

Sustainable building materials from rice straw

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Cairo, 12-12-11



Overview presentation

- Introduction
- Sustainable building
- Building materials from rice byproducts
 - Experimental results
- Outlook

Transition towards “Biobased economy”



Transition to a **bio-based** economy



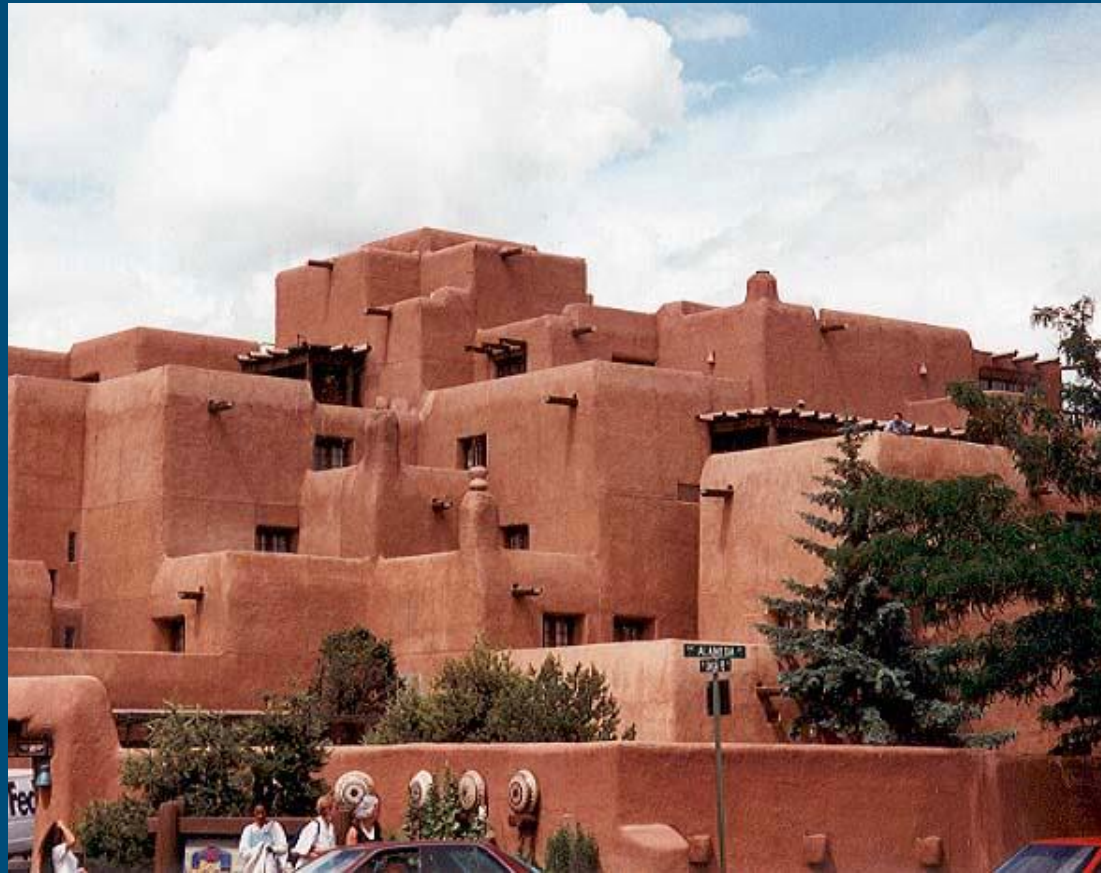
Options for sustainable building

- Reuse and recycling of building materials
- Energy saving
 - by insulation
 - during production of building materials
 - alternative energy sources (photovoltaic cells, heat pumps)
- Application of renewable resources

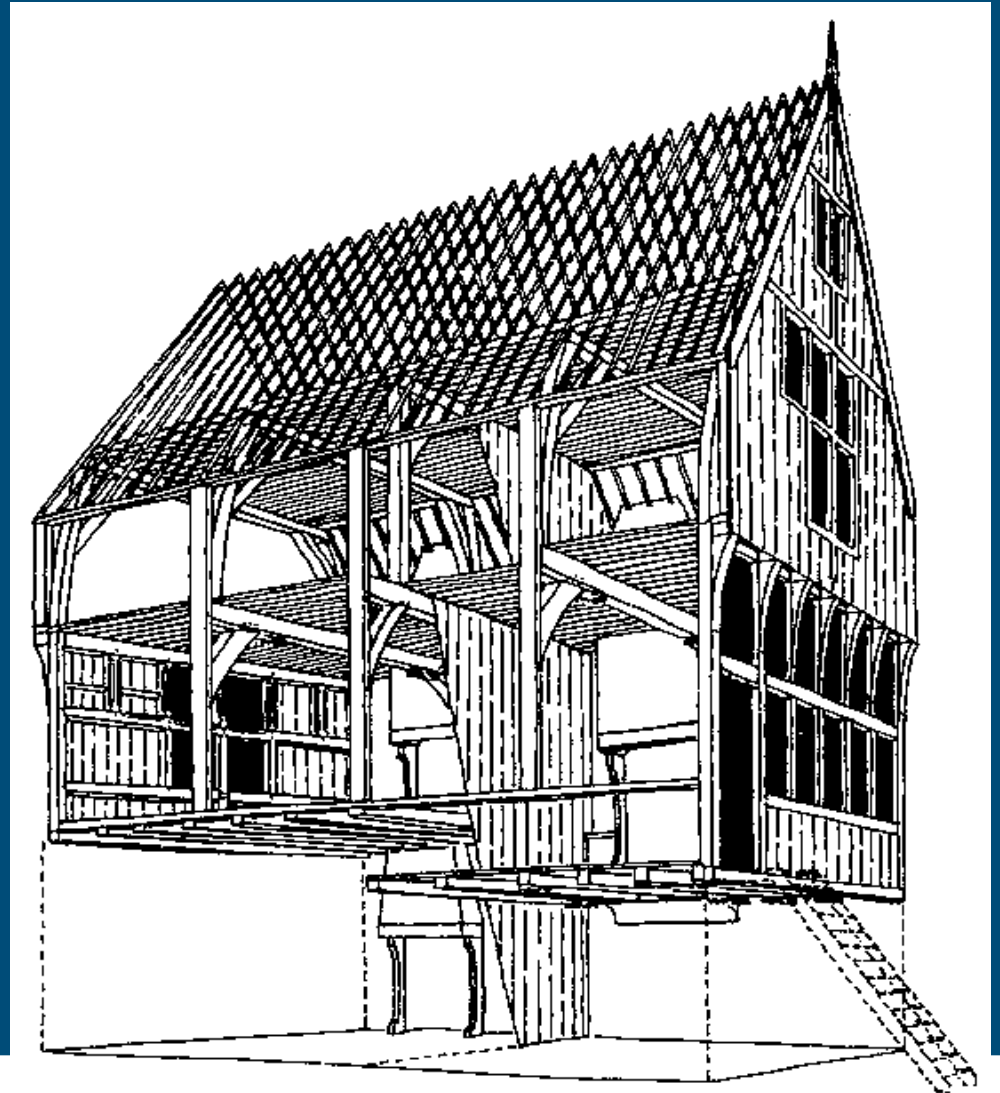
Ecological building



Sustainable building: Adobe



Sustainable building: Wood frame



Sustainable building: Straw bale



Sustainable building: Agrodôme



Building material selection: Agrodôme

- Foundation
 - Ground floor
 - Outer walls
 - massive wall
 - cavity wall
 - Floors / ceiling
 - Roofing material
 - pitched or flat
 - Coatings/Adhesives
 - Paint
 - Insulation
- inside walls
 - supporting wall
 - partition wall



Rice



Byproducts

- Rice Husk
- Rice Straw



Building Materials

- Rice straw
 - Particle board
 - Straw Board
 - **Medium density fibre board**
 - **Composites**
 - **Paper and Board**
 - Cement bonded boards
 - **Resin and Fibres**

Rice straw: Particle board

- Use
 - Inner walls
 - Sound absorbing
- Production Process
 - UF: urea formaldehyde resin
- Improvements
 - Mechanical strength
 - Water Absorption



[Hiziroglu, 2005] [Yang, 2003]

Rice Straw: Straw board

■ Use

- Walls, Roofing

■ Production process

- Without binder
- With binder
- Covered with outside layers

■ Improvements

- Mechanical properties



Rice Straw: Medium Density Fibreboard

- Use:
 - Walls, ceilings, furniture
- Resin
 - UF: Urea Formaldehyde
 - MUF: Melamine urea Formaldehyde
 - pMDI: polymeric methylene diphenyl diisocyanate
- Improvement
 - Silica: Cutting tool wear
 - Mechanical strength
 - Water resistance

[Hiziroglu 2007]

California Agriboard LLC [McLeod, 2004]



Rice Straw: Medium Density Fibreboard

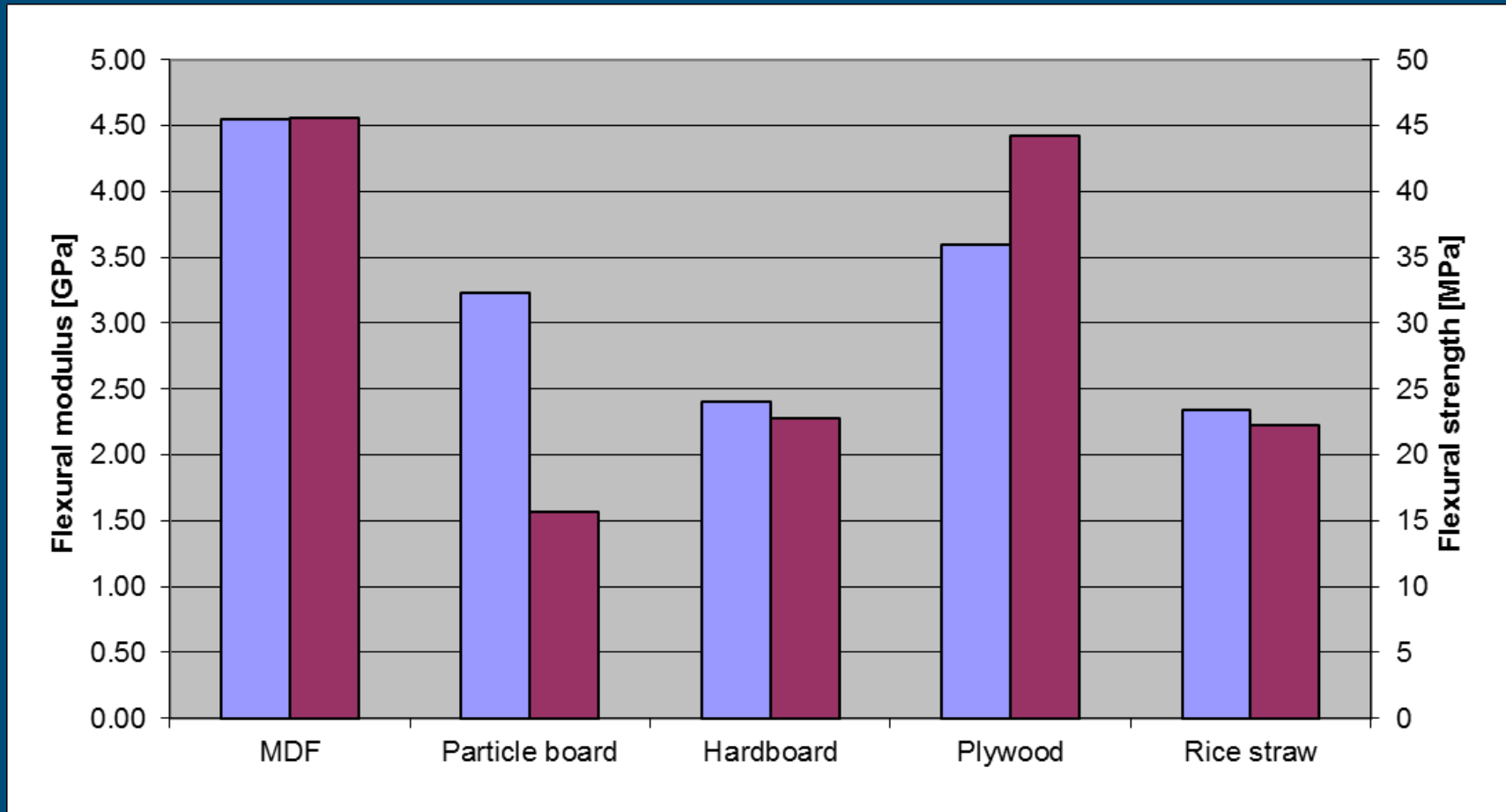
Experimental results

- Production on lab scale of rice straw fibre boards
 - Rice straw milled
- Rice straw MDF sample
 - Rice straw refined
 - Local industry & The National Research Council from Egypt



Rice Straw: Medium Density Fibreboard

Experimental results



Rice straw: Composites

■ Thermoplastics

- Polyethylene [Yao, 2008] [Habibi, 2008]
- Polypropylene [Grazdanov, 2006]

■ Thermoset

- Polyester [Hassan, 2002]
- Polyvinylchloride (PVC) [Kamel, 2004]

■ Improvements

- Mechanical properties
- Compatibilisers
- Chemical pretreatment straw



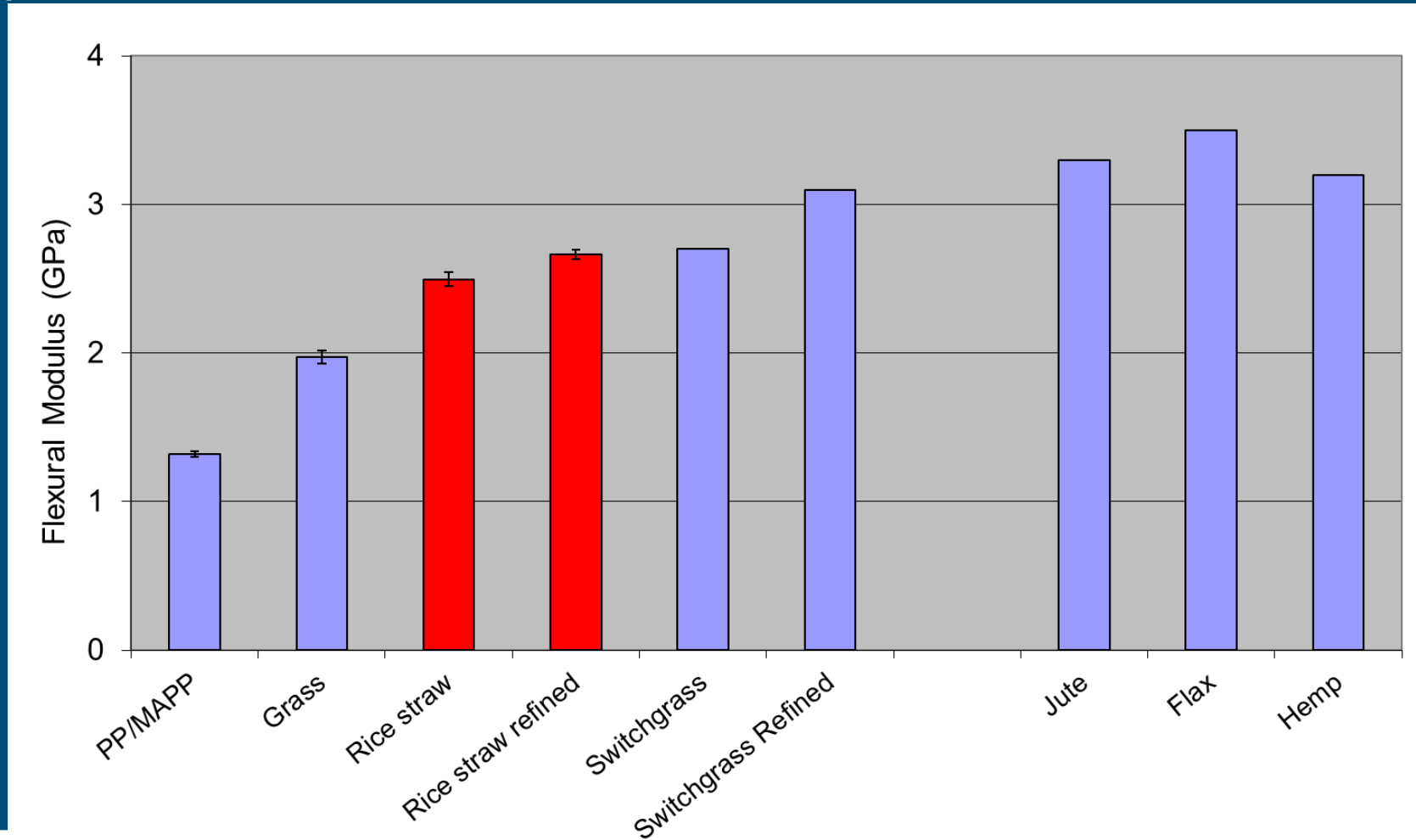
Rice straw: Composites

- Experimental results
 - Thermoplastics
 - Polypropylene



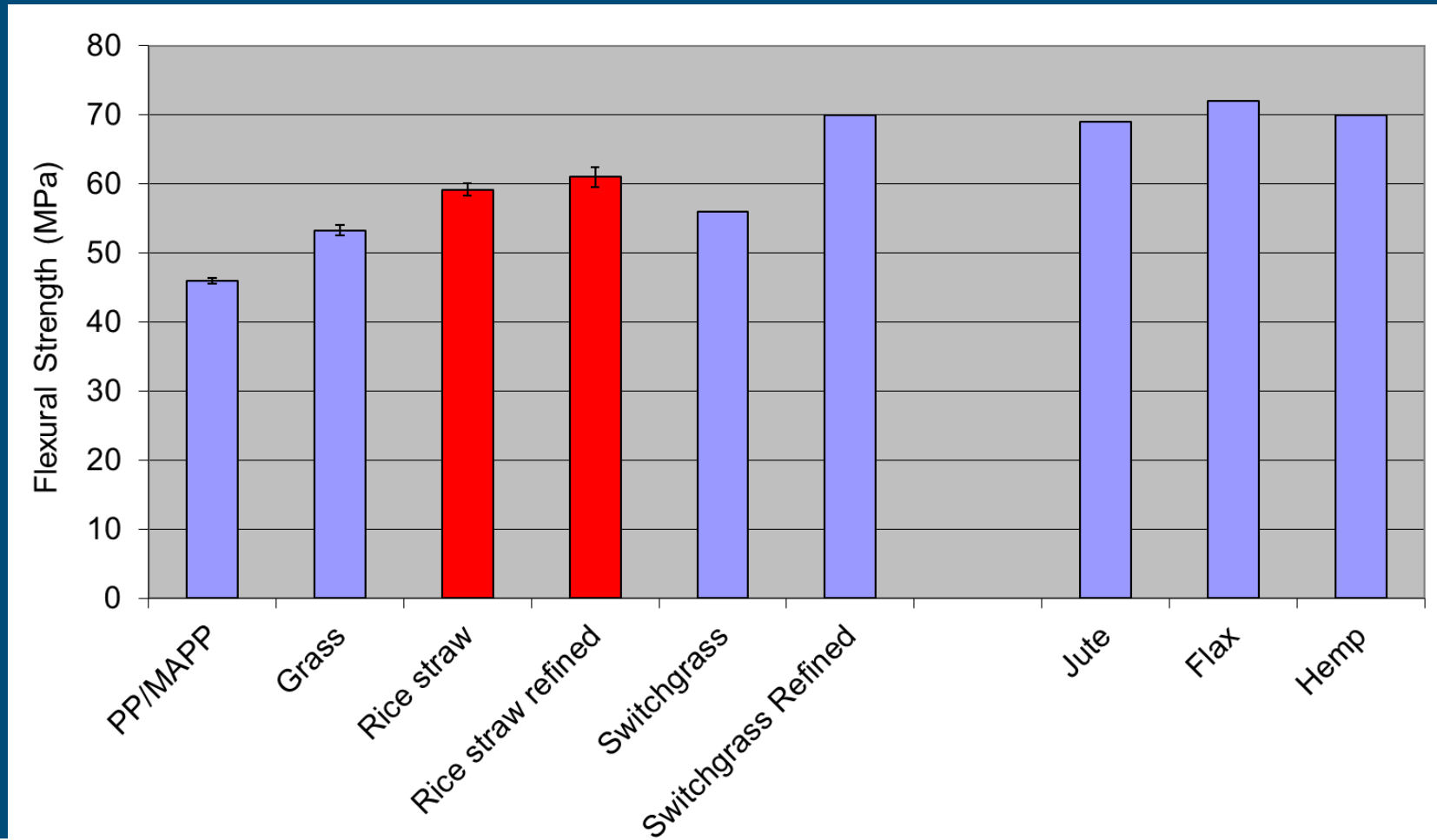
Rice straw: Composites

■ Experimental results



Rice straw: Composites

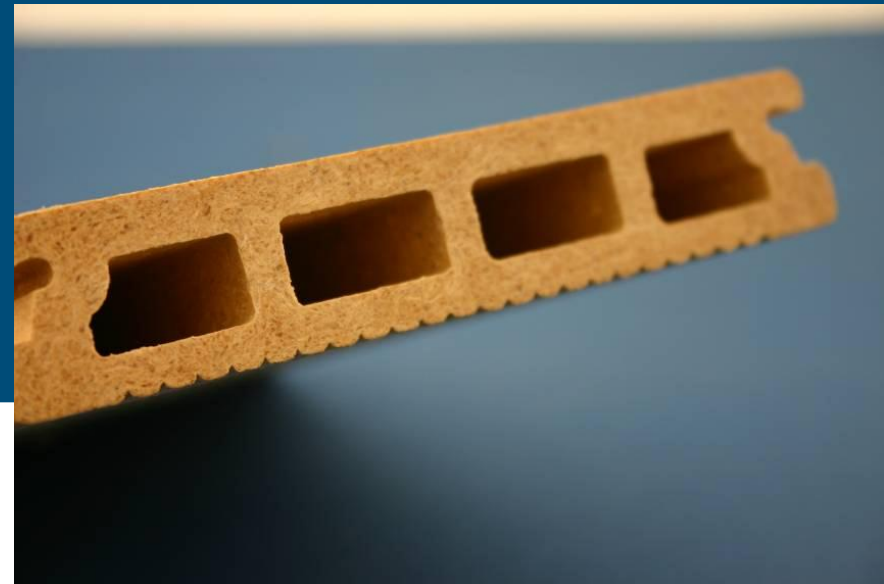
■ Experimental results



Rice straw: BioComposites

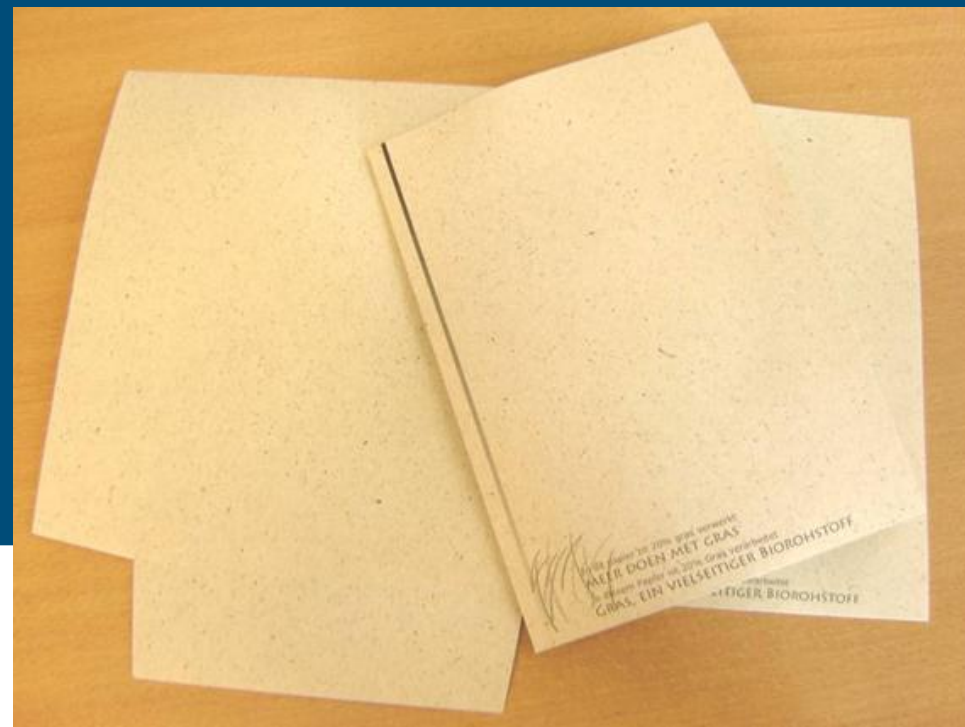
- Composites of biobased plastics and fibres
 - PHBV: Poly HydroxyButyrate-co-hydroxyValerate
 - PLA : Poly Lactic Acid
- Use
 - Structural, thermal insulating panels
- Improvements
 - Mechanical strength
 - Economics

[Buzarovska, 2008]



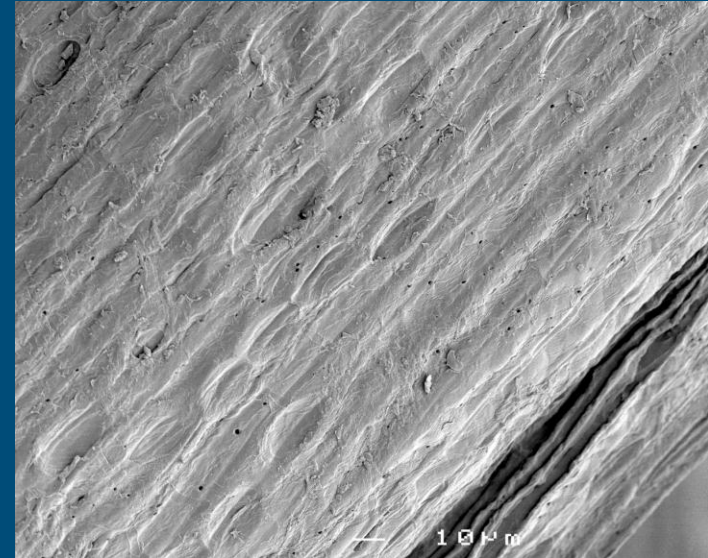
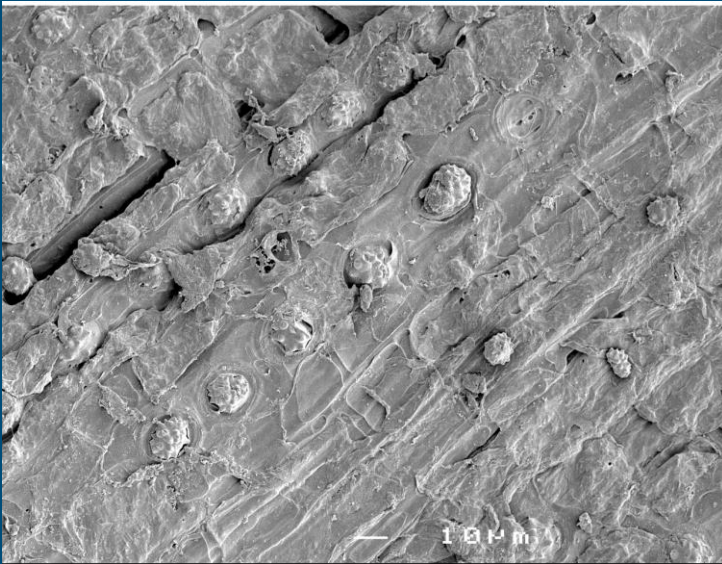
Rice straw: Paper and Board

- Increasing demand for wood
- Paper and Board industry is looking for alternatives
- Main disadvantage: Silica content of rice straw
- Example: Board containing grass [Netherlands]



Rice straw: Paper and Board

- Experimental results



- Silica can be removed or retained depending on pulping process

[Empty fruit Bunch, Organosolv]

Rice straw: Cement bonded boards

■ Use

- Building blocks
- Ceiling panels

■ Straw-fibre cement building blocks

- Cheap recyclable building material
- Low strength
- Thermal insulation

■ Improvements

- Bond between straw and cement
- Acidity straw



[Mansour, 2007]

Rice straw: Resin and Fibres

■ Use: Resin

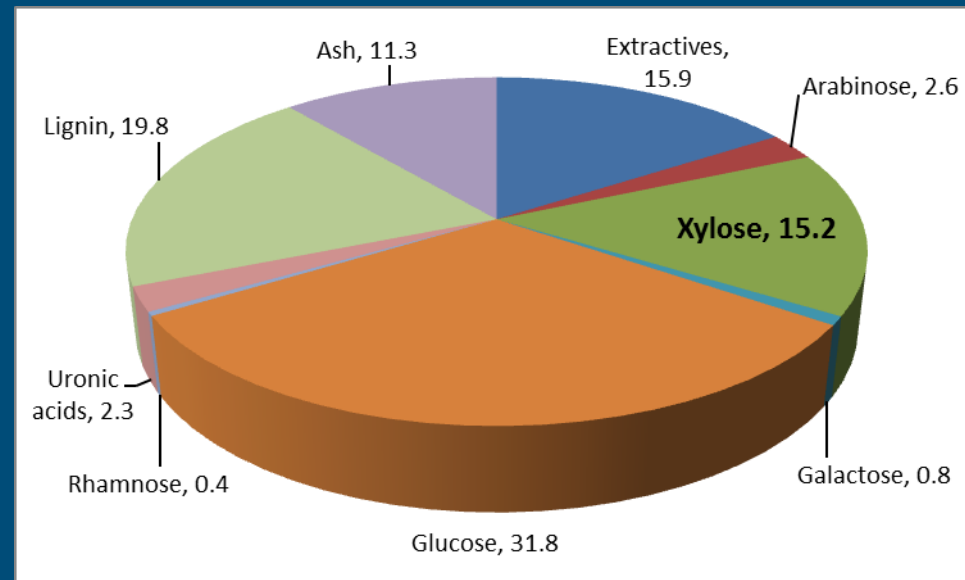
- Furan resins
 - MDF – boards
 - Wood conservation

■ Use: Fibres

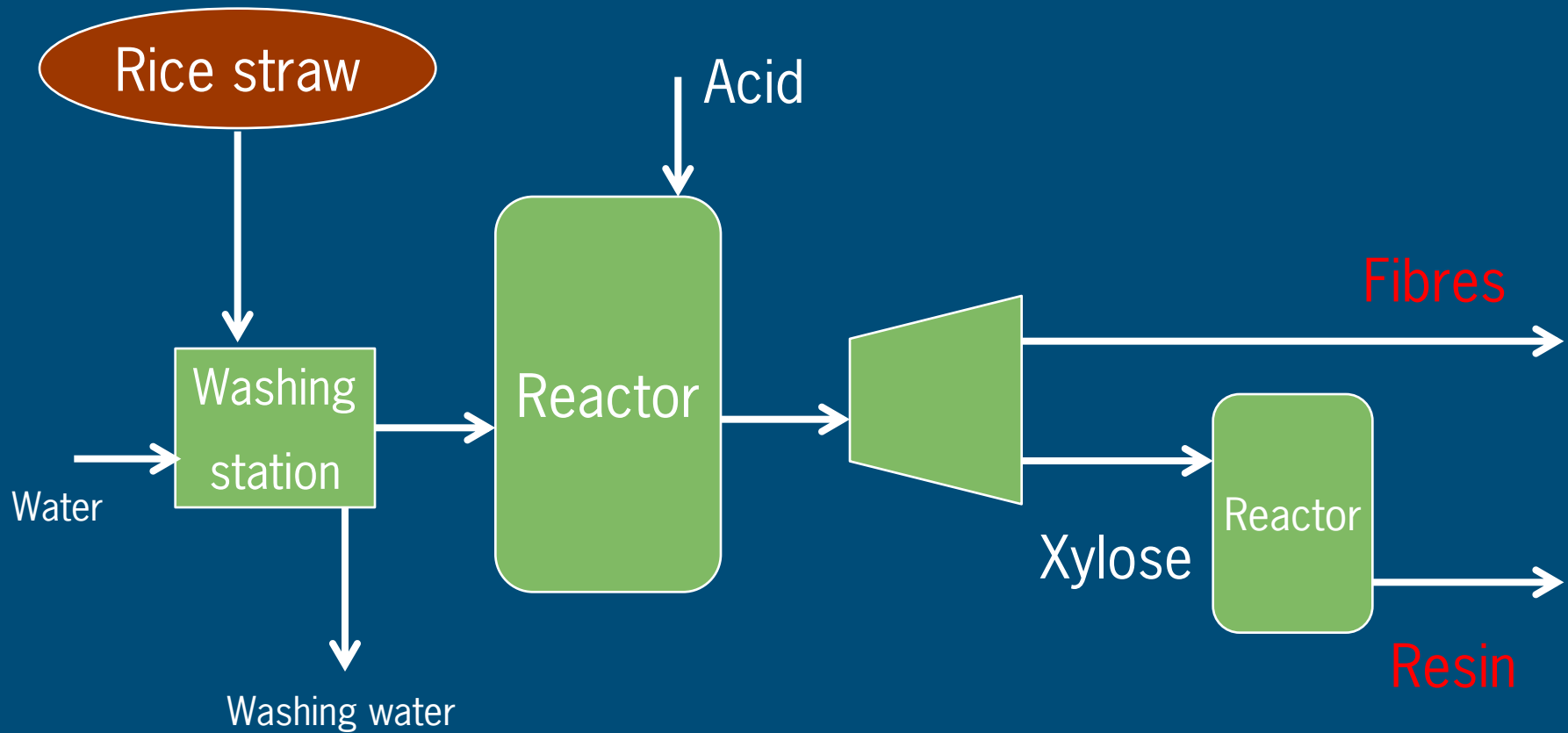
- Cement bonded boards
- Improved binding

■ Production process

- Acidic hydrothermal treatment



Rice straw: Resin and Fibres



Outlook

■ Fibre boards

- Mechanical properties comparable with hard board
- Improvement necessary towards MDF quality

■ Composites

- Refining fibres increases composite strength
- Average mechanical properties

■ Paper and Board

- Development of new pulping processes necessary

■ Resin and Fibres

- Opportunities to combine resin production with fibre improvement

Thank you for your attention.

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