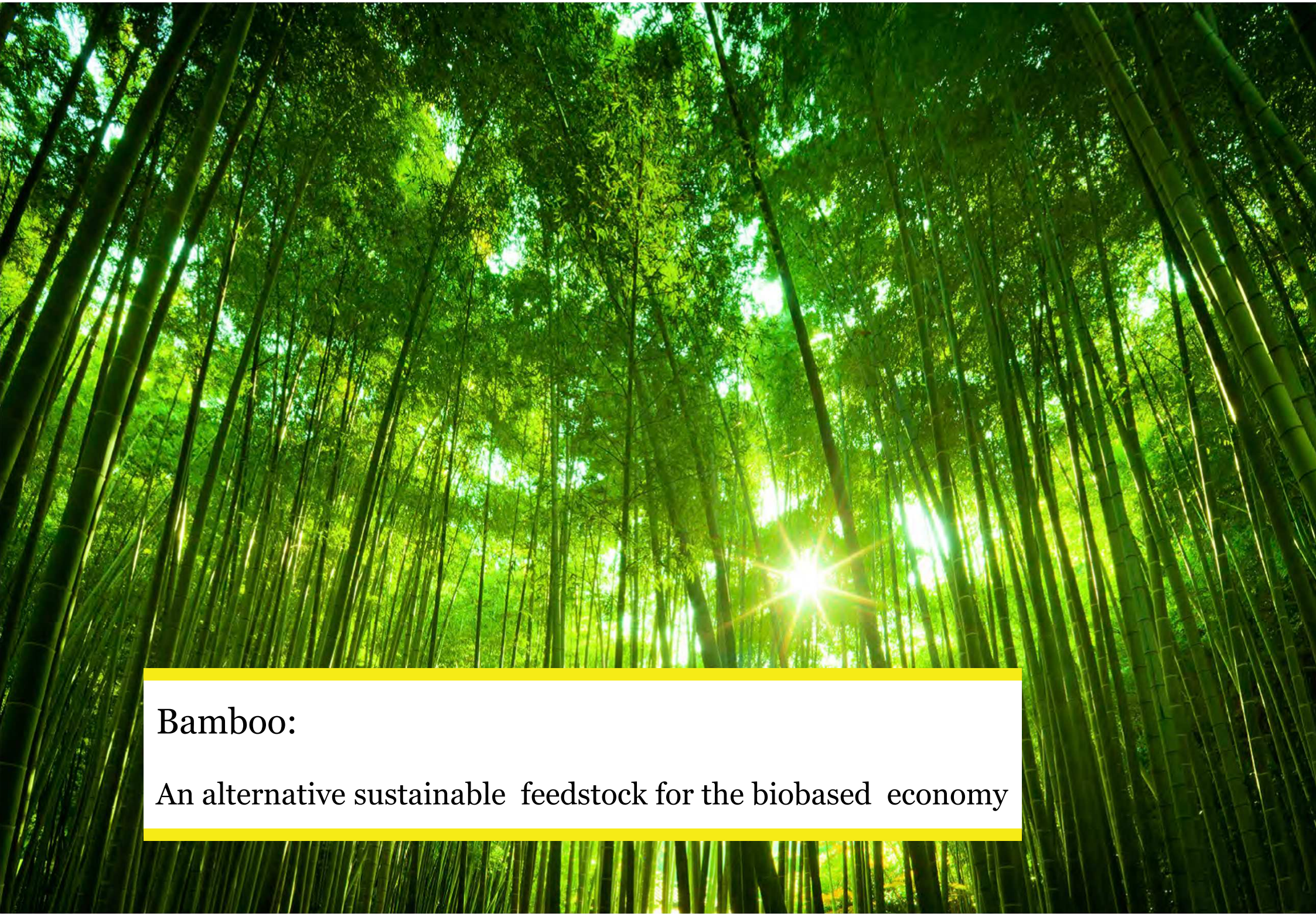
Sustainable Biomass



Sustainability Themes

- **Greenhouse gas emissions**
- Competition with food and local applications
- Biodiversity
- **Environment**
- Prosperity
- Social well-being.

Criteria➔Indicators

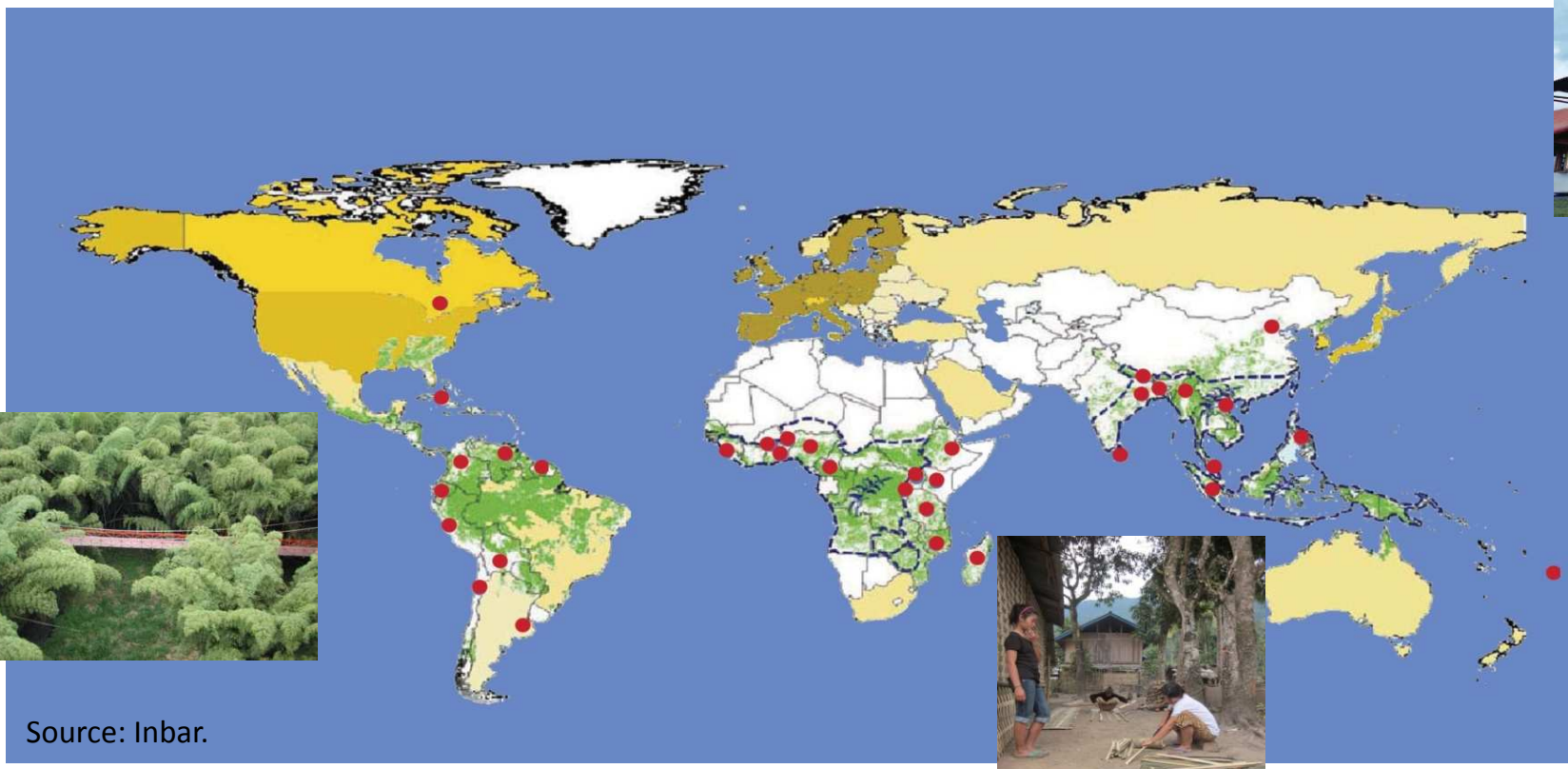


Bamboo:

An alternative sustainable feedstock for the biobased economy

Why bamboo?

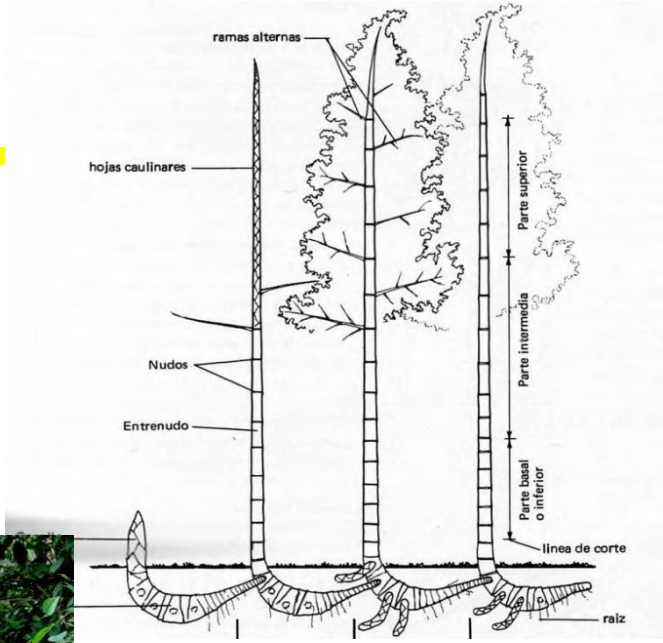
- ±36 Million Hectares
- Millions of tons could be harvested sustainably each year
- Opportunities for sustainable development



Source: Inbar.

Why bamboo?

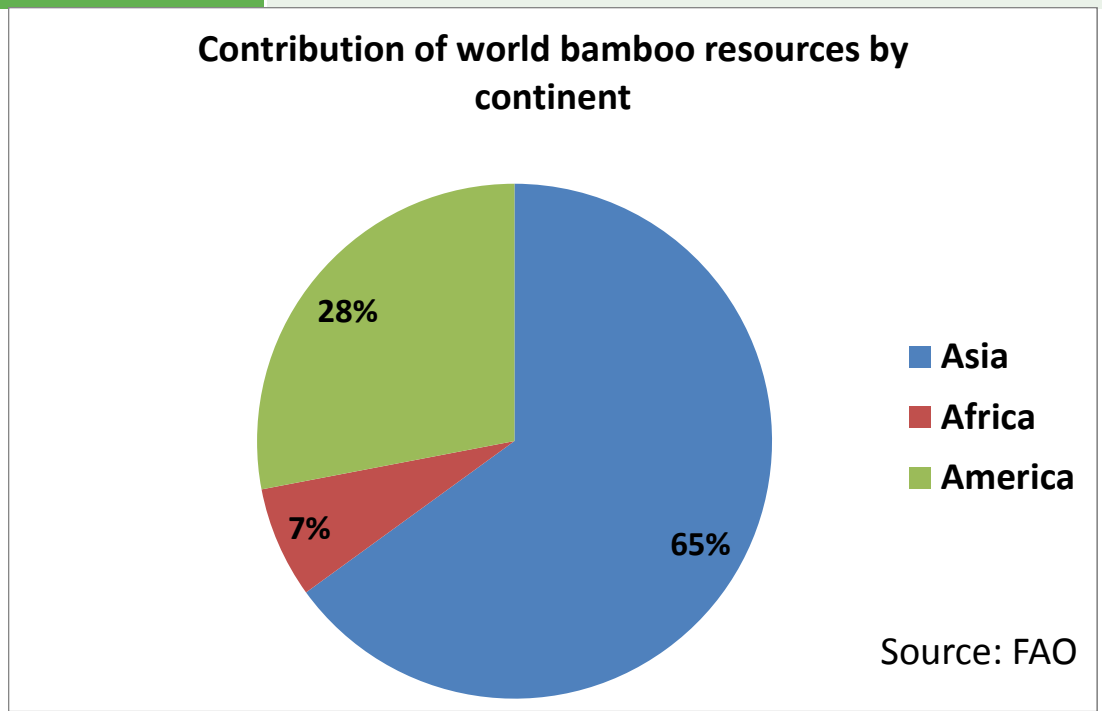
- Fast growing
  - 10-40 Ton/Ha-year
- **Regenerates itself** after it has been responsibly cared for and harvested➔ **No replanting**
- Excellent reforesting crop
  - Low consumption of fertilizers ➔(GHG)
  - Easy propagation➔**no seeds**
  - Water table preservation
  - Biodiversity preservation
- CO_2 sump
- Opportunities for rural development
  - Product diversification



Current Uses

Major global supplier of products: China

Plant section	Current use
Culm	Finished products: housing, flooring furniture, paper, charcoal.
Leaves	Left in the field as fertilizer, and/or collected for animal feed.
Branches	Low value applications, low market (chopsticks)
Roots	Food



BAMBUSA VULGARIS VAR. VULGARIS SCHRADER EX WENDLAND

ECN

SOCIEDAD COLOMBIANA DEL BAMBU

Lignocellulosic feedstock

Logistics Cost

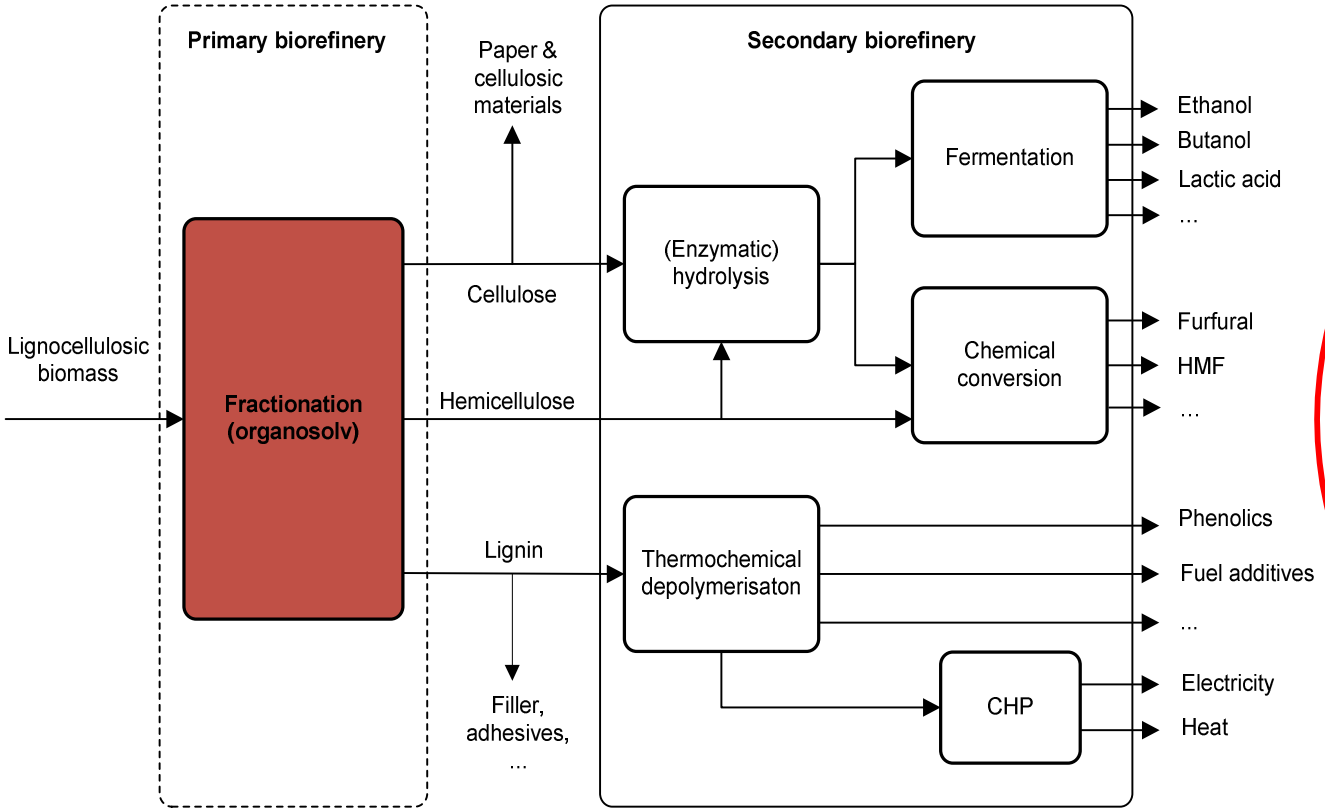
Feedstock		Bamboo culm	Cane Bagasse	Wheat straw	Wood
HHV (dry)	MJ/kg	17-20	18-20	16-19	17-20
Density	kg/m^3	**500-700**	150-200	160-300	200-500
Yield	Ton/Ha-year	**20-40**	7-10	6-12	10-20
Overall composition (dwt %)					
Cellulose		40-60	35	38	50
Hemicellulose		20-30	25	36	23
Lignin		20-40	20	16	22
Others**		2-10	20	10	5

** Ash, resins, etc.

Yields and composition depend on: specie and age of the plant, plant section, cultivation site and harvesting season.

Biobased: Chemicals+ Materials+ Energy

Lignocellulosic Biorefinery



Fibers
Fertilizer
Biochar

Solid Fuel in Power Plants

Coal & biomass

Bamboo Project: Jan 2011-April 2013

Torrefied Pellets for
Sustainable Biomass Export from Colombia

Assessing the whole chain of bamboo cultivation & collection via torrefaction upgrading to application as biofuel

NL Agency
Ministry of Economic Affairs

Bamboo as a biomass import chain

Assessment of:

- technical suitability
- sustainability
- economical feasibility

for:

- Co-firing torrefied Colombian bamboo pellets in NL

NL Agency
Ministry of Economic Affairs

The SBI scheme aims to give an impulse to the promotion of the sustainability of the biomass import chains for **biobased energy and chemical applications/transport/electricity/heating and chemicals/materials**

Looking for certification

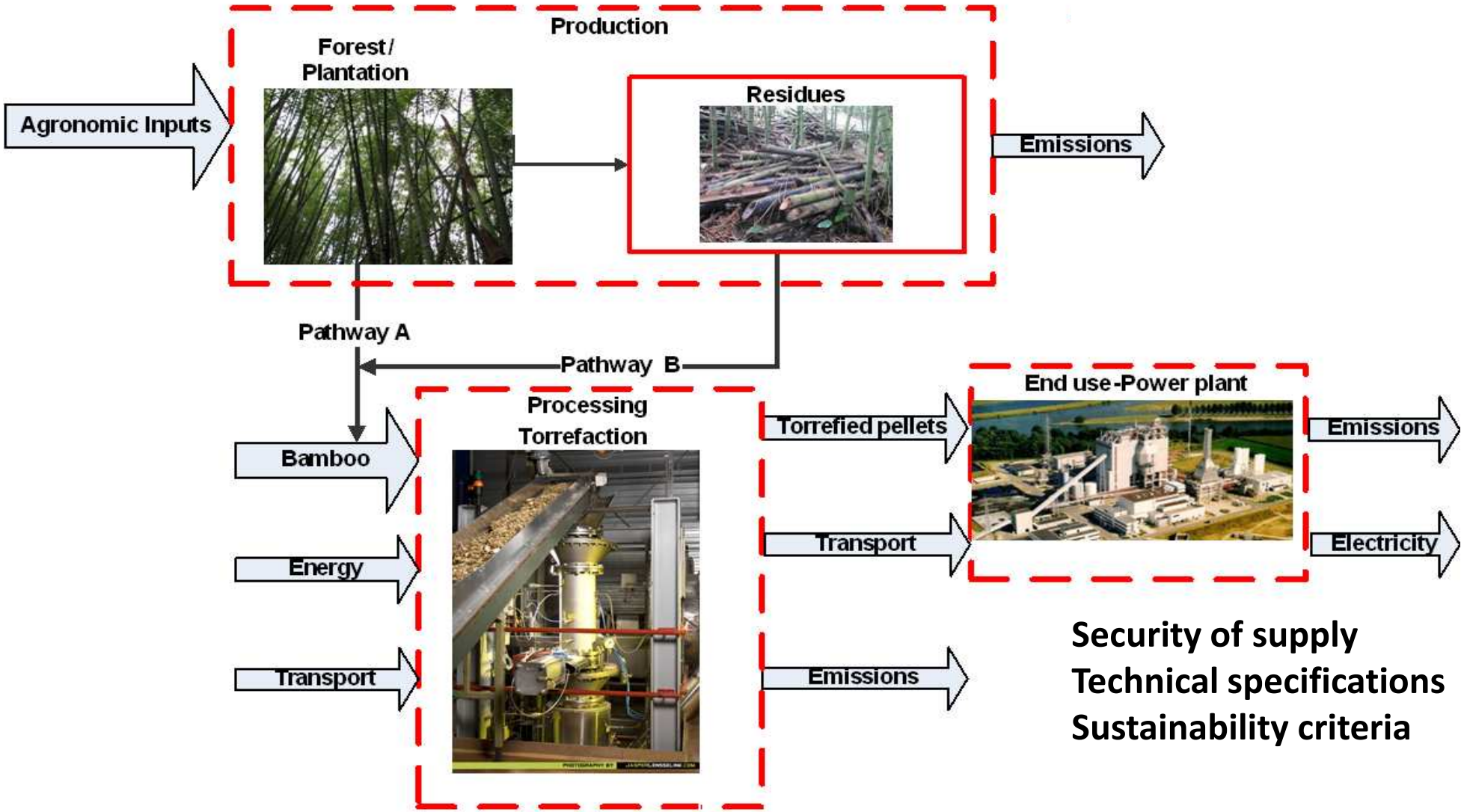
The Dutch technical agreement (NTA8080) describes the requirements for **sustainably produced** biomass for energy applications (power, heat & cold and transportation fuels).

Biomass includes solid as well as liquid and gaseous biofuels. The NTA 8080 is intended to be applied at organizations that wish to sustainably:

- **Produce,**
- **Convert,**
- **Trade; or**
- **Use biomass for energy generation or as transporting fuel.**

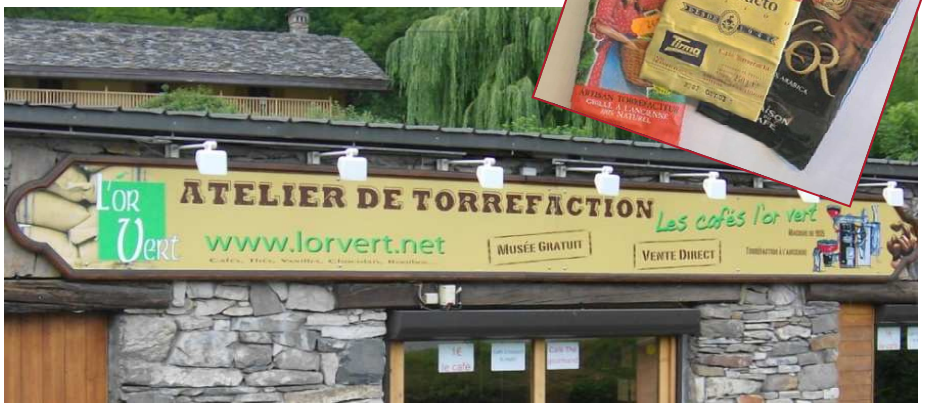
  - **Currently being revised and extended to bio-based products**

Biomass chain assessment



Torrefaction for upgrading biomass

- Process parameters
  - Temperature: 200-300 °C
  - Absence of oxygen



Tenacious and fibrous
LHV = 9 - 12 MJ/kg
Hydrophilic
Biodegradable
Heterogeneous

Torrefaction

Friable and less fibrous
LHV = 18 - 24 MJ/kg
Hydrophobic
Preserved
Homogeneous

Pelletisation

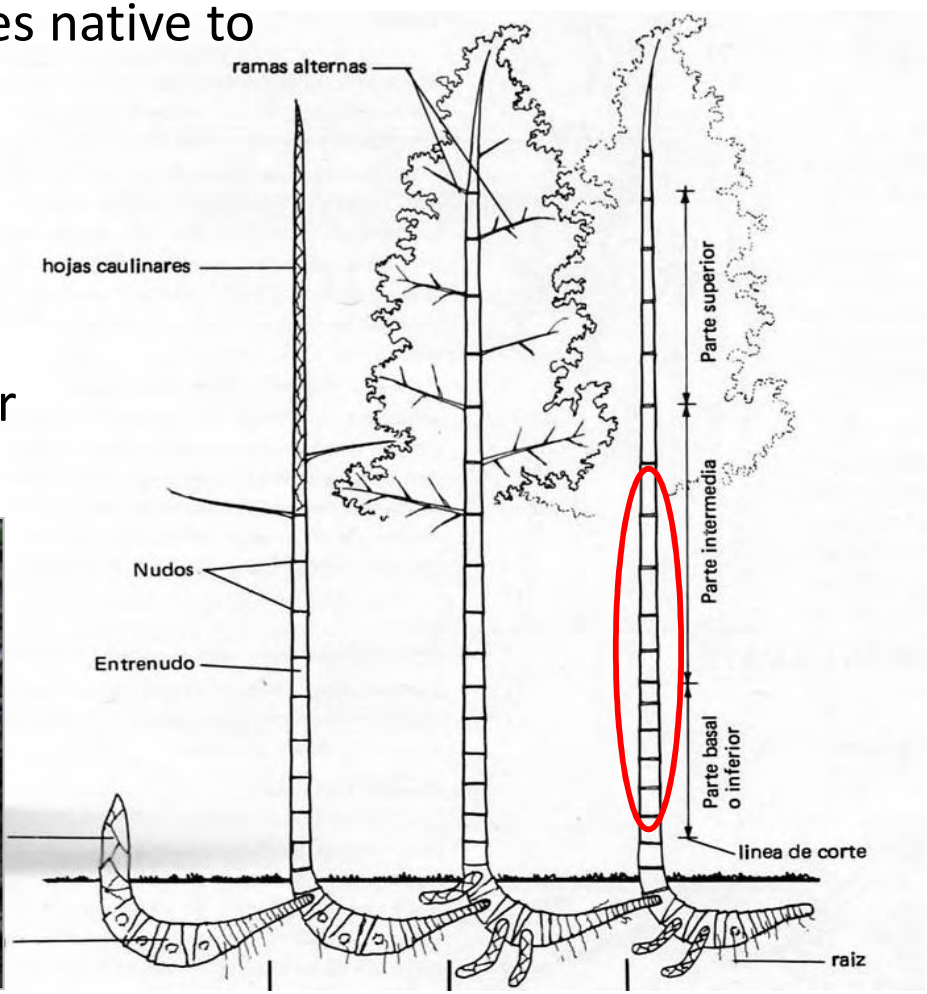
Bulk density = 650-800 kg/m^3
Bulk energy density = 12 - 19 GJ/m^3

Case study: Guadua *angustifolia*

- Woody bamboo species native to Latin America.
- Fast growing:

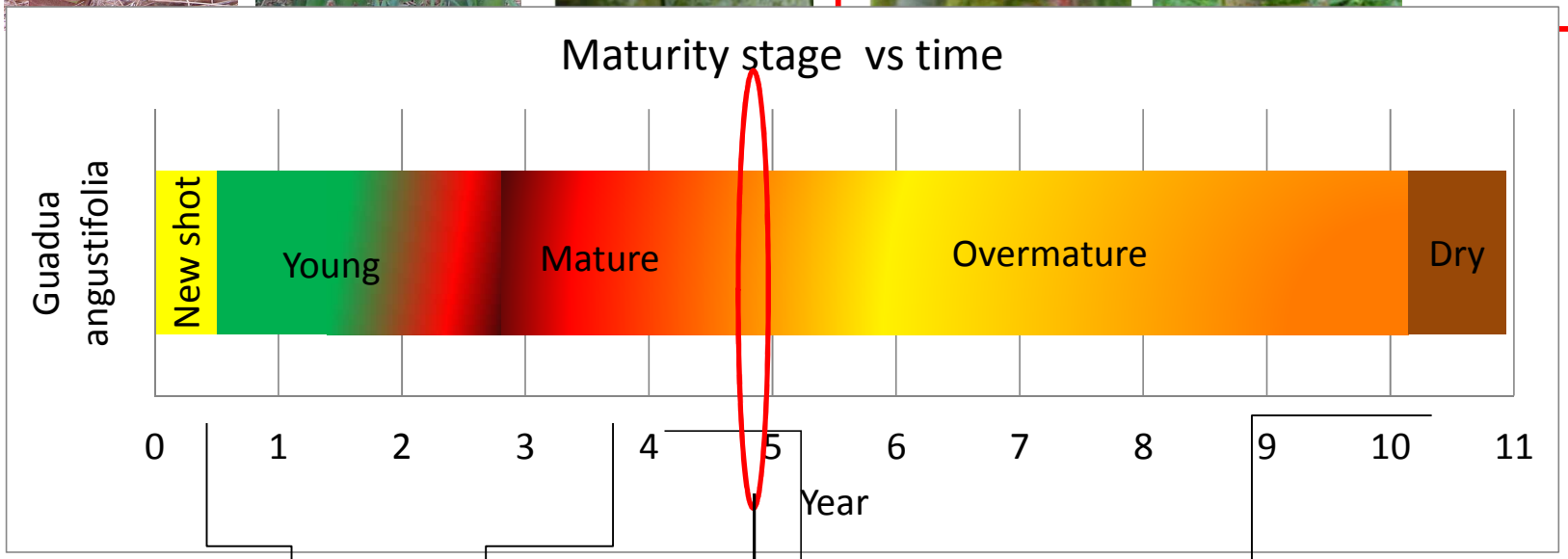
  30 m in 6 months

  20-40 Ton/ha-year



Guadua *a.* development stages

Residues

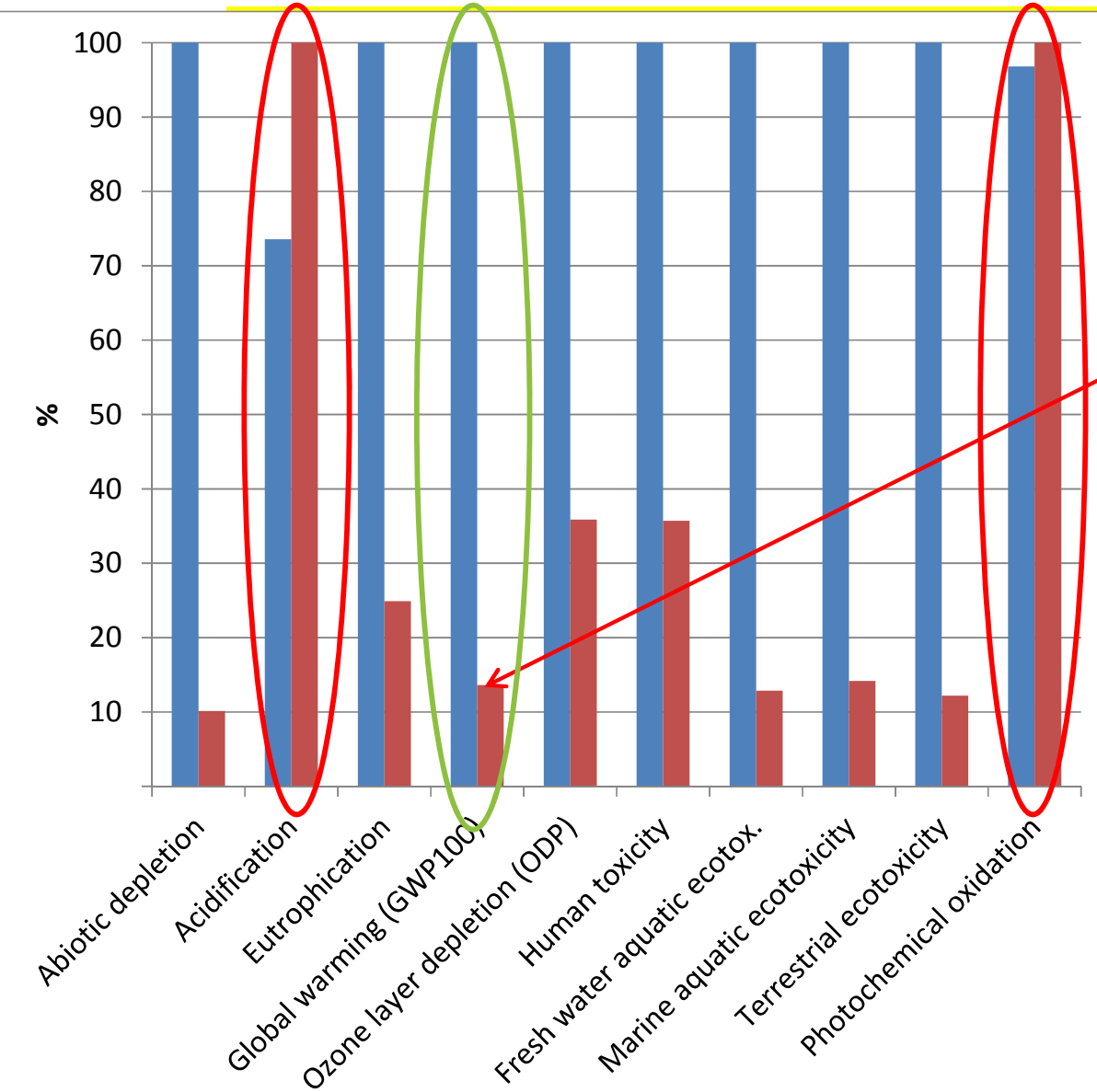


Major components	Celullose Hemicellulose		Lignin
End Use	Biorefining	Construction	Fuel

Sustainability certification

Sustainability criteria included	FSC	NTA8O8O
Biodiversity	Yes	Yes
GHG	No	Yes
Environment	Yes	Yes
Social	Yes	Yes

1 MJ of Electricity: Coal vs. Bamboo



88 % GHG emission reduction

NTA8080 = 70%

Accounting methodology follows:

EC recommendations for solid biomass

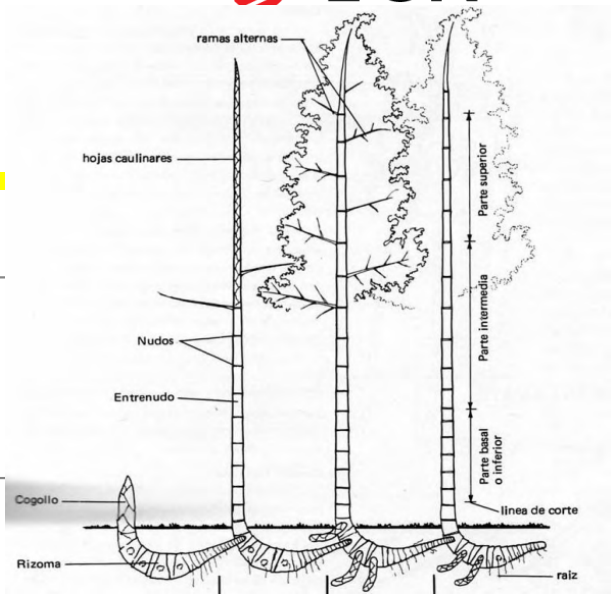
Default values/processes/references

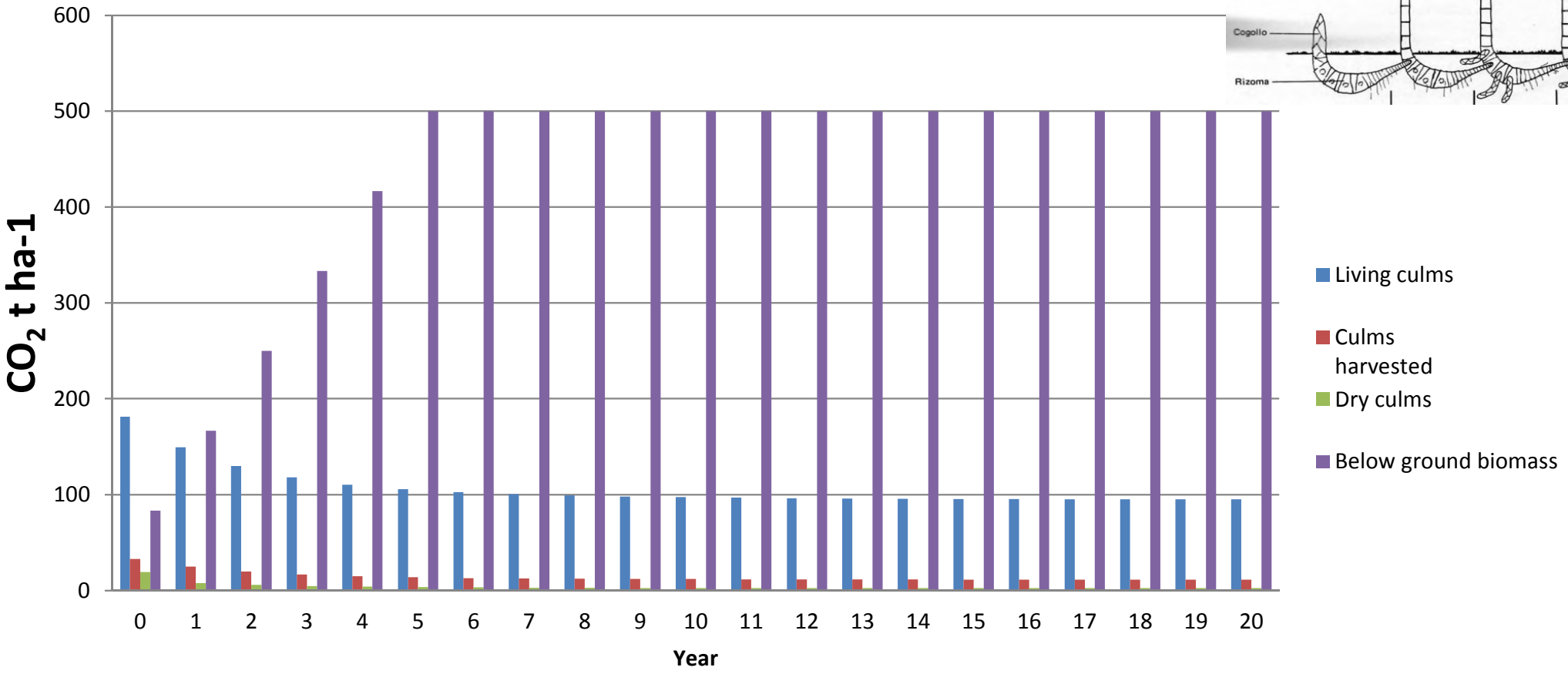
Carbon stock is not included

What if carbon stock is included?

Living stands

Below ground biomas: (soil organic carbon, roots)





When carbon stock is included: CO_2 storage

Estimated GHG emissions:

Reduction: 300 % vs. 88%

Harmonize methodologies

Measure, monitor and demonstrate

Conclusions

- Bamboo has the potential to be a highly sustainable biomass source for the biobased economy➔ species, location and practices dependent.
  - Fuels
  - Chemicals
  - Materials
- Sustainability certification is possible
- Regulatory framework in producing countries
- Research and Development
  - New “traditional” biomass chain
  - Multidisciplinary approach

Thank you for your attention

This work forms part of the project: “Torrefied bamboo pellets for sustainable biomass import from Colombia”. Financial support by NL Agency under the subsidy scheme Sustainable Biomass Import. Partners in the project were: Imperial College of London (UK), Technological University of de Pereira (Co), Colombian Bamboo Society (Co).

NL Agency
Ministry of Economic Affairs

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