Fipronil delivered through a nanocellulose system

Drs. M. Soledad Peresin, Ryan L. Nadel, and I. Beatriz Vega Erramuspe

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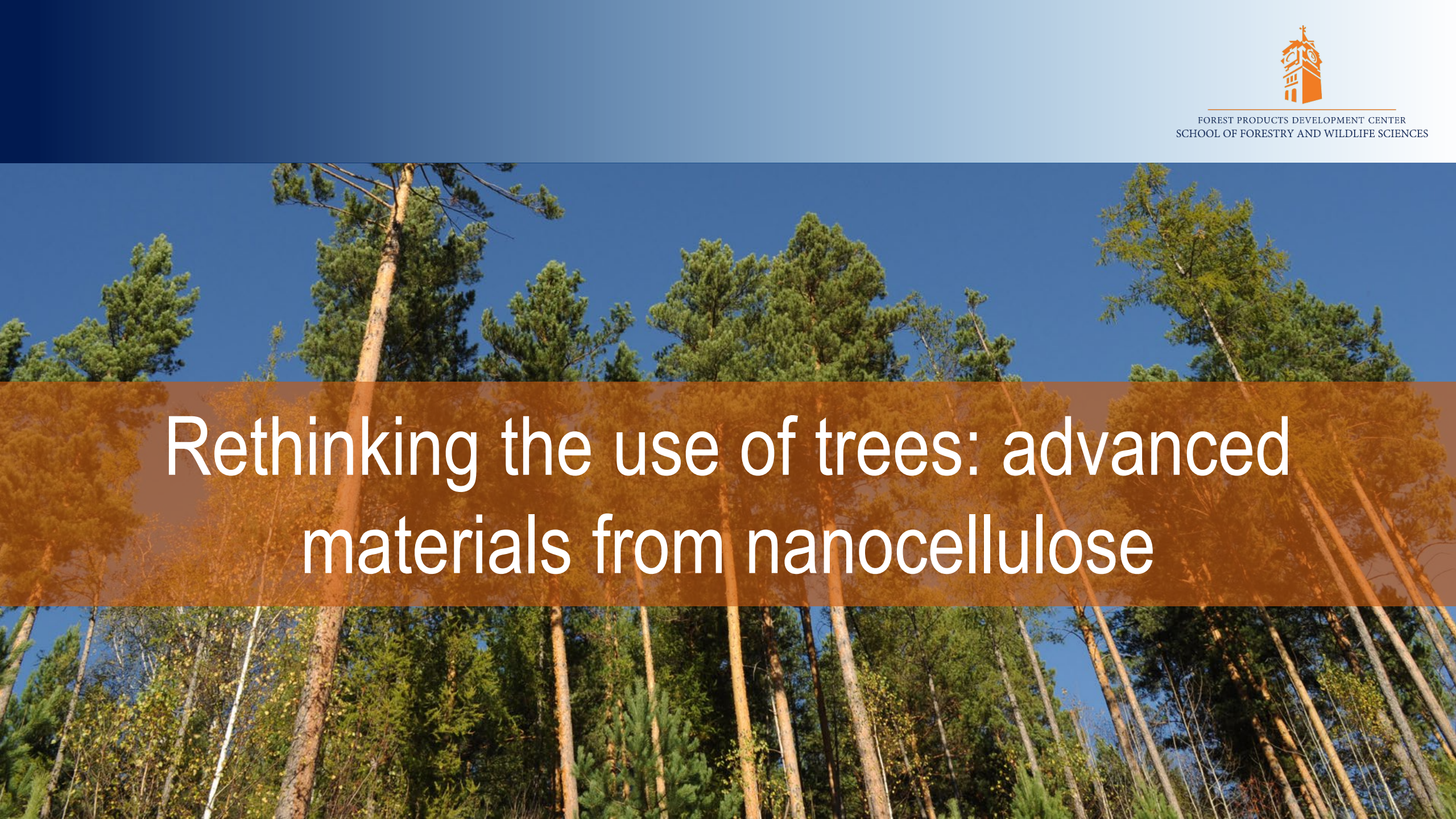

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Rethinking the use of trees: advanced materials from nanocellulose

Traditional Uses of Wood

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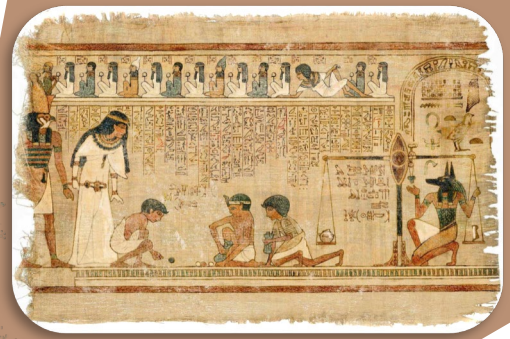
HOUSING

Nideröst-House (Switzerland)

COMMUNICATION



Papyrus (Egypt)

TRANSPORTATION

Vasa Ship (Sweden)

Fuel!

The drivers towards a global bio-based economy

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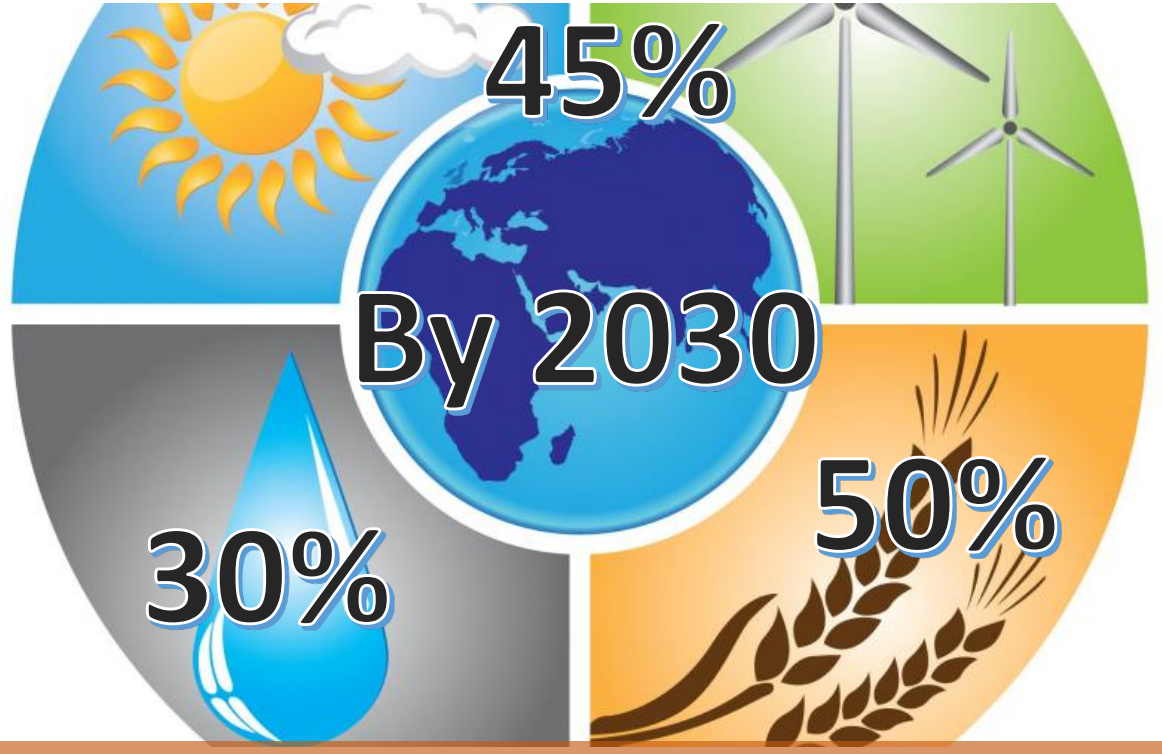
- Population growth
- Declining of natural resources
- Loss of biodiversity
- Climate change



BIOECONOMY INCLUDES

1. **Use** of renewable, bio-based natural resources,
2. Environmentally friendly **clean technologies** and
3. Efficient **recycling** of materials

YK (2012): Resilient People, Resilient Planet: A future worth choosing
The Finnish Bioeconomy strategy - Biotalous

A deeper look into biomass

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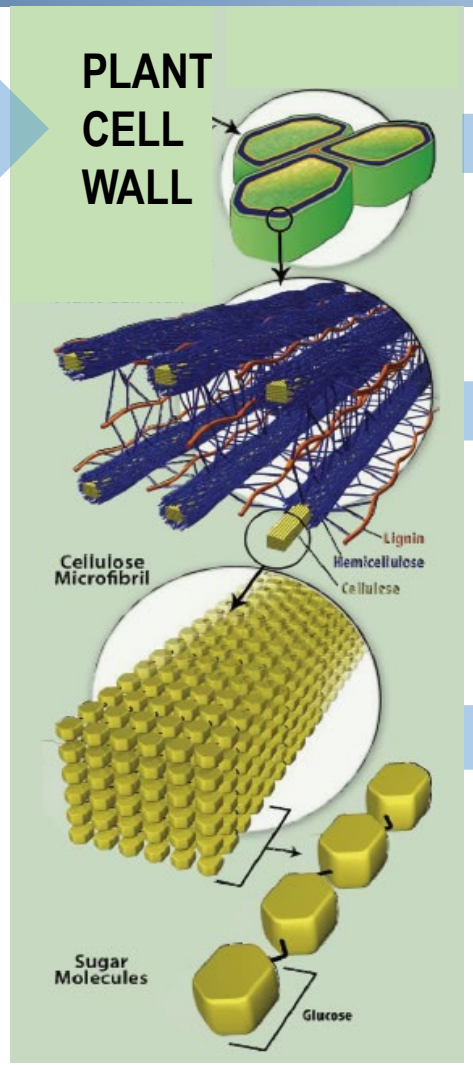
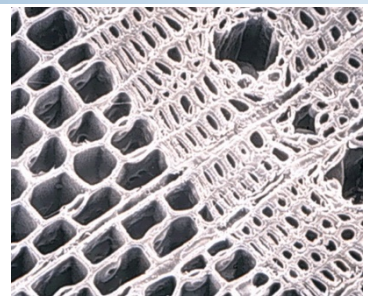
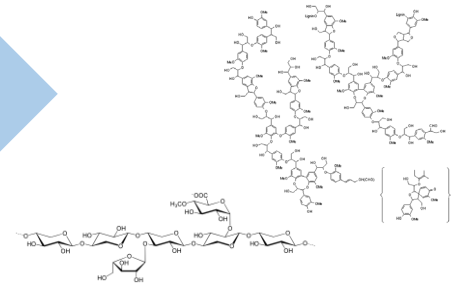
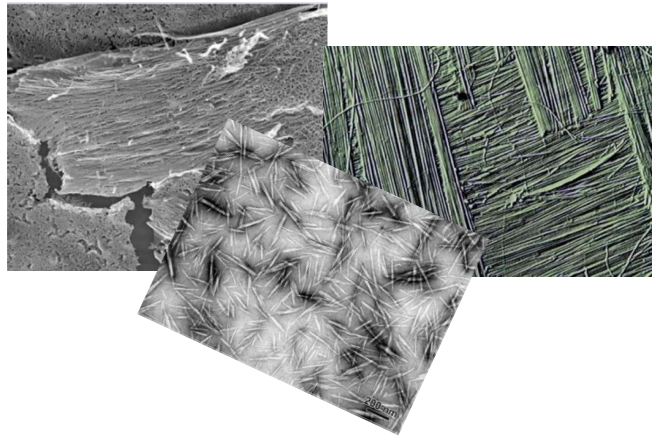
BIOMASS



http://www2.lbl.gov/Publications/YOS/Feb/







The scale of “things”

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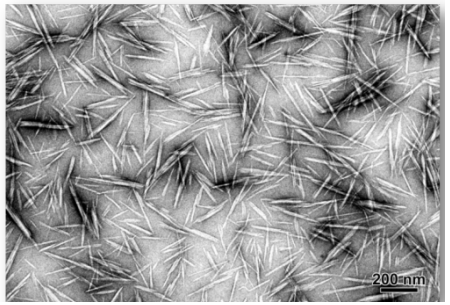
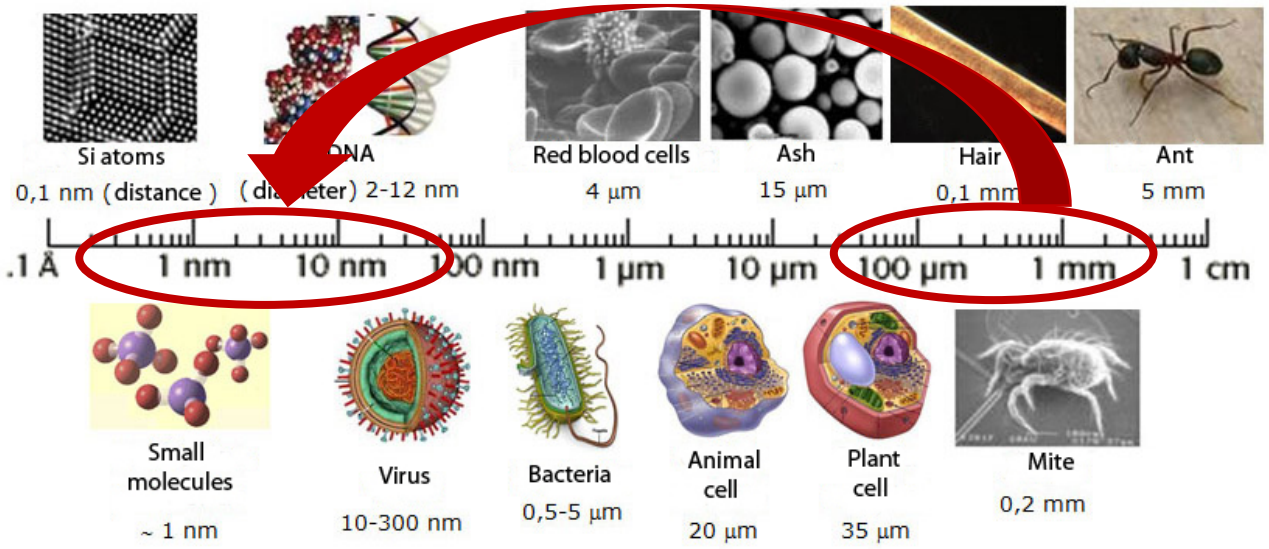
CELLULOSE NANOCRYSTALS



200 nm



CELLULOSE FIBERS

200 um

http://www.davidfunesbiomed.eu/2015/06/nanotechnology-introduction.html

LESS space, material, energy

NEW properties and phenomena

Nanocellulose production

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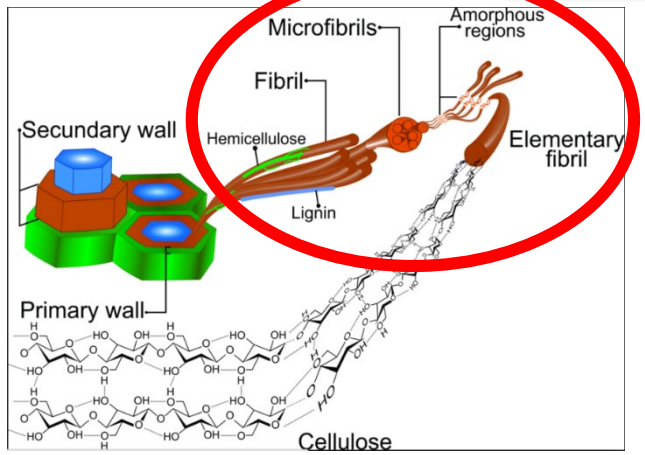
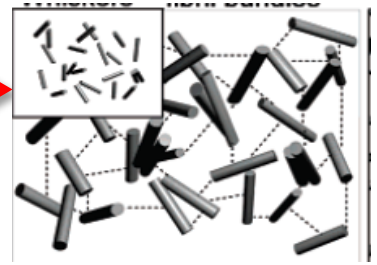
Fiber deconstruction

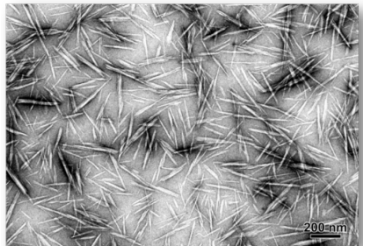


John Rojas, et al *DOI: 10.5772/61334*

Acid hydrolysis

Cellulose nanocrystals (CNC)





Peresin et al. *Biomacromolecules* (2010) 11, p. 674
Adapted from Pakko et al. *Biomacromolecules* (2007) 8 p.1934

Nanocellulose production

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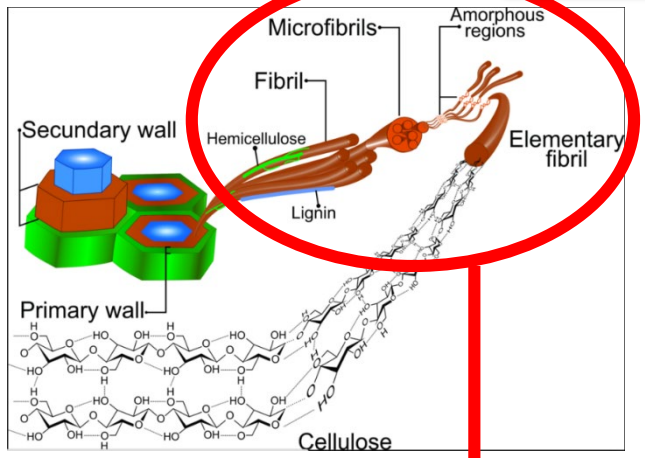
Fiber deconstruction



John Rojas, et al *DOI: 10.5772/61334*

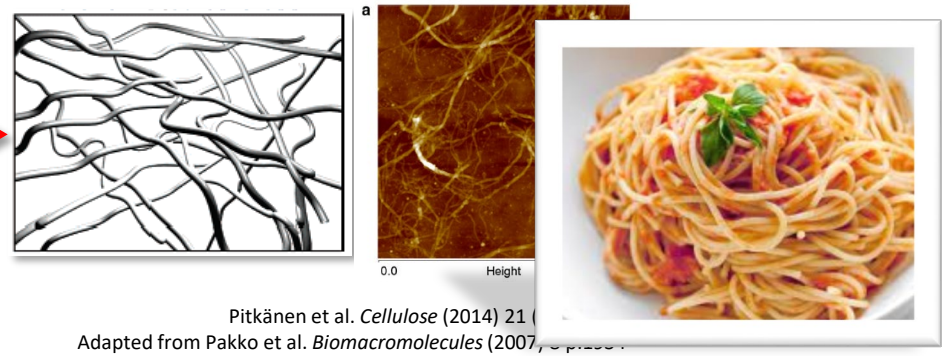
Acid hydrolysis

Cellulose nanocrystals (CNC)

Peresin et al. *Biomacromolecule*
Adapted from Pakko et al. *Biomacromolecu*

(Enzymatic/chemical pre-treatment)
Mechanical treatments

Cellulose nanofibrils (CNF)



Pitkänen et al. *Cellulose* (2014) 21 (
Adapted from Pakko et al. *Biomacromolecules* (2007,

Nanocellulose production and properties

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- Chemical process, acid hydrolysis
- Whiskers – short and
- Crystalline
- Self assembly possible
- Defined rheology

- Mechanical process, or chemi-mechanical
- Long fibrils
- Amorphous and crystalline regions
- No self assembly
- Strongly shear thinning (rheology depends on the manufacturing process

- **Renewable**
- **Biocompatibility**
- **High surface-area**
- **Excellent mechanical strength**
- **Abundant free hydroxyl groups**

Pitkänen et al. *Cellulose* (2014) 21 (
Adapted from Pakko et al. *Biomacromolecules* (2007,

Rethinking the use of trees (and other biomass)

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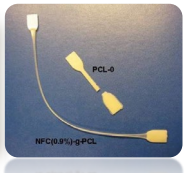

COSMETICS

FOOD

TISSUE ENGINEERING

LIGHT WEIGHT COMPOSITES

MEMBRANES

HOUSING, COMMUNICATION and TRANSPORTATION

FUNCTIONAL TEXTILES and FIBERS

PACKAGING

SMART SENSORS and PRINTED ELECTRONICS

Nanotechnology as promising alternative for seedling production

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- Nanotechnology a means of encapsulating the active compound.
- Primary purpose is to reduce dose amounts.
- Reduce the amount of pesticides used but maximise the yield.
- Reduce concentration of pesticides
- Improve the overall pesticide application process.

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Pesticides delivered through nanocellulose system

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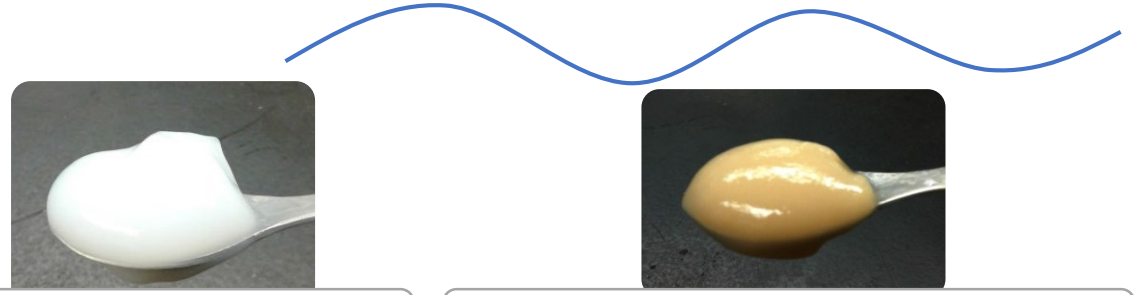
HYPOTHESIS:

- **CNF will improve systemic adsorption of pesticide in trees**
- **CNF will decrease the amount of the recommended dose (RD) of pesticides, with the same/improved(?) efficiency**

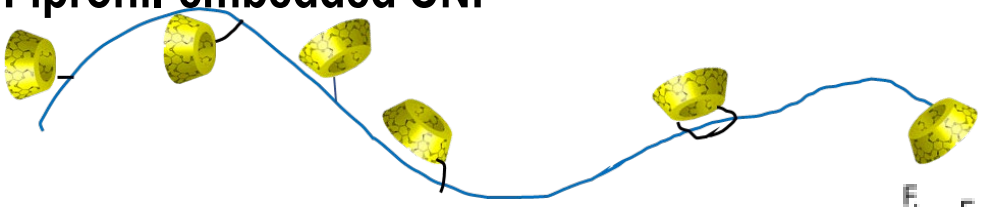
Cellulose Nanofibrils (CNF)

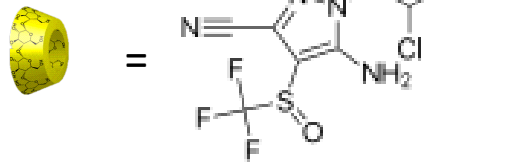


Bleached (only cellulose)

Unbleached (cellulose+lignin+hemis)

Fipronil-embedded CNF





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Methodology

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			Bleached and Unbleached nanofibers			
		Control	¼ RD	½ RD	RD	RD - control
Insecticide *	mL	0	0.154	0.615	1.23	1.23

*Insecticide with 9.1% active ingredient fipronil

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Methodology

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12 months

Testing of roots, stems and leaves by HPLC

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Results

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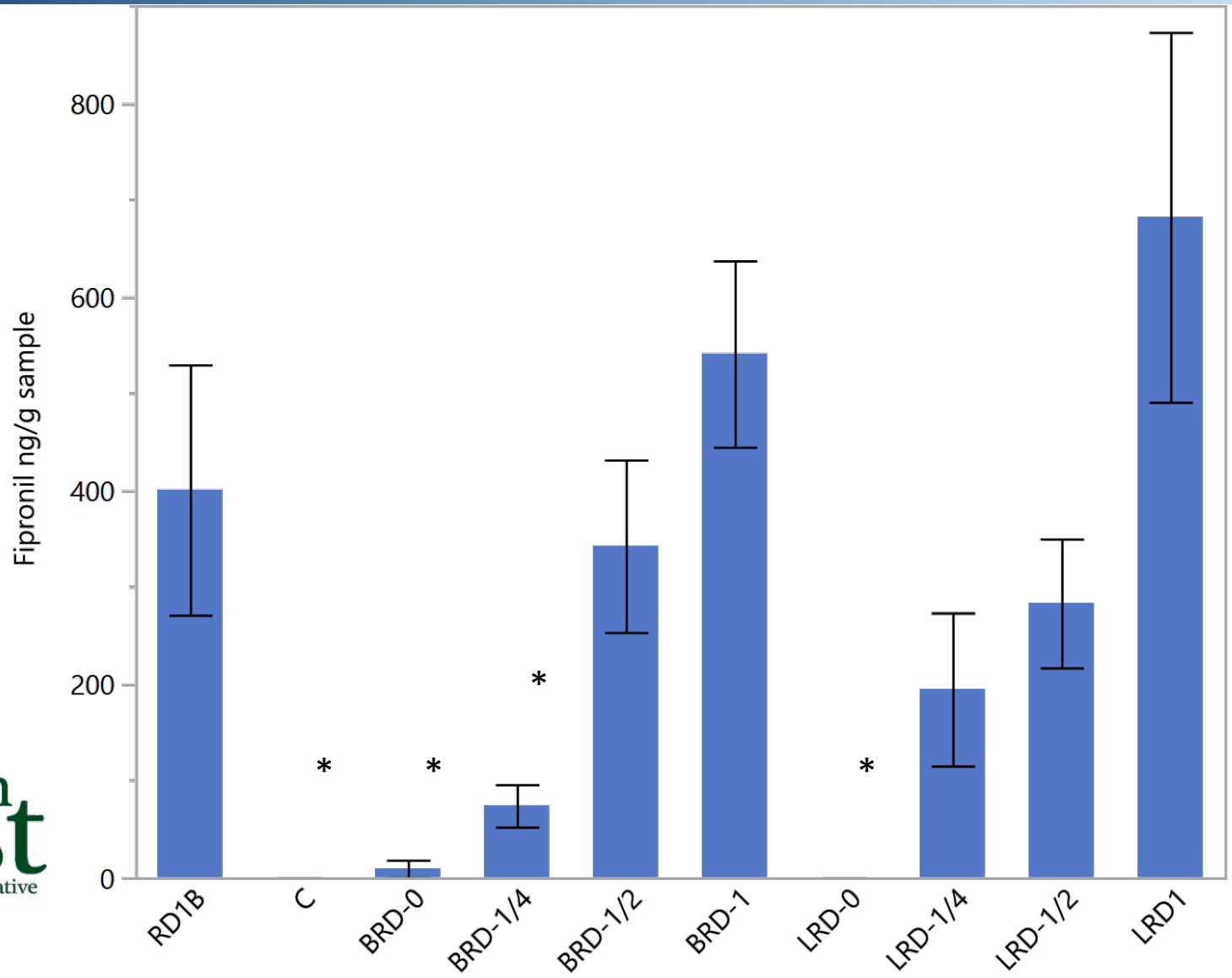

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Results

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- A new method tested and developed to apply pesticide to tree seedlings based on absorption.
- A new method for sampling and monitoring pesticide residuals in different parts of the seedling (stems, roots, needles) up to 12 months following application.

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Summary

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- We have filed an invention disclosure and provisional patent for the system.
- The invention is the development of an encapsulation system for the delivery of pesticides in tree seedlings, based on nanocellulose fibres.
- Able to increase the retention time of pesticide within a tree while decreasing the amount of active compound needed to reach optimum effect.
- This method will reduce costs of pesticide applications.

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