



PULP AND PAPER
INSTITUTE, LJUBLJANA
Innovative Cellulose Products

Circular Paper – paper from biomass waste streams

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ICP – Pulp and paper institute

- Located in Ljubljana (Slovenia)
- R&D institution focused on development of materials and products from lignocellulosic biomass
- Reference laboratory for papermaking and fiber based products - from laboratory to semi-industrial trials
- Demonstration and training center for characterization and functionalization of fibrous materials in support for industry engaged in circular bioeconomy.
- Training and education centre for papermaking and packaging industry

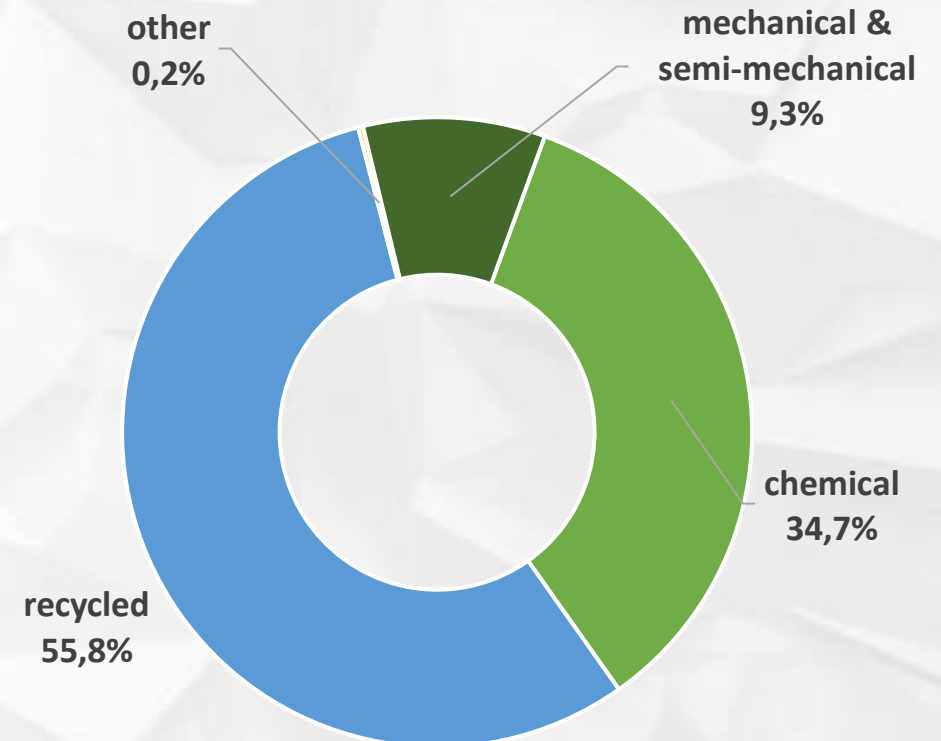
Why residual biomass as fiber source?

- reduced availability of wood for wood pulp
- many alternative sources of cellulose / pulp
- economical reasons – conversion of waste material
- material management – efficient / cascade use
- supporting circular economy

CEPI Press release (February 13, 2023):

„Non-wood fibre is a new innovation frontier for Europe’s paper and board sector, shows nova-Institute study.“

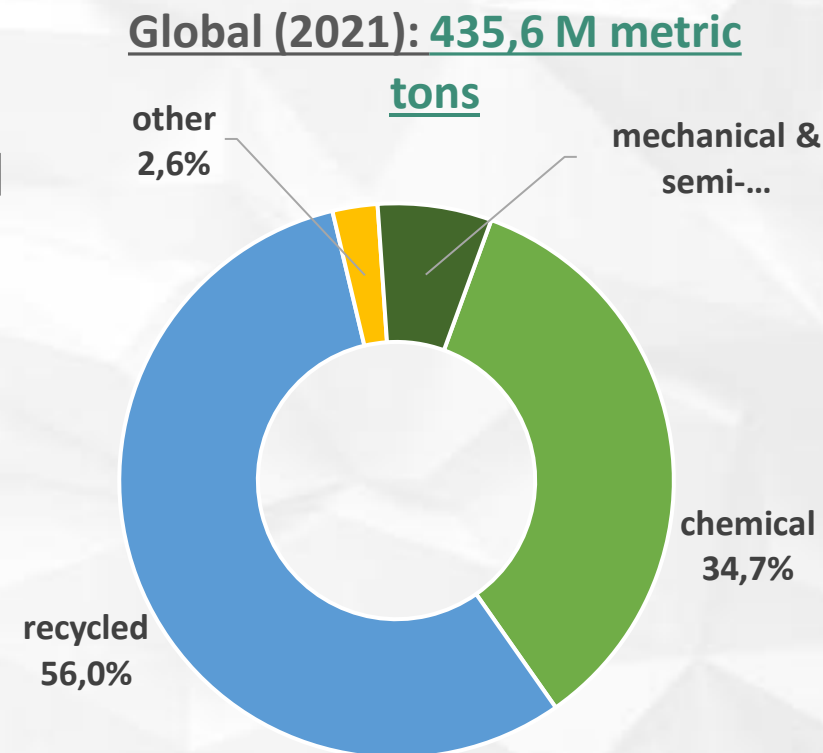
CEPI (2021): 91 M metric tons



Source: CEPI Key Statistics 2021

Alternative sources of pulp – global situation

- Approx. 10 M metric tons of pulp produced globally
- Main capacities are in Asia and South America
- Main raw materials:
 - ❖ straw,
 - ❖ bagasse,
 - ❖ bamboo,
 - ❖ reeds & grasses,
 - ❖ kenaf,
 - ❖ hemp.



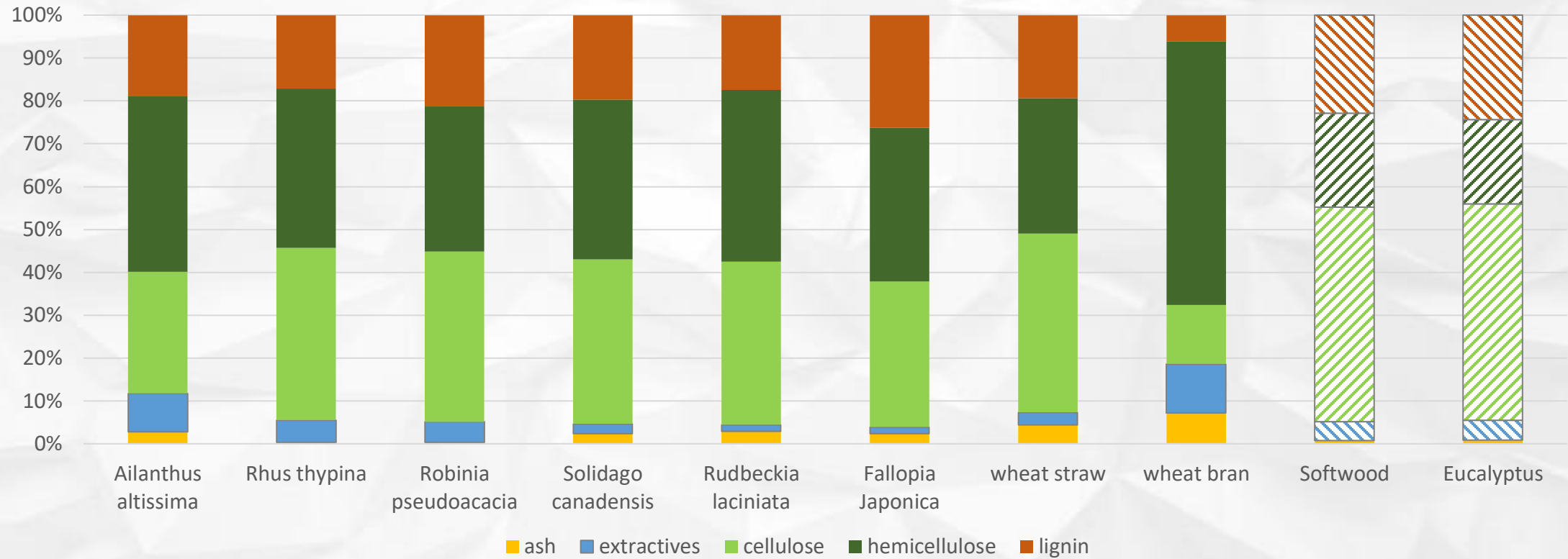
Source: FAO (fao.org)

country	% global capacity
China	70,7
India	8,0
Pakistan	1,96
Venezuela	1,1
Columbia	1,0
Mexico	0,92
Thailand	0,88
Turkey	0,76
Brazil	0,73
Greece	0,64

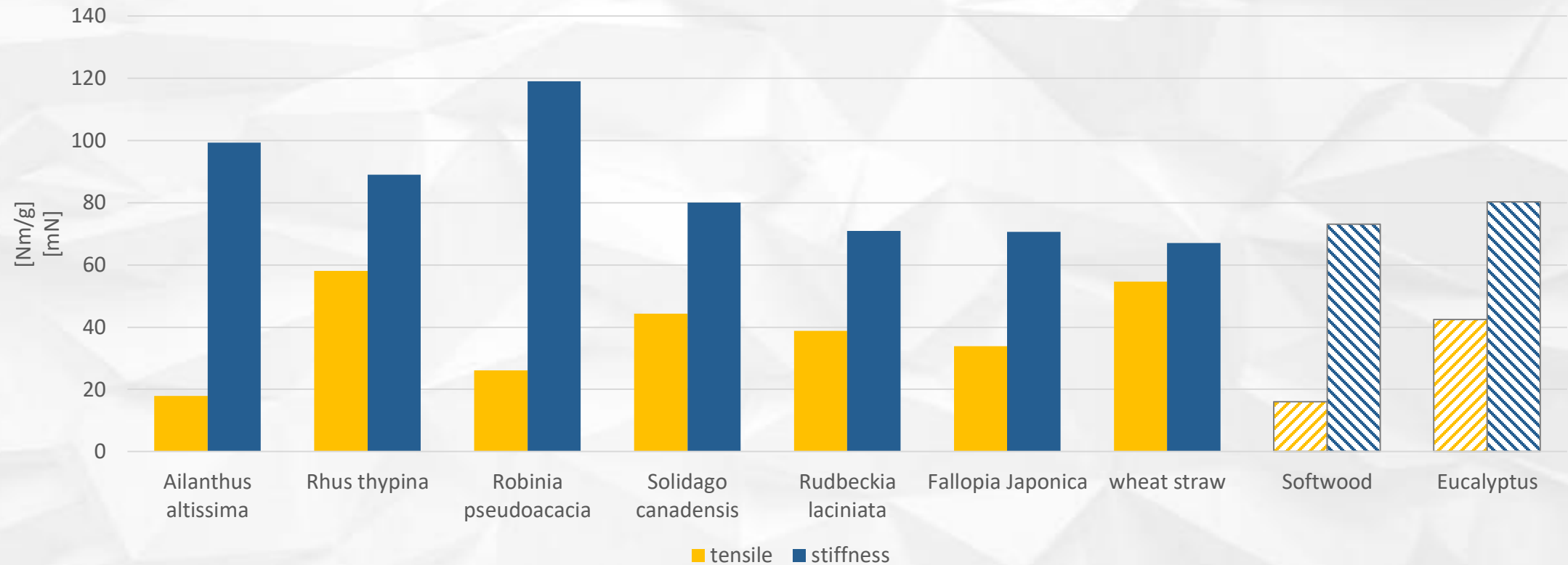
Potential sources of biomass

- Fast growing plants cultivated for cellulose production (miscanthus, silphie)
- Waste streams from:
 - ❖ wood processing (sawdust, pruning residues)
 - ❖ agriculture (straw, reeds & grasses, hemp, kenaf, tomato stems, hops, bamboo)
 - ❖ food processing (beetroot pulp, wheat bran, onion peelings, fruit pulps)
- Invasive alien plant species (Japanese Knotweed, Canadian Goldenrod, Black Locust)
- **Pulp and paper institute has built a database containing key material properties of more than 50 non-wood biomass sources of cellulose**

Chemical composition



Pulp properties – tensile index & stiffness



The approach



- Preparation of a solution concept
- Material research and design
- Product design
- Testing and verification
- Scale-up (pilot paper machine, pilot printing machine, pilot packaging production)

- Application – production and testing of pilot series
- Evaluation of product environmental impact (biodegradability, compostability)
- Evaluation of product legal conformity (international, national legislation)

Papers produced from invasive plants or cultivated plants



Japanese knotweed



Canadian goldenrod



Miscanthus



- Raw material sources – japanese knotweed, canadian goldenrod, black locust, miscanthus...
- Addition up to 40 % to a standard paper recipe
- Mechanical and printing properties similar as with standard paper

Paper and board produced from agricultural residues



- Raw material sources – wheat straw, tomato stems,
- Addition up to 30 % to a standard paper recipe
- Mechanical and printing properties similar as with standard paper
- Tested also in production of cardboard boxes

Other potential sources



- Raw materials – jute bags, sawdust, food processing residues (wheat husks, onion peelings, citrus peelings)
- High variation in composition and cellulose properties
- Tested mostly only in lab scale only
- Products yet to be designed

Challenges with potential use

- Seasonal and geographical availability, bulk or dispersed sources
- Conversion facilities (pulp mills/biorefineries) – not many available, low capacities, process robustness
- Low cellulose content – economical feasibility?
- Lignin can be used as raw material for other processes / products (different pulping process)
- High content of hemicelluloses – possible use in coatings or for production of base chemicals
- High variability of pulp properties, depending on raw material source
- Partial use as fibre raw material, depending on the paper grade
- Influence on paper properties (mechanical and optical)

Further information

María Eugenia Eugenio et al.: Alternative Raw Materials for Pulp and Paper Production in the Concept of a Lignocellulosic Biorefinery

<https://www.intechopen.com/chapters/69880>

M. Patel: Bioeconomy and the Pulp & Paper Industry Part II Bioeconomy-Biorefinery

https://www.researchgate.net/publication/372336363_Part_II_Bioeconomy-Biorefinery

A. Gonzalo et al.: Evaluation of different agricultural residues as raw materials for pulp and paper production using a semichemical process

https://www.researchgate.net/publication/316019792_Evaluation_of_different_agricultural_residues_as_raw_materials_for_pulp_and_paper_production_using_a_semichemical_process

Twosides: Paper From Alternative Fibres

<https://www.twosides.info/documents/factsheets/7-Paper-From-Alternative-Fibres.pdf>

CEPI: Growing interest in non-wood pulp for paper, hygiene products and packaging

<https://www.cepi.org/press-release-non-wood-fibre-is-a-new-innovation-frontier-for-europes-paper-and-board-sector-shows-nova-institute-study/>



THANK YOU

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