Laboratoire de Physique et Mécanique Textiles

UNIVERSITÉ HAUTE-ALSACE

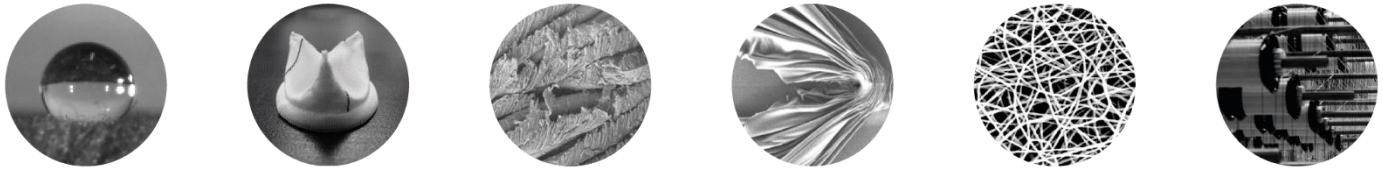
Positionnement chanvre - lin - coton et procédés alternatifs au rouissage

Jean-Yves DREAN

ENSISA – LPMT

80ème Journée Technique de l'ACIT

21 mars 2019 - Mulhouse



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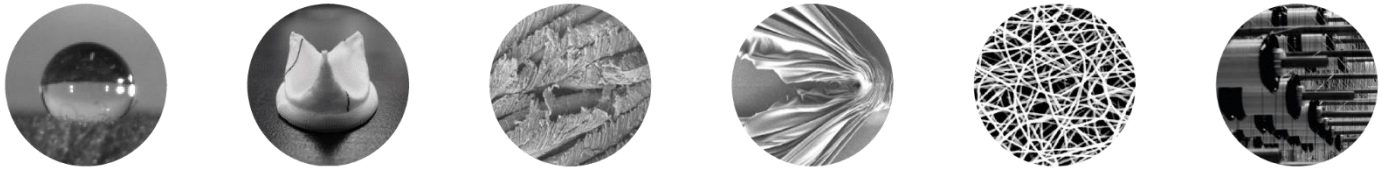
Cotton – Flax – Hemp positioning and alternative retting processes

Jean-Yves DREAN

ENSISA – LPMT

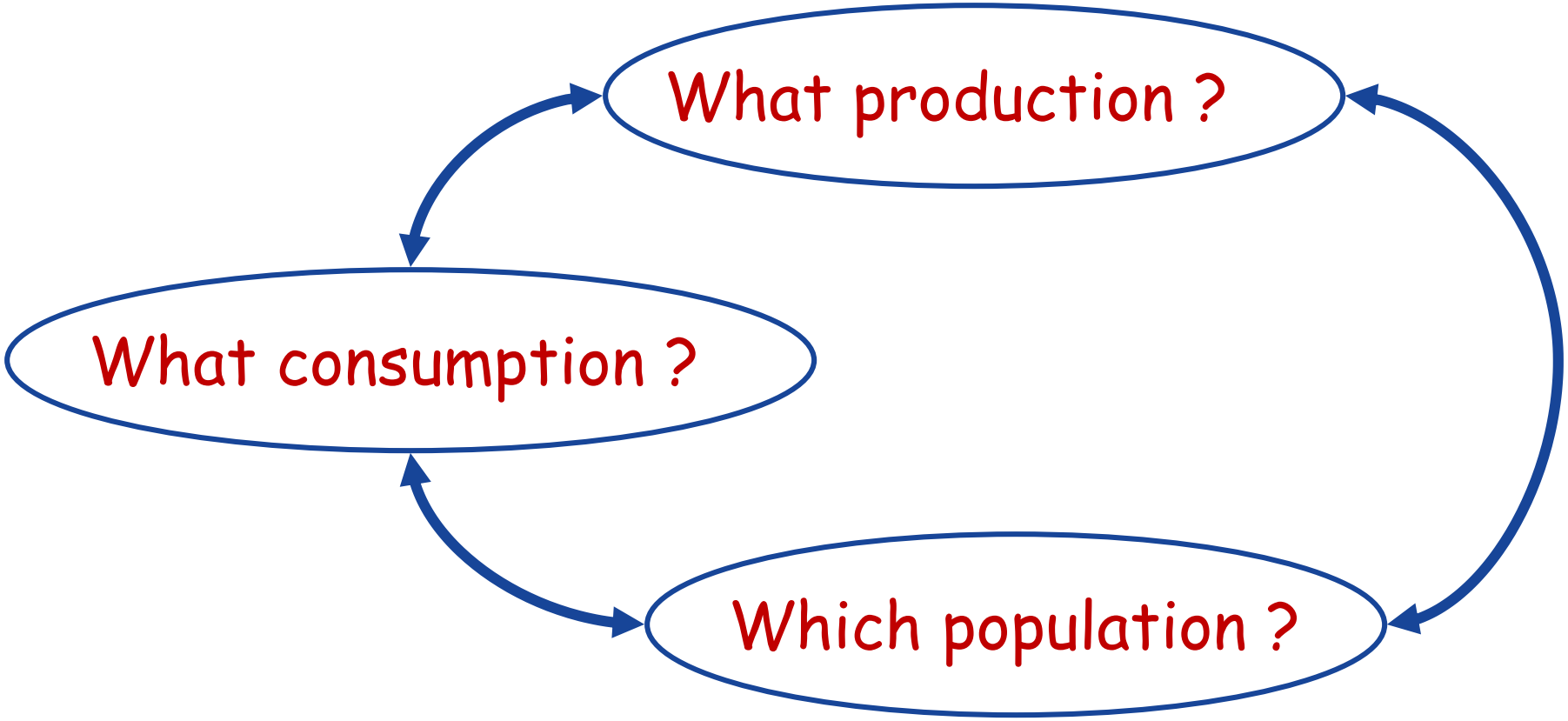
ACIT 80th Technical Day

March 21st , 2019 - Mulhouse



Foreword

- **Fibres?**



Foreword

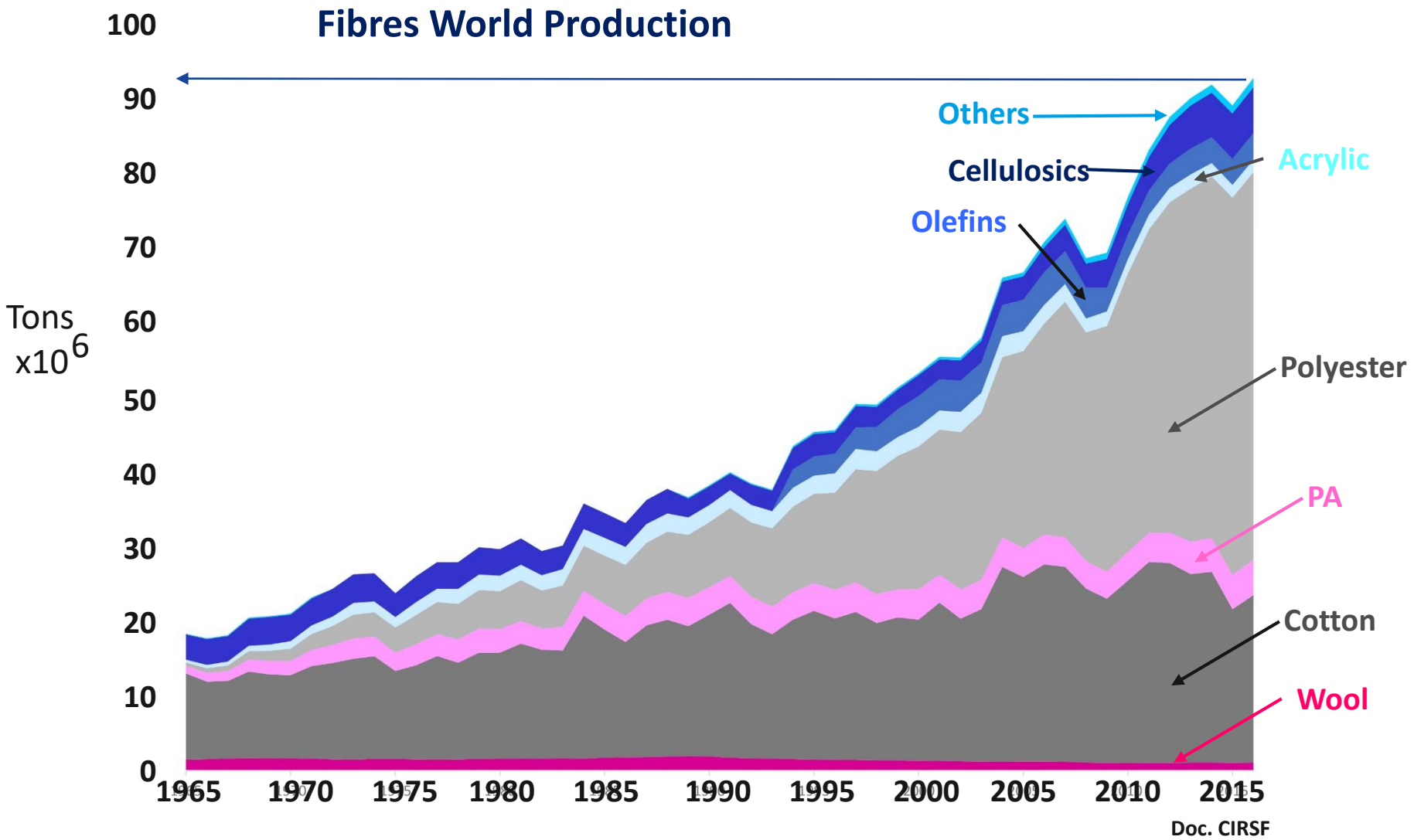
- Fibres?

7,63 Billions

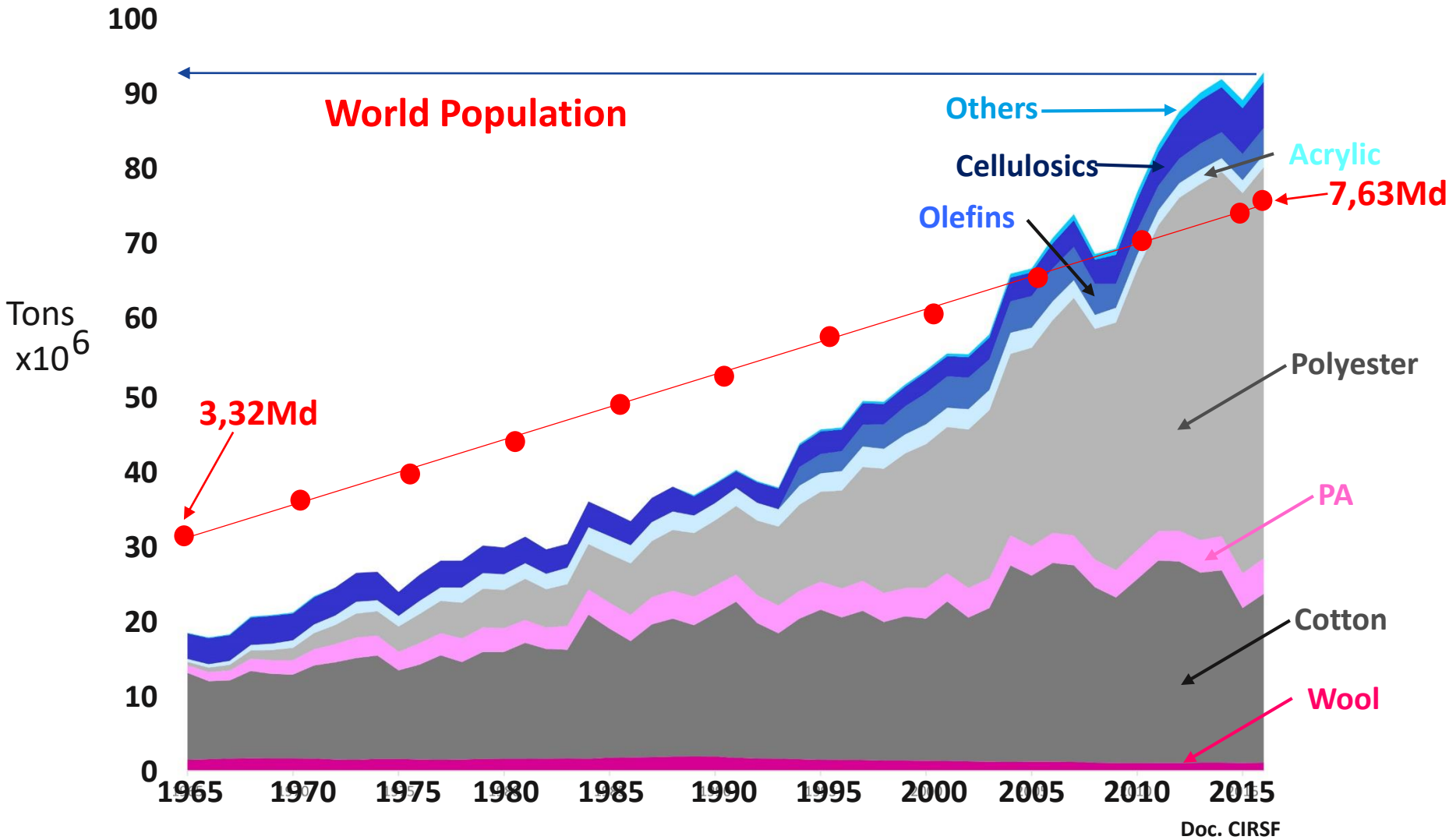
12 kg/year/capita ?

92 millions tons / year

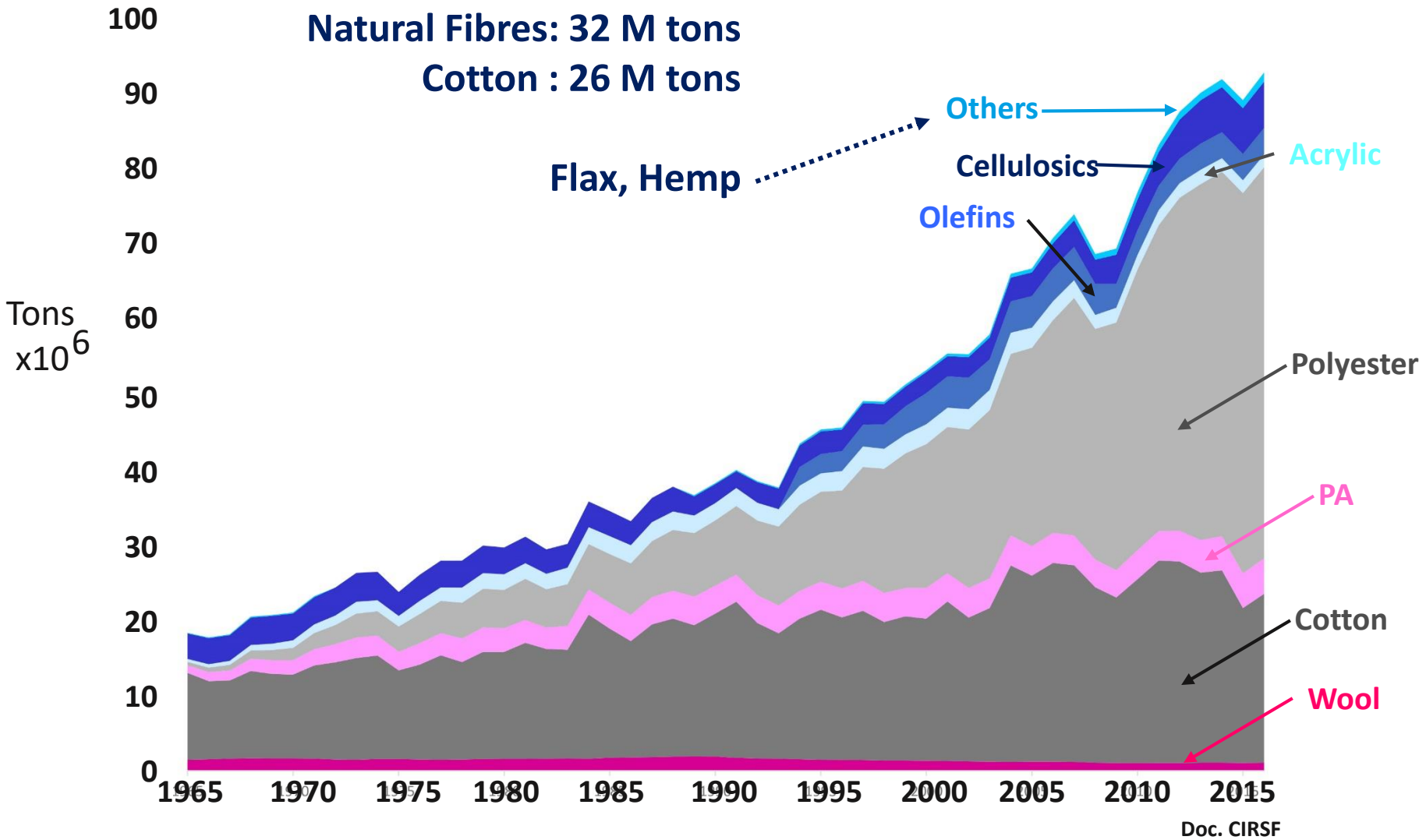
Foreword


Fibres World Production
Tons x10^6
100
90
80
70
60
50
40
30
20
10
0
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Others
Cellulosics
Olefins
Acrylic
Polyester
PA
Cotton
Wool
Doc. CIRSF

Foreword


Tons x10^6
100
90
80
70
60
50
40
30
20
10
0
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
World Population
3,32Md
7,63Md
Others
Cellulosics
Acrylic
Olefins
Polyester
PA
Cotton
Wool
Doc. CIRSF

Foreword


Natural Fibres: 32 M tons
Cotton : 26 M tons
Flax, Hemp
Others
Cellulosics
Acrylic
Olefins
Polyester
PA
Cotton
Wool
Tons x10^6
100
90
80
70
60
50
40
30
20
10
0
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Doc. CIRSF

Needs in fibres

Instead of man made fibres

Instead of classical natural fibres

… Hemp is a good candidate

- Bio sourced fibre
- Cultivation with a small quantity of water
- Growth with a small quantity of fertilizer
- Growth without pesticide
- Weak environmental impact

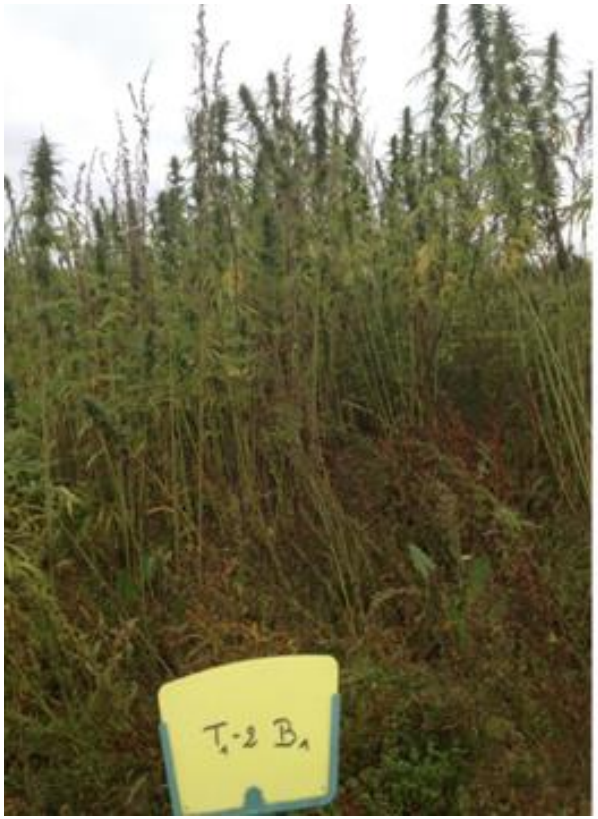
→ PROBLEM : Fibre extraction

Hemp - Flax - Cotton Positioning

- **Cotton : Plant seed fibre**
- **Flax, hemp : Bast Fibres**

Cotton

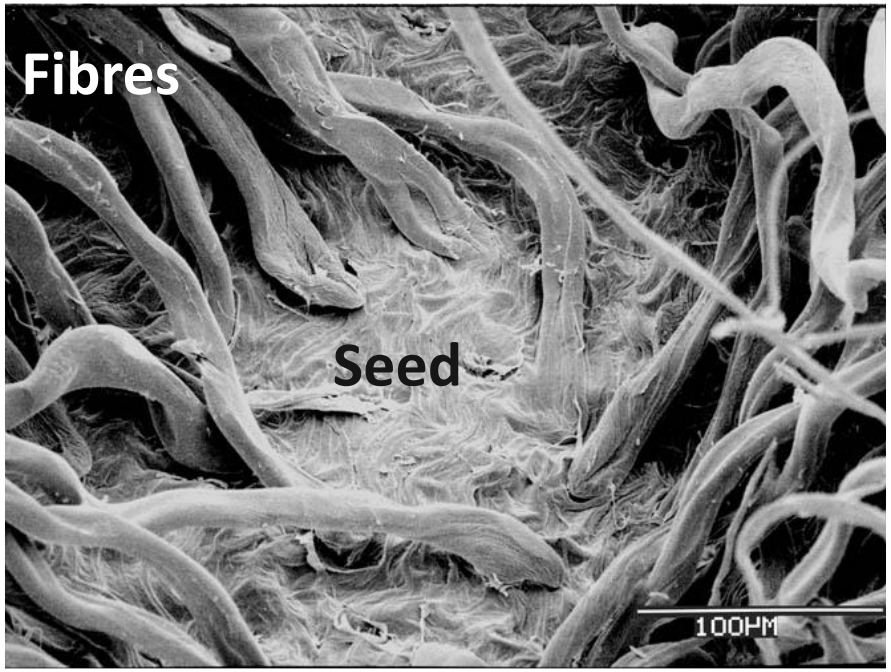
Flax



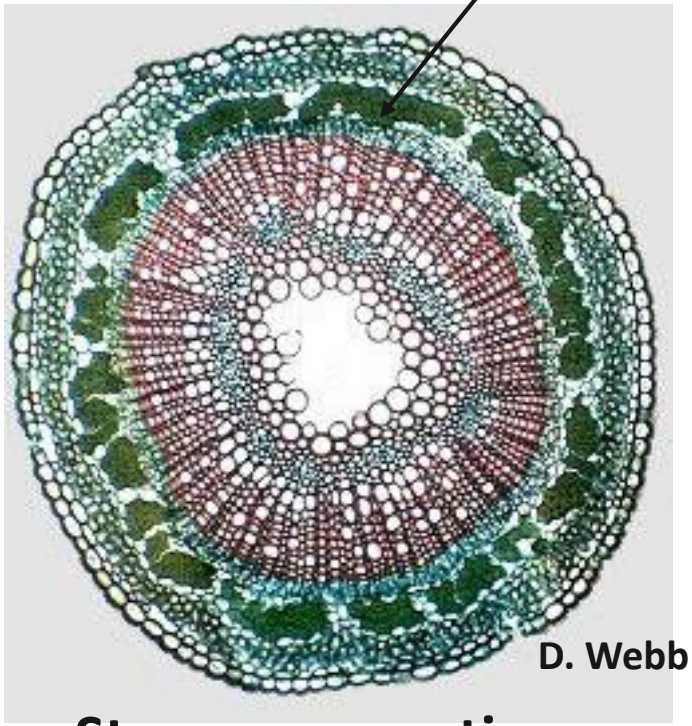
Hemp

Hemp - Flax - Cotton Positioning

- **Cotton : Plant seed fibre**
- **Flax, hemp : Bast Fibres**



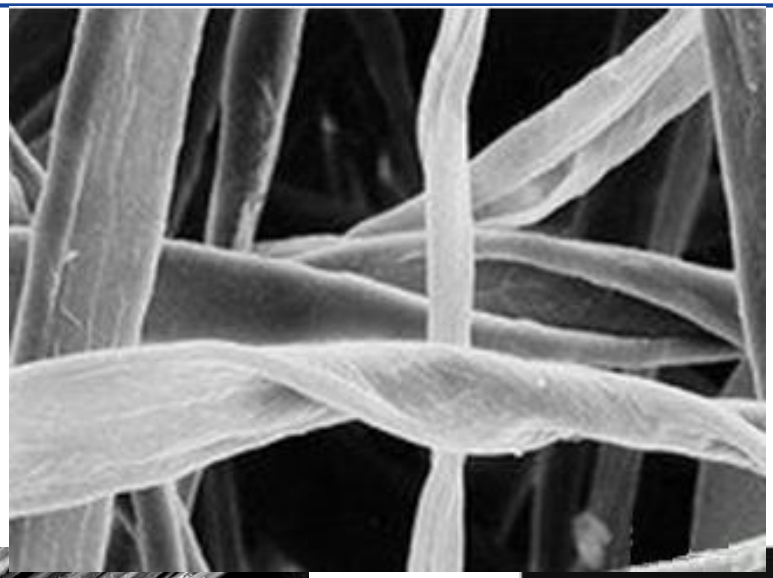
Cotton



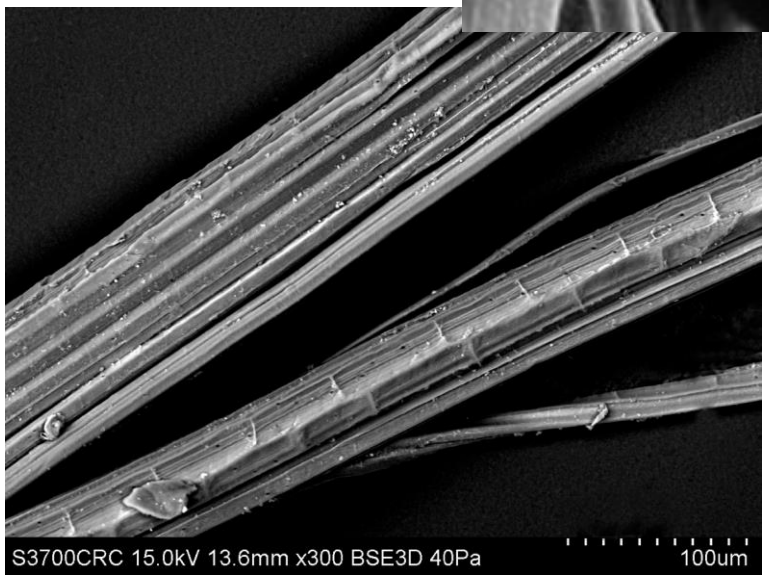
Stem cross section

Bast Fibres

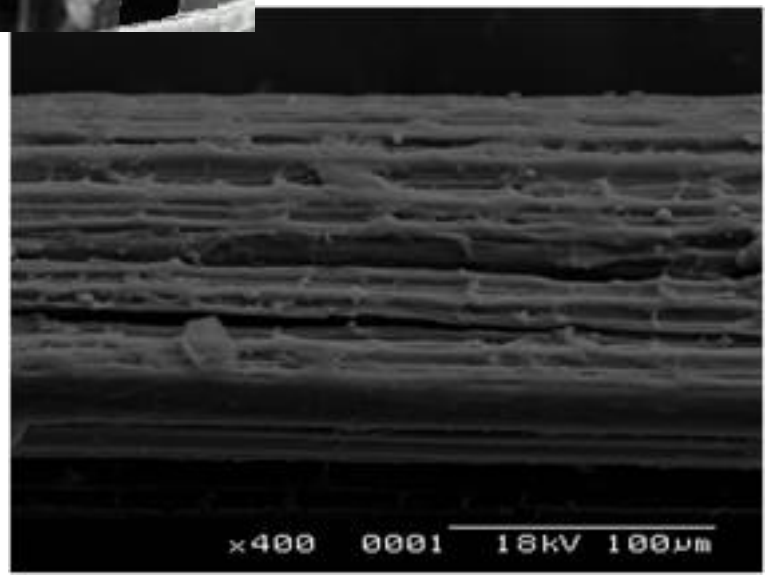
Hemp - Flax - Cotton Positioning



Cotton



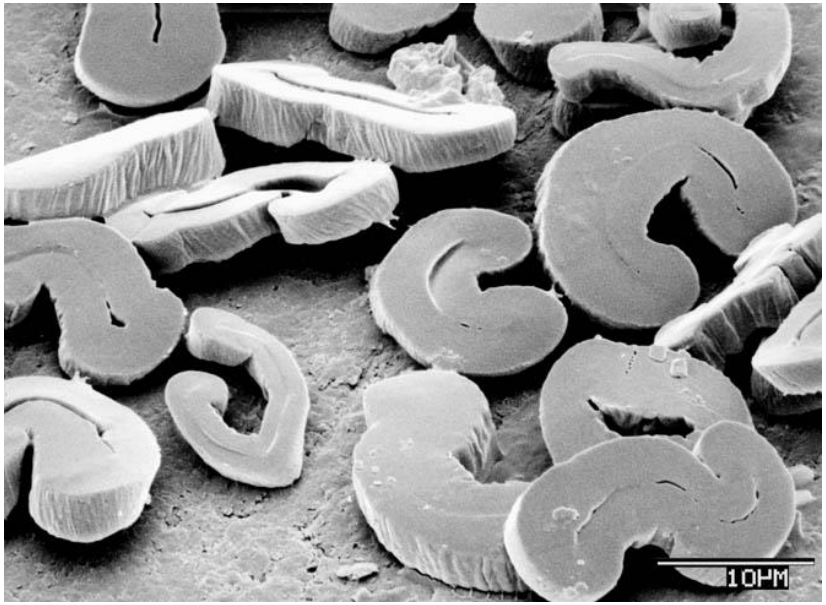
Flax



Hemp

Hemp - Flax - Cotton Positioning

- **Cotton morphology**

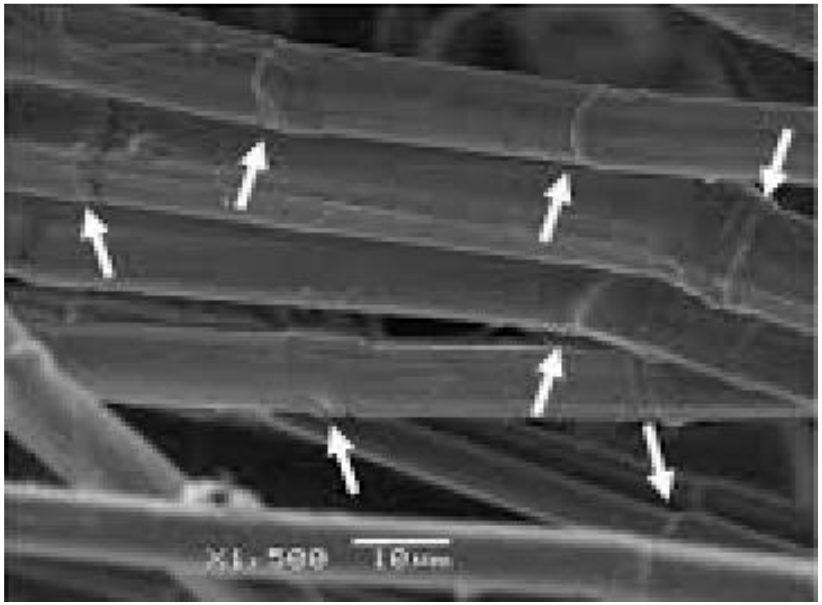


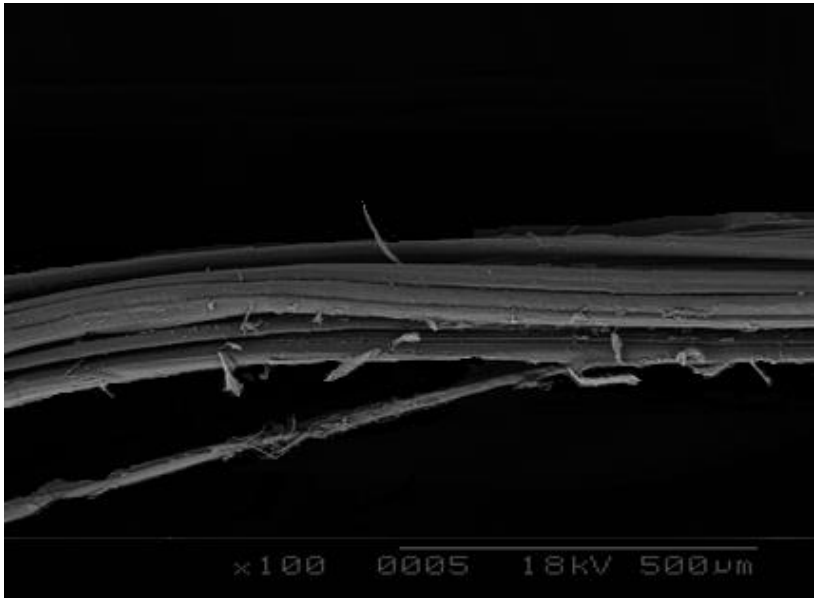
Flat twisted ribbon-like with a wide inner hollow (lumen)

Chemical composition %				
Cellulose	Lignin	Pentosan	Wax	Silica
85 - 90	0.7 - 1.6	1 - 3	0.6 - 1	-

Hemp - Flax - Cotton Positioning

- **Bast fibres morphology**





Flat twisted ribbon-like with a wide inner hollow (lumen)

	Chemical composition %				
	Cellulose	Lignin	Pentosan	Ash	Silica
Flax	43- 47	21 - 23	24 - 26	5	-
Hemp	57 - 77	9 - 13 ?	14 - 17	0,8	-

Hemp - Flax - Cotton Positioning

- **Fibre fineness and length**

Cotton fibre : 1.2 – 1.4 dtex

∅ eq ≅ 10 µm

L = 25 – 50 mm

Flax , Hemp : >>> 10 µm

L = a few dozen cm

Hemp - Flax – Cotton Positioning

- **Spinnability limit**

Short staple fibres : 80 – 100 fibres in yarn cross section

Long staple fibres : 40 – 60 fibres in yarn cross section

Ref : Breny, Martindale, Huberty, Monfort

Extraction methods…

Method	Advantages	disadvantages
Retting on ground	Good separation	Depends on weather
Cryo retting	Good separation	Strongly depends on the weather
Enzymatic treatment	Ecological	Low efficiency costly
Enzymatic treatment (paper)	Ecological	Short fibres Weak fibres
Chemical treatment	Fast, efficient and cheap	Fibre degradation Water pollution
Steam explosion	Fast and good separation	Scale-up?
Ultrasonic	Fast, efficient and ecological	Laboratory scale

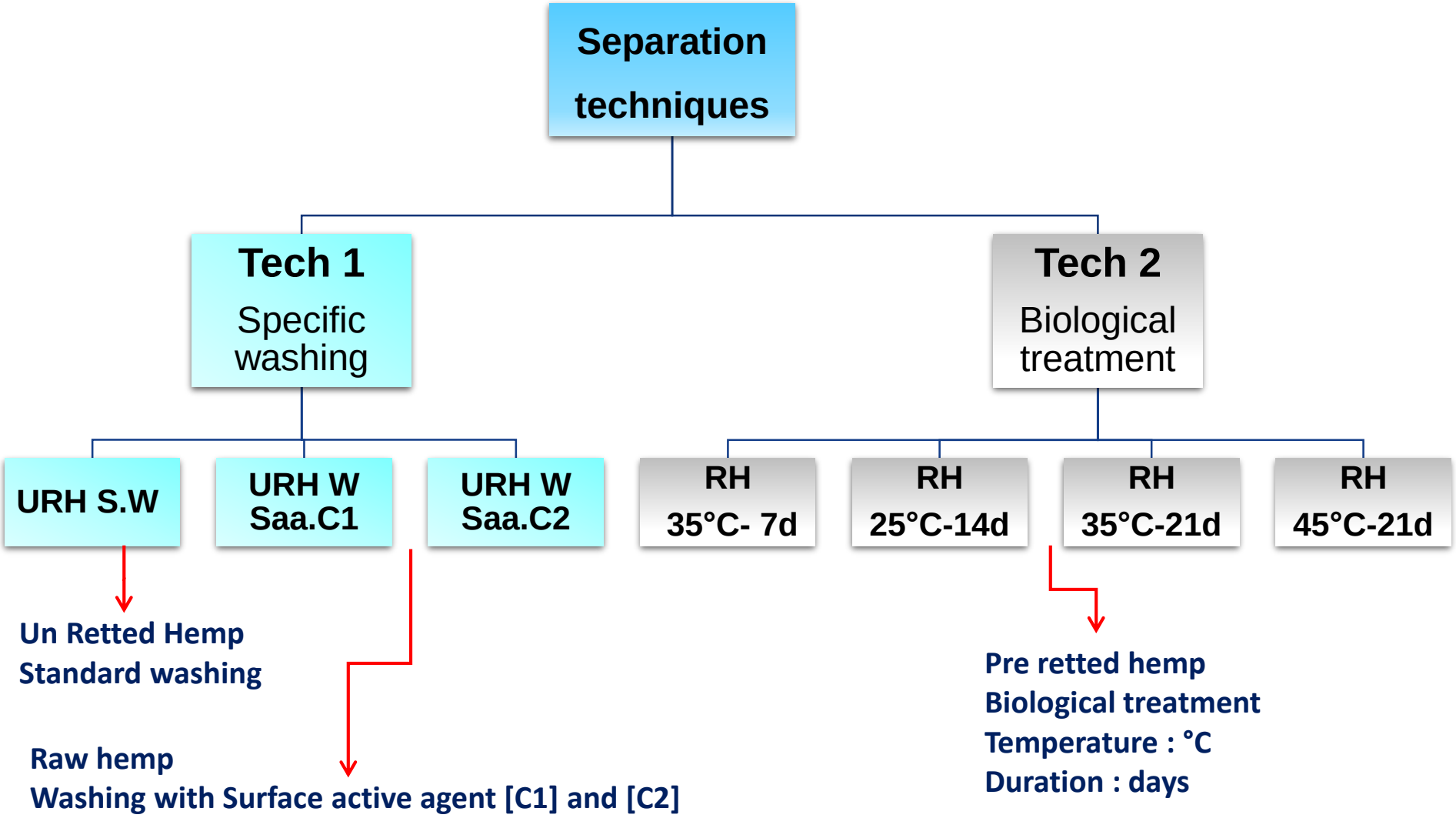
2 new methods

Extraction methods…

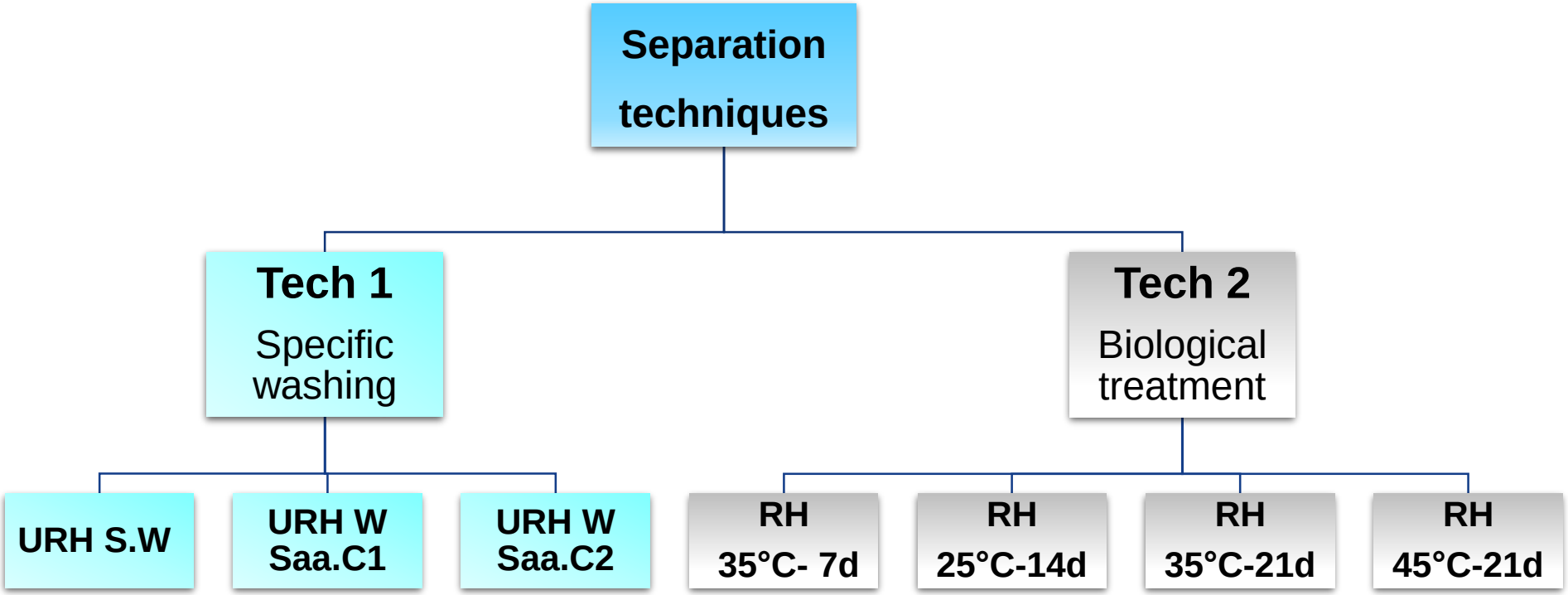
2 new methods

- **Tech 1 : Specific washing super critical C02 based**
- **Tech 2: Specific biological treatment methanization based**

Experimental protocol



Experimental protocol

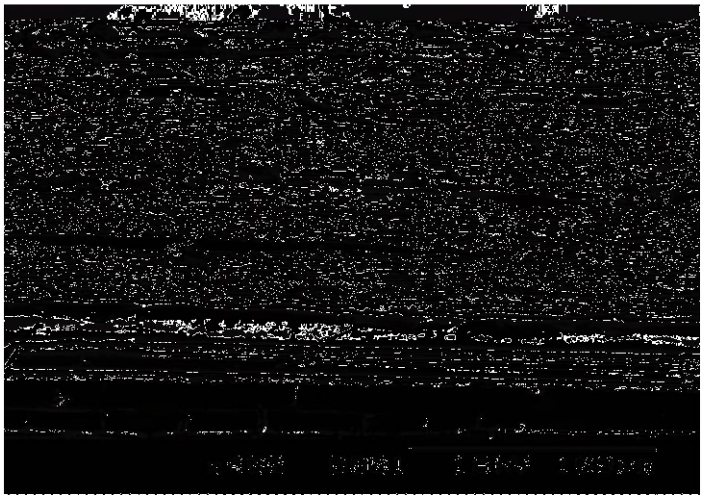


Analysis techniques

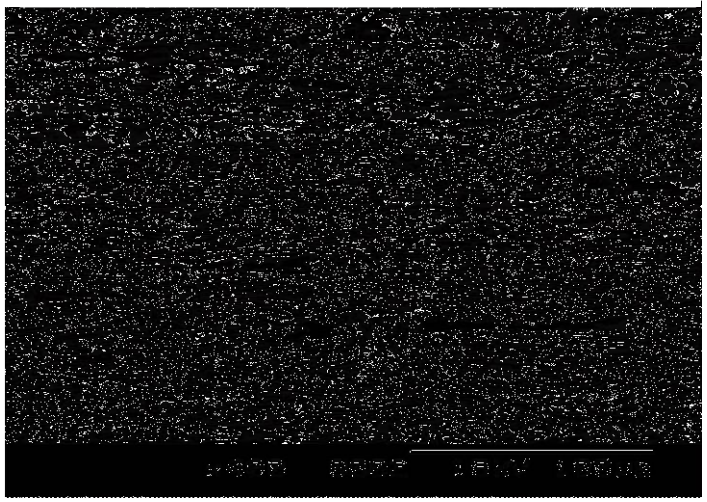
- **SEM**
- **Tensile test machine**
- **FT-IR**

SEM results Tech 1…

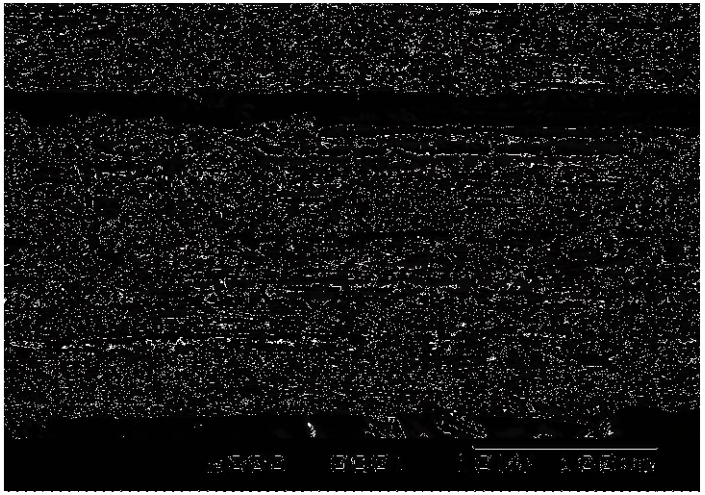
Raw hemp before washing



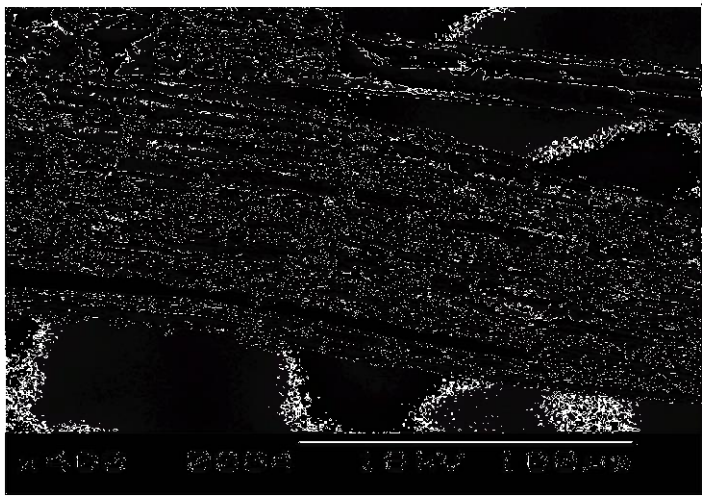
Raw hemp standard washing



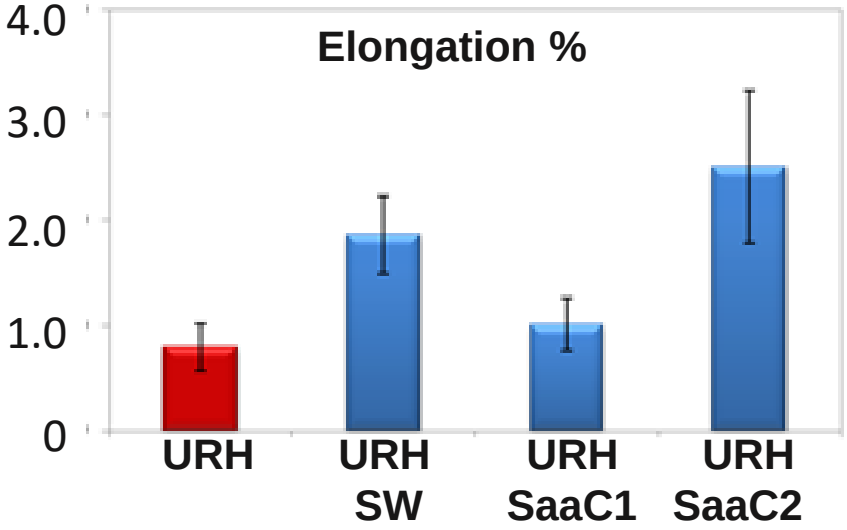
Raw hemp washing Saa [C1]

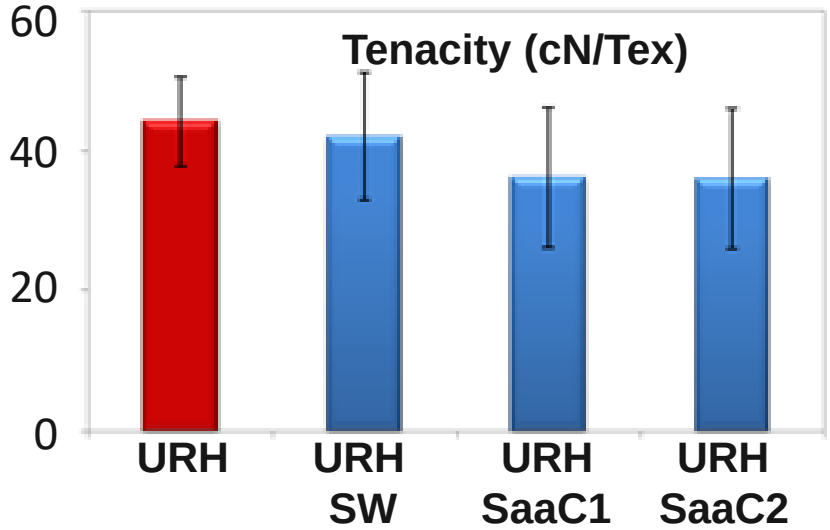


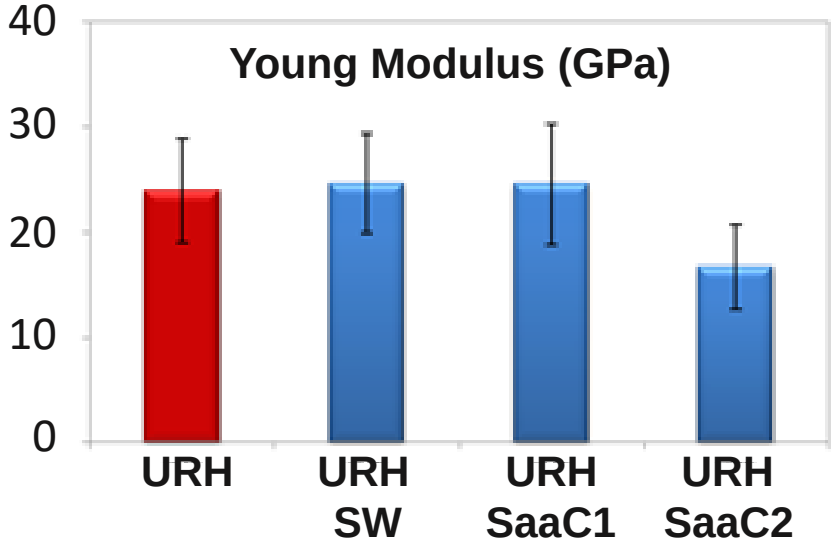
Raw hemp washing Saa [C2]

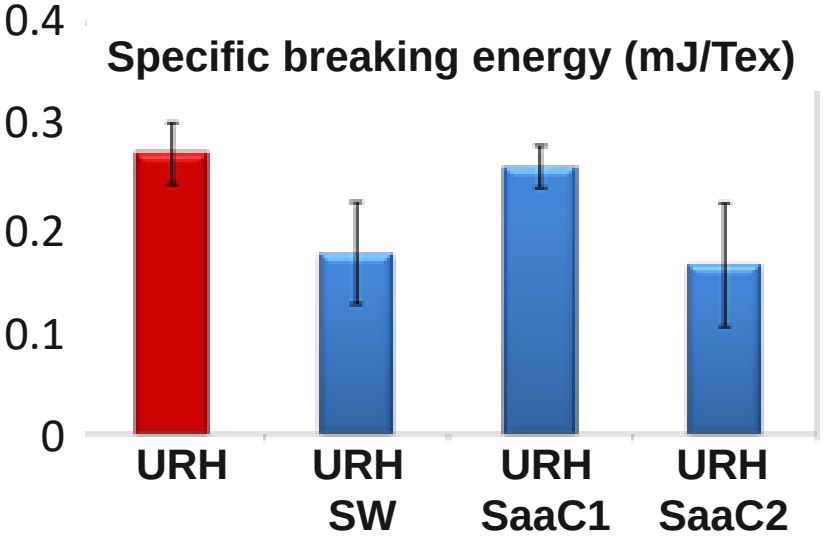


… Mechanical properties Tech1



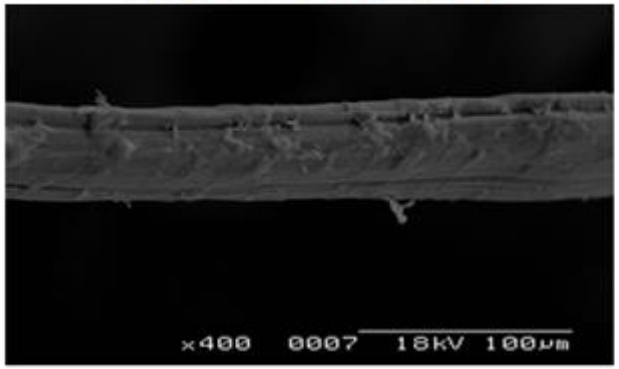




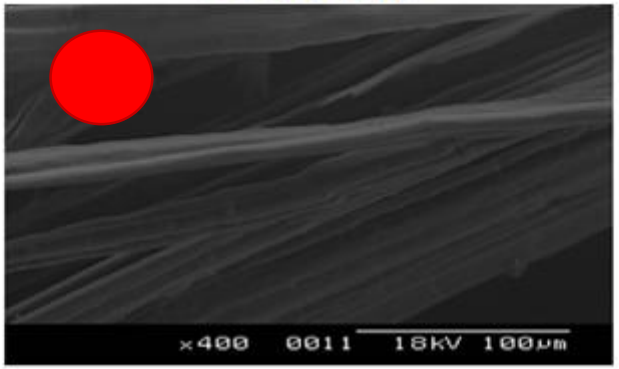


SEM results Tech 2…

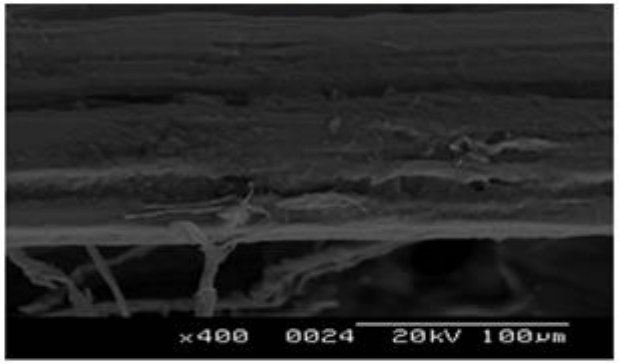
Hemp before washing



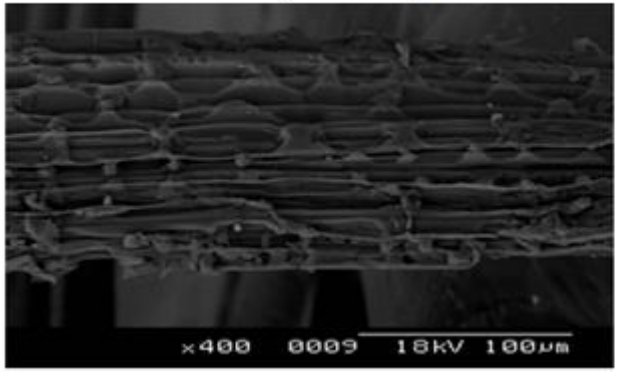
35°C / 7 days



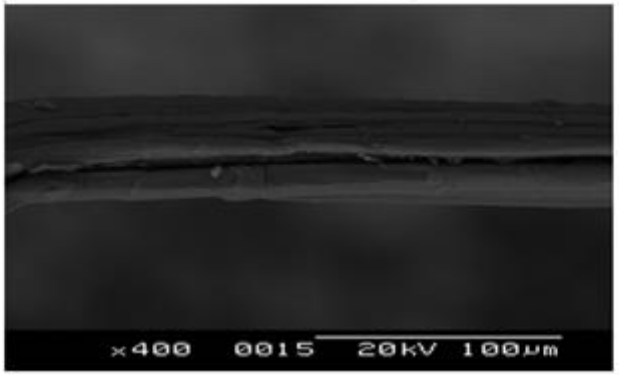
45°C / 21 days



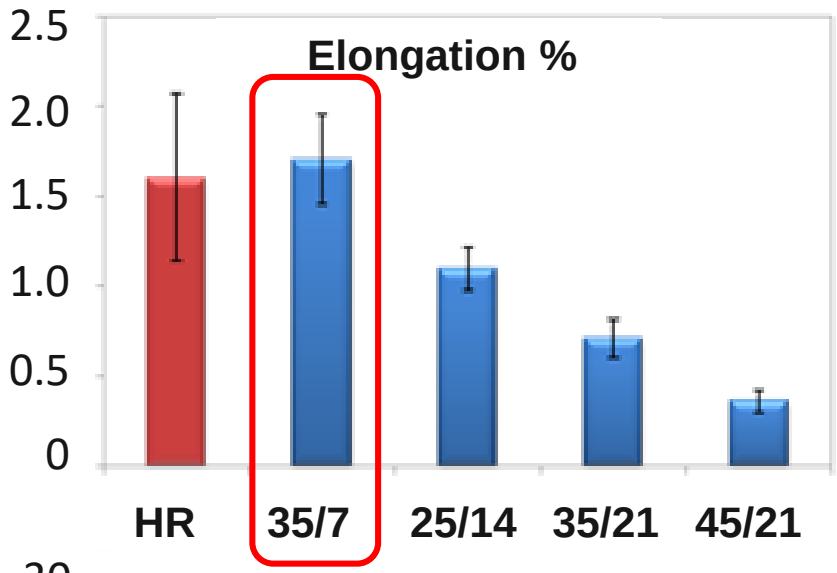
25°C / 14 days

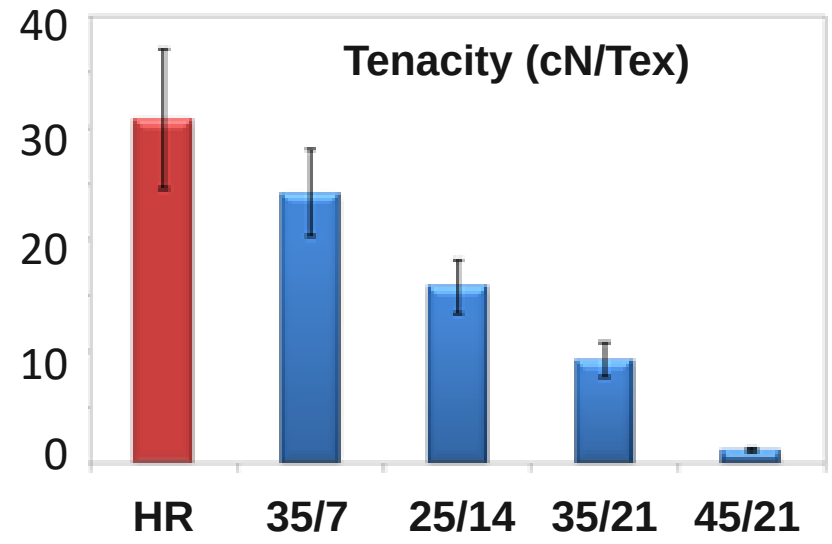


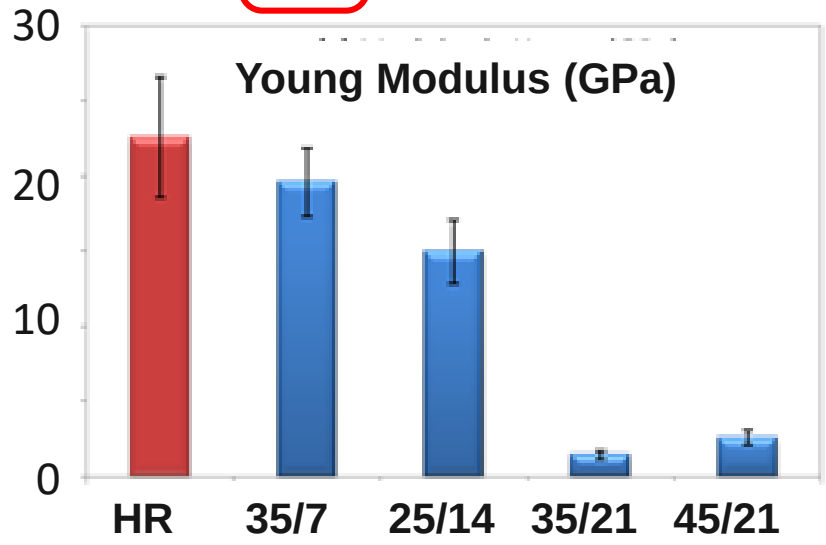
35°C / 21 days

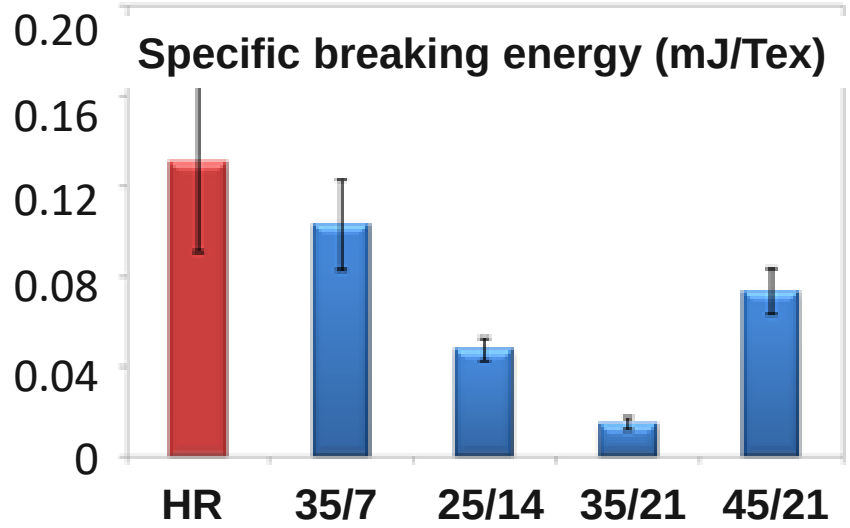


… Mechanical properties Tech2





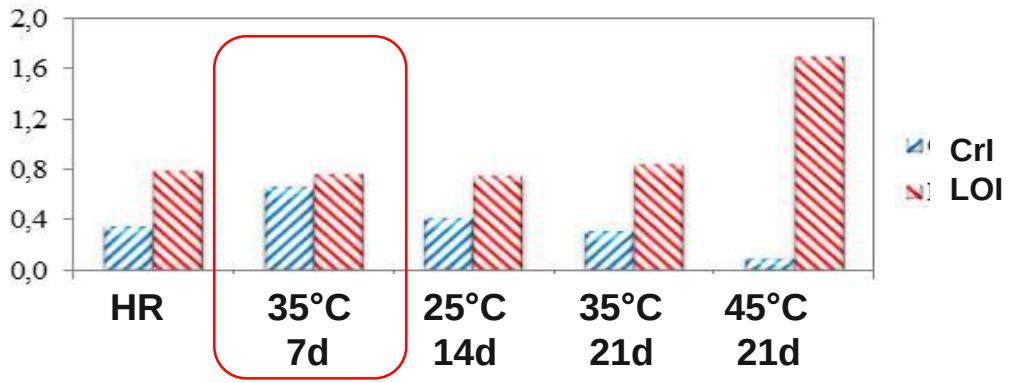




FTIR Tech 1 and Tech 2

Tech 1

Tech 2



Conclusions

Tech 1: Specific washing

- **The surface active agent concentration has a significant influence on the quality of fibres.**
- **The obtained quality is not good enough for textile applications.**

Tech 2: Biological treatment

- **The best result is obtained à 35°C / 7days**
- **The obtained quality is good enough for textile applications.**
- **How to scale up this process?**

Future prospects

- Fibre needs grow faster than world population growth
- Cotton will remain a major natural fibre
- Bast fibres will compete with cotton when their refining will be better optimized
- The spinning laws, Breny, Martindale, Huberty, Monfort, … still remain!

Thank you for your attention

Merci pour votre attention