

Sustainable building materials from rice straw

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Overview presentation

- Introduction
- Sustainable building
- Building materials from rice byproducts
- Product development



Transition towards “Biobased economy”



Transition to a **bio-based** economy



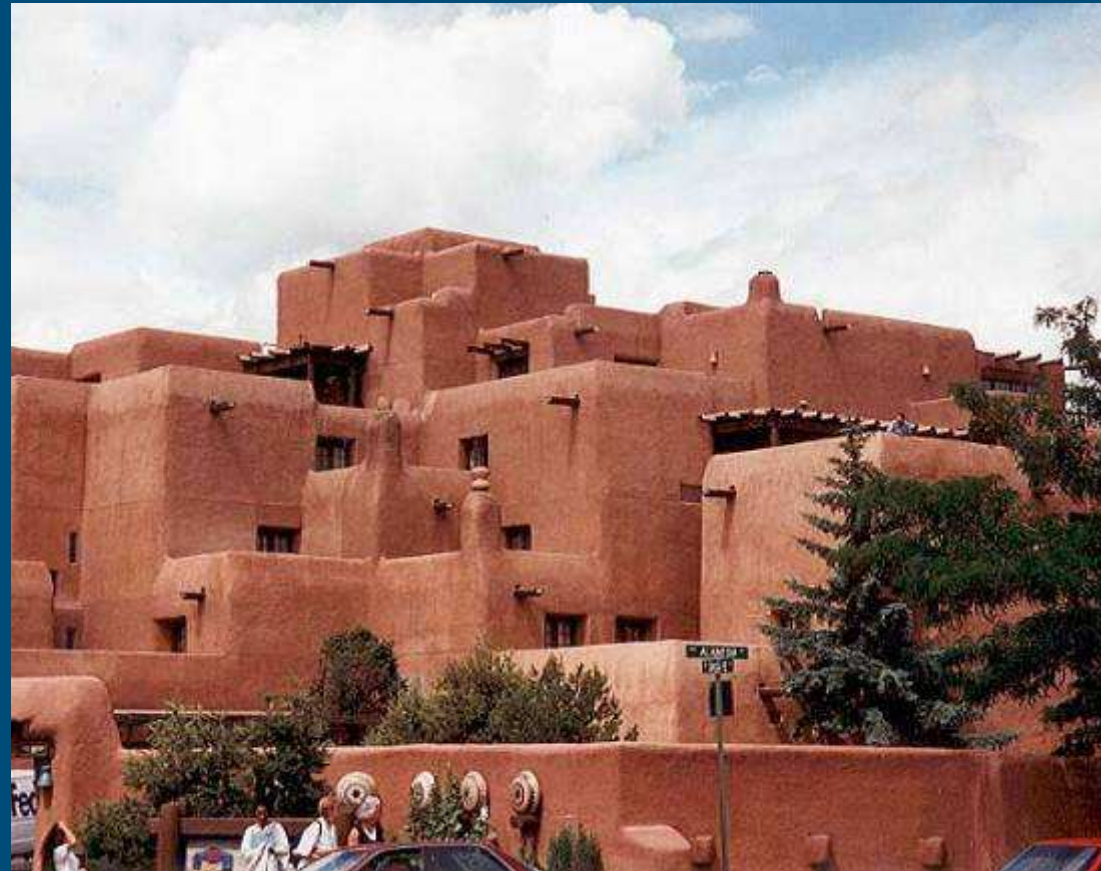
Options for sustainable building

- 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

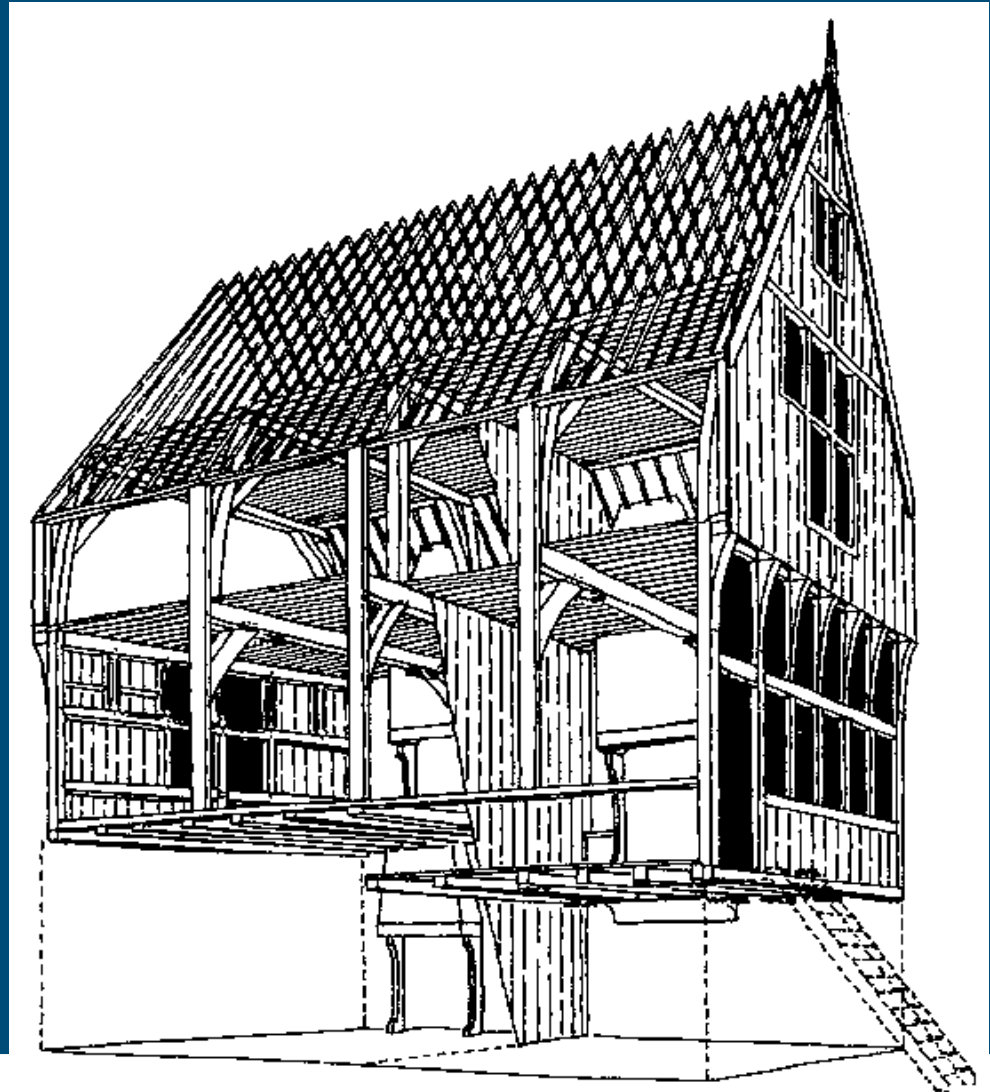


Sustainable building: Ecolonia



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Sustainable building: Wood frame



Sustainable building: Straw bale



Sustainable building: Agrodôme



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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
- Medium density fibre board
- Straw Board
- Straw Bales
- Thatched roofs
- Cement bonded boards
- Composites

■ Rice husk

- Cement
- Gypsum Board



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: 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: Straw board

- Use
 - Walls, Roofing
- Production process
 - Without binder
 - With binder
 - Covered with outside layers
- Improvements
 - Mechanical properties



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: Thatched Roofs

- Improvements
 - Fire Hazard
 - Durability



[Matt Carter, 1997]



Rice straw: Composite board

Waste Tires - Rice straw

■ Use

- Sound absorbing insulation boards in construction

■ Production Process

- Cutting/Milling
- Polyurethane binder
- Hot pressing

■ Improvements

- Toxicity check
- Compatibilisers
- Process

[Yang, 2004]



Rice straw: Composites

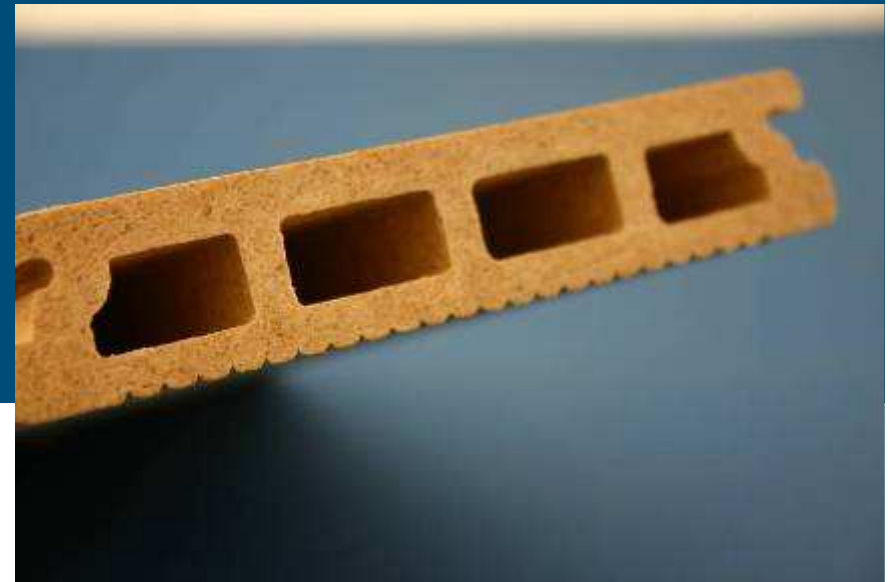
- Thermoplastics
 - Polyethylene [Yao, 2008] [Habibi, 2008]
 - Polypropylene [Grazdanov, 2006]
- Thermoset
 - Polyester [Hassan, 2002]
 - Polyvinylchloride (PVC) [Kamel, 2004]
- Improvements
 - Mechanical properties
 - Compatibilisers
 - Chemical pretreatment straw



Rice straw: 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 Husk: Gypsum board

■ Use

- Wall panels
- Ceiling panels

■ Production process

- Husk content <30%
- Cold production using citric acid

■ Properties

- Increased mechanical properties
- Decreased water absorption



[Kim, 2009]



Rice husk: Cement

Large experience in rice husk cement and concrete

■ Use

- Rice hull ash is converted to $\beta\text{-Ca}_2\text{SiO}_4$ a component of commercial portland cement
- Lightweight insulating concretes for low cost housing

[Salas, 1986] [Romano, 2007]
[de Paiva, 2005] [El-Dakroury, 2008]



Rice husk: CLSM

Self-Compacting low-strength, cementitious materials

- Use
 - Backfill, void fill, utility bedding

- Composition
 - Fine aggregates, Portland Cement, water, rice husk ash

- Rice husk ash:
 - pozzalanic properties



[Nataraja, 2007]

Rice Straw: High end applications

■ Hierarchical porous carbon from rice straw

- Lithium ion batteries
- High rate performance
- High capacity

[Zhang, 2008]



■ Textile fibres

- Chemical and enzymatic extraction
- Natural cellulose fibres
- Properties comparable to linen

[Reddy, 2006]

Product development

- Product at competing price
- Product with new properties
- New technologies
- New products

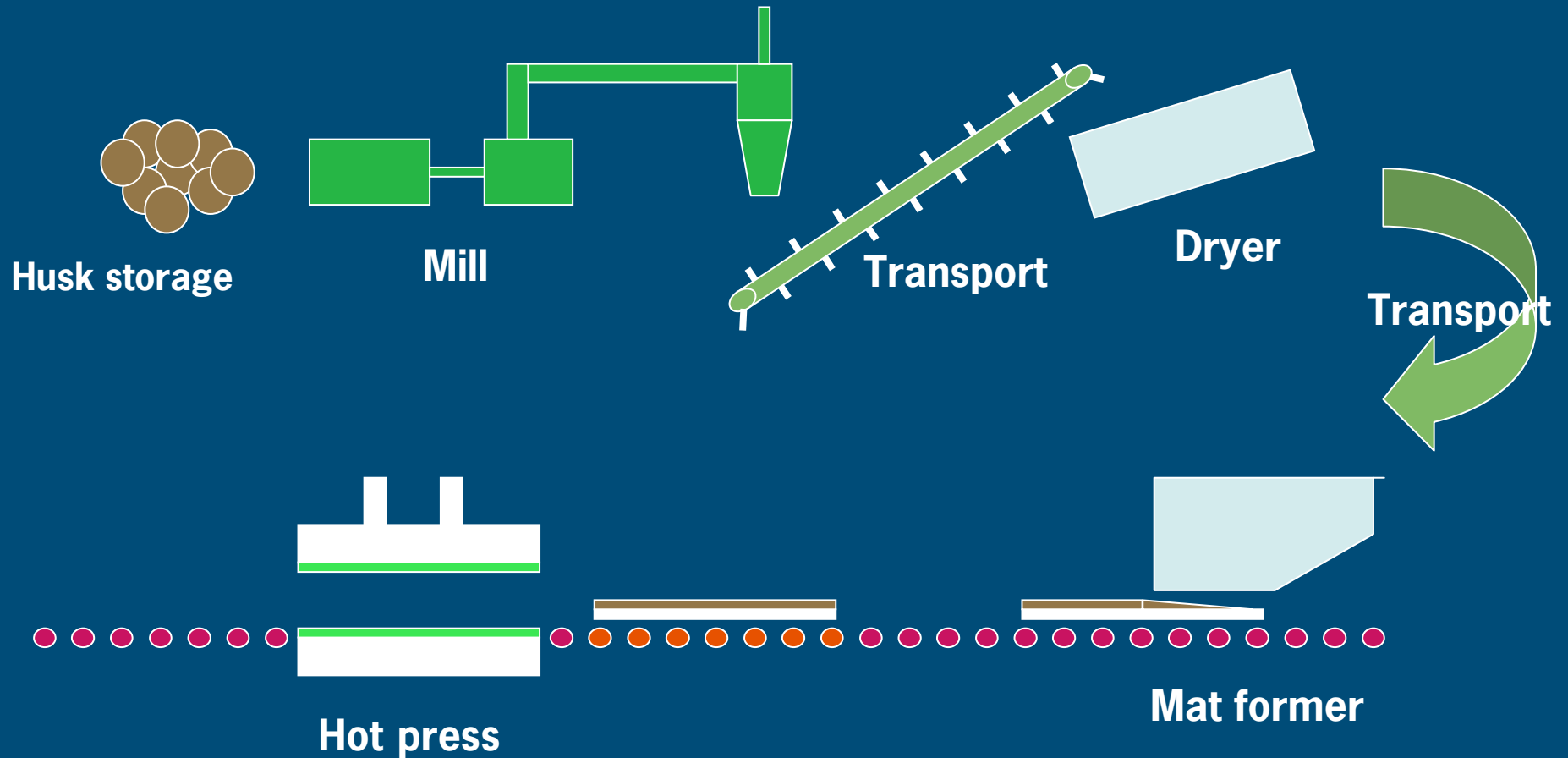


Biomass from agro-industrial residues

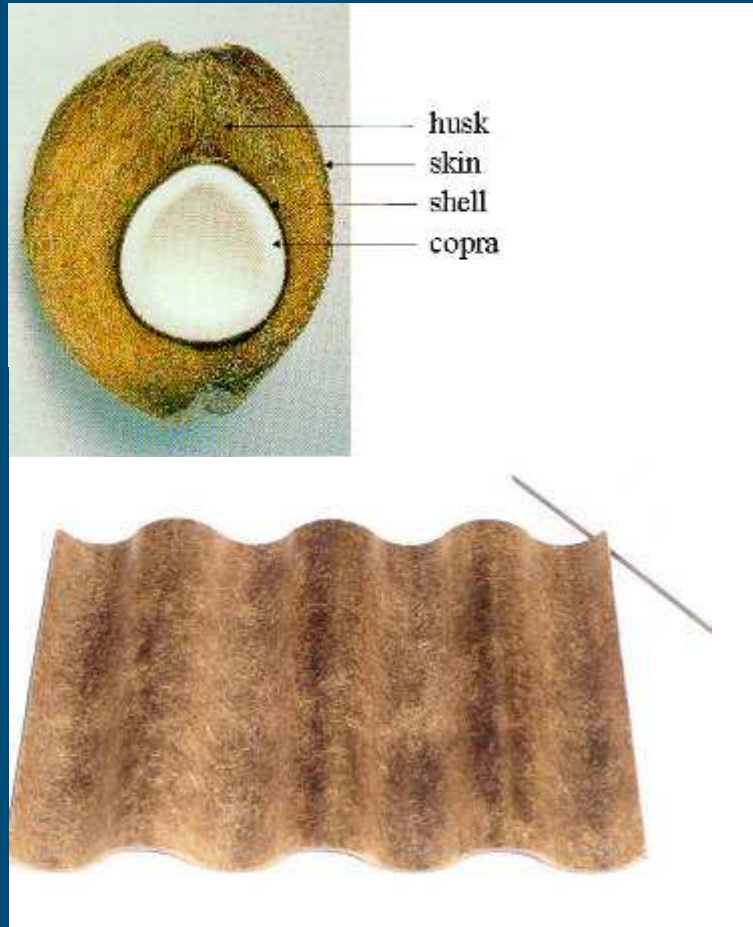
World production capacity coconut husk
15-20 million tons /year



Overview continuous pilot line



Building and construction materials



Composites



Conclusions

- Multiple opportunities for Rice Byproducts in sustainable building materials
 - Alternatives for existing wood products
 - New products
- Product development necessary
 - Improve products
 - Economy processes
- Rice straw part of Biobased Economy



Thank you for your attention.

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