



Sheep in Southern Finland, photo by SusTexEdu

# 1.2 Introduction to production processes of natural textile fibres

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SusTexEdu



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# SusTexEdu | Erasmus+

This learning material was developed in the Erasmus+ funded project [Education Partnership of Textile and Clothing Sector Materials & Sustainability \(SusTexEdu\)](#)

The goal of the project is to research and develop education in the textile and clothing sector related to textile materials, sustainability and circular economy.

The learning material has been prepared for piloting, and students will be asked for voluntary feedback after the course for the further development of the material.

**Project coordinator:** Metropolia UAS

**Partners:** Hogent (BE), Mome (HU), Omnia (FI), TTHK (EE), TTK UAS (EE), University of Borås (SE)

**Funding:** [Erasmus+](#)

**Project period:** 2022-2024



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# About this learning unit

## ▼ CONTENT DESCRIPTION

- ❖ Production of various natural fibres
- ❖ Environmental sustainability aspects in the manufacture of fibres

## ▼ LEARNING OUTCOMES

Student will:

- ❖ know the productions methods of the natural fibres
- ❖ understand the environmental sustainability aspects in the manufacture of fibre based on different areas of use

## ▼ STUDENT WORKLOAD

1 ECTS, which is equal to 25-30 hours of work:

for example

- ❖ Lectures 12-16 h
- ❖ Group activities 4 h
- ❖ Independent study 9-14 h
- ❖ Learning diary 2 h ?

# Natural Fibres by source

## Plant fibres

- ❖ Seed fibre (cotton)
- ❖ Leaf fibre (banana, pineapple)
- ❖ Bast fibre (flax, jute, linen, kenaf etc.)
- ❖ Stalk fibre (rice, bamboo etc.)

## Animal fibres

- ❖ Animal hair
- ❖ Fibre secreted by glands



# Production process of natural fibres

## Plant fibres

### Seed fibre - Cotton

- ❖ Cultivation
- ❖ Harvesting
- ❖ Ginning
- ❖ Baling
- ❖ Garding

Grow cycle of cotton is 5-6 months.



Cotton harvesting, photo by David Nance on Wikipedia, Public Domain (also on the cover page)



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[How is cotton grown?](#) Cotton Australia

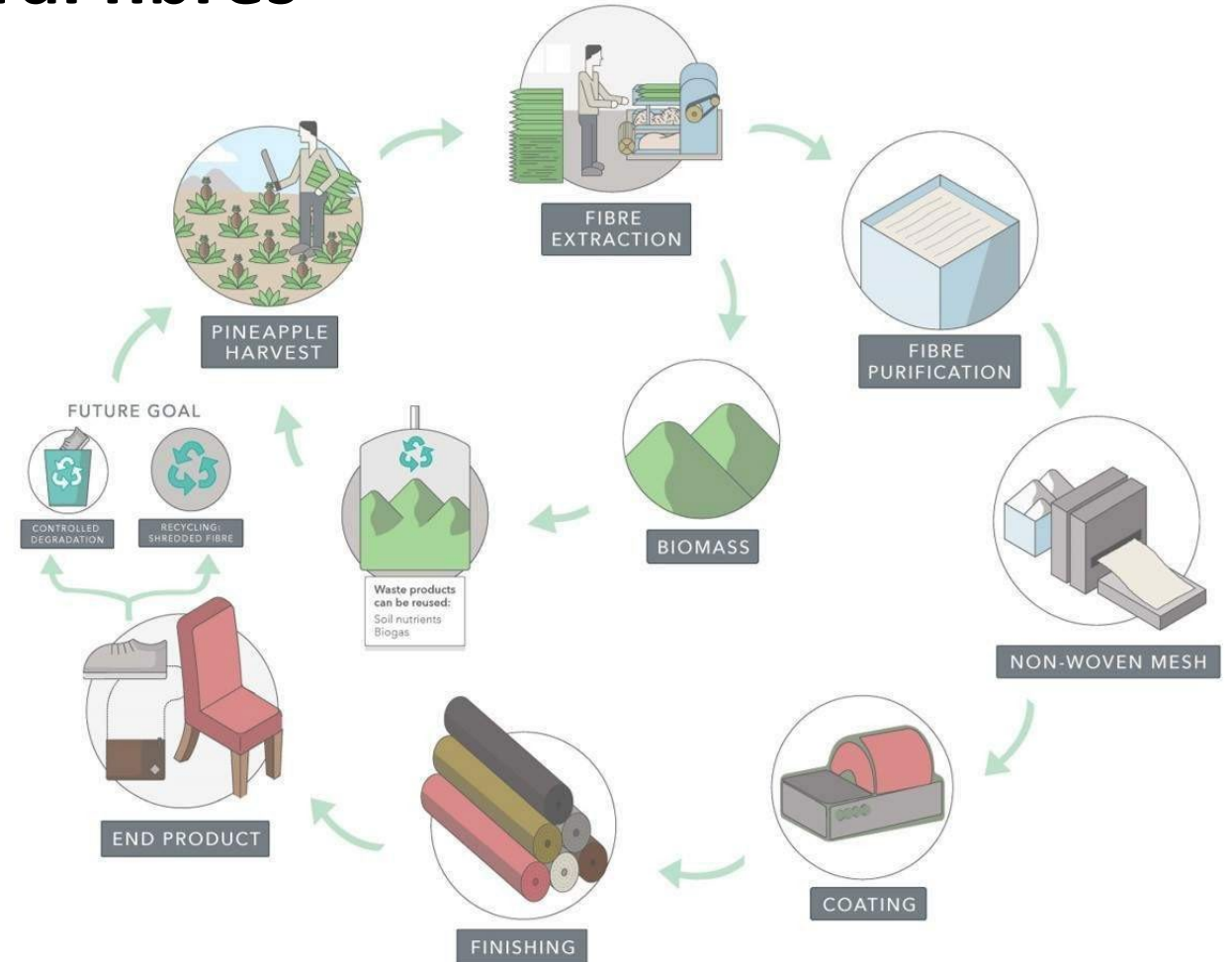
VIDEOS to be found from the processes with keywords: cotton, processes, Science Channel

# Production process of natural fibres

## Plant fibres

### Leaf fibre - Pineapple

- ❖ Selection of pineapple leaves
- ❖ Extraction of pineapple leaf fibres
- ❖ Retting of pineapple leaves
- ❖ Degumming of pineapple leaf fibre
- ❖ Chemical modifications



[Ananas Anam: the pioneers of innovative natural textiles from waste pineapple leaves.](https://www.ananas-anam.com/about-us/)

Photo credit: <https://www.ananas-anam.com/about-us/>

VIDEOS from the processes to be found with keywords: pineapple, processes, pina fiber extraction



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# Production process of natural fibres

## Plant fibres

**Bast fibres** - flax, jute, kenaf etc.

### Jute

- ❖ Sowing of jute
- ❖ Harvesting
- ❖ The Fibre extraction
- ❖ Retting
- ❖ Stripping (fibre extraction)
- ❖ Washing and drying
- ❖ Bailing and packing



Peeling off the jute fibre in Bangladesh, photo by Nahid Hossain on Wikipedia, CC BY-SA 2.0 DEED



**SusTexEdu** VIDEOS from the processes to be found with keywords: jute, processes



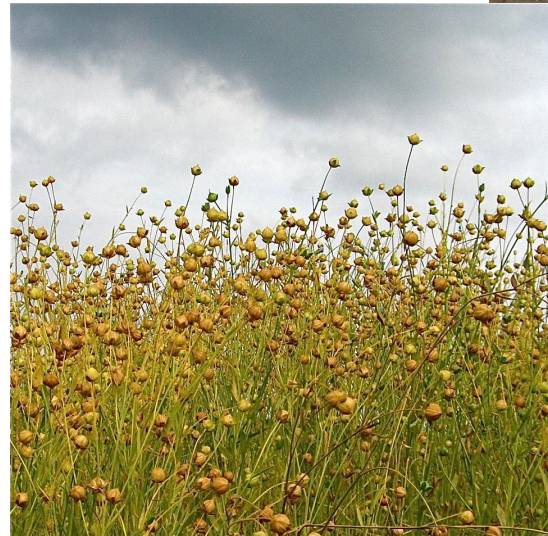
# Production process of natural fibres

## Plant fibres

Bast fibres - flax, jute, kenaf etc.

### Flax/linen

- ❖ Planting
- ❖ Growth
- ❖ Harvesting
- ❖ Fibre separation
- ❖ Breaking
- ❖ Combing
- ❖ Spinning
- ❖ Reeling
- ❖ Drying



Flax field in Germany, photo by Handwerker on Wikipedia, CC BY-SA 3.0 DEED  
(also on the cover page)



Flax field in France, photo by Rilegator on Wikipedia, CC BY-SA 3.0 DEED



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VIDEOS from the processes to be found with keywords: linen, flax, processes



# Production process of natural fibres

## Plant fibres

**Stalk fibres** - rice, bamboo etc.

### Bamboo

- ❖ Harvesting
- ❖ Bamboo strip
- ❖ Steaming of bamboo strip
- ❖ Crushing and decomposing
- ❖ Biological enzyme degumming
- ❖ Fibre carding
- ❖ Fibre



Bamboo Harvesting in India, photo by Biswarup Ganguly on Wikipedia, GFDL



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VIDEOS from the processes to be found with keywords: bamboo, processes



# Production process of natural fibres

## Animal fibres

### Animal hair - Wool

- ❖ Shearing
- ❖ Grading and sorting
- ❖ Cleaning and scouring
- ❖ Carding
- ❖ Spinning
- ❖ Weaving
- ❖ Finishing



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[Wool Fibre | Manufacturing Process of Wool Fibre | Part 02](#)

Textile Study Center

VIDEOS to be found with keywords: wool production and processing



Sheep shearing, photo by Martin Pot on Wikipedia, GFDL



# Production process of natural fibres

## Animal fibres

### Fibre secreted by glands - Silk

- ❖ Sericulture
- ❖ Sorting cocoons
- ❖ Softening and sericin
- ❖ Reeling
- ❖ Throwing



Cut-cocoon, photo by LoggaWiggler on Wikipedia, Public Domain



Eri silkworm, photo by Simtastic01 on Wikipedia, CC BY-SA 4.0 DEED



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[Manufacturing Process of Silk](#). Textile Learner  
[Sericulture, silk production](#) on Britannica.com

**VIDEOS** to be found with keywords:  
silk production, how silkworms make silk

# Environmental aspects of producing natural fibres

- ❖ Natural fibres are popularly regarded as sustainable. They are all biodegradable in their pure form.
- ❖ Life Cycle Assessment / Analysis (LCA) is an established method to quantify multiple environmental impacts arising from the value chain including processes related to the life cycle of a product or a service.
- ❖ Data inventory is a crucial part of any LCA study in which all relevant inputs and outputs of the analysed system are collected. Inputs include e.g. raw materials, energy, and water and by-products, waste, and emissions as outputs.

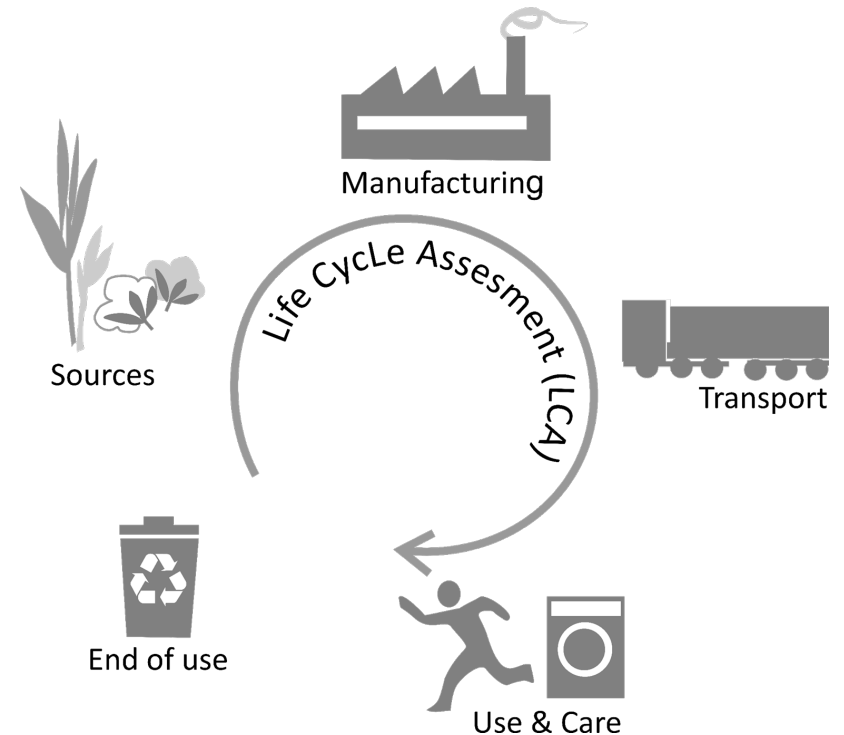


Image by SusTexEdu





# Environmental & social aspects of producing natural fibres

- ❖ Most common environmental impact categories where the life cycle assessment is done include e.g. climate change, toxicity, eutrophication, resource use, acidification, fine particles, ozone depletion and land use.
- ❖ Beside environmental impact the processes of natural fibres also have social impacts related both to workers, local communities and consumers. Social life cycle assessment (S-LCA) is a method to assess social and socio-economic aspects and impacts along the life cycle of products and services.
- ❖ Impacts to animals' welfare are also to be noted when producing animal fibres.



Manually decontaminating cotton before processing at an Indian spinning mill, photo by CSIRO on Wikipedia, CC BY 3.0 DEED



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[Social life cycle assessment.](#)

S.Yang, K. Ma, Z.Liu, J. Ren, Y.Man 2020

## Ecological and social costs of seed fibres - Cotton

- ❖ Cotton industry has remarkable economic impact in the producing countries. Income worldwide is more than 250 millions.
- ❖ Cotton products are pleasant to wear and they last quite long, they can last up to 200 washing cycles.
- ❖ Anyhow, cotton production plays a remarkable role in climate change by using of lot of water, 20 000 liters of water for one kilogram of cotton, and by using toxic pesticides and industrial fertilizers.
- ❖ Nitrates introduced to the land leads to the creation of nitrous oxides, a greenhouse gas that is far more harmful than carbon dioxide by 300 times in terms of global warming.



Cotton field, photo by David Nance on Wikipedia, Public Domain



## Ecological and social costs of leaf fibres - pineapple

- ❖ As by-product of an existing industry, pineapple leaves require no extra environmental resources.
- ❖ Pineapple requires certain type of climate to grow but soil requirements are low and cultivating requires minimal amount of chemicals. Also the use of water is moderate during the material formation period.
- ❖ Energy is required to dry the fibres industrial.
- ❖ Piñatex, trade name of leatherette made of pineapple, is not as durable as leather. It is also not fully biodegradable, because it contains PLA – a bioplastic made with corn.



Pineapple fibres drying after washing outside, photo by Piñatex on Wikipedia, CC BY-SA 4.0 DEED



## Ecological and social costs of bast fibres - flax, jute, kenaf etc.

- ❖ Bast fibres – flax, hemp, jute and ramie – are seen as sustainable chiefly because their cultivation requires just a little irrigation and treatment, and the impact on soils is low.
- ❖ Processing the fibres however, particularly ramie and some hemp, can involve chemicals unless newer methods are used.
- ❖ European countries produce most flax, while China dominates hemp and ramie.
- ❖ Flax (producing linen), hemp and ramie

are chiefly used in garments, in pure form but often in blends with other fibres.



Ramie, photo by Sphl on Wikipedia, CC BY-SA 3.0 DEED





## Ecological and social costs of stalk fibres - rice, bamboo etc.

- ❖ Cultivating bamboo is quite sustainable. It can be grown without using pesticides. It has high growing rate and low water consumption.
- ❖ Compared to cotton, the same volume of material can be produced from under 10% of the land area. Bamboo forests are so dense that they produce up to 35% more oxygen per hectare than hardwood trees.
- ❖ Organic bamboo that hasn't been chemically treated or dyed is 100% biodegradable.
- ❖ Anyway, bamboo fibre is produced mainly as viscose and its manufacturing uses a lot of chemicals, which decreases its sustainability.



Bamboo forest, photo by Lance Vanlewen on Wikipedia, CC BY-SA 4.0



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[About bamboo](#) on Eco Nation

[About bamboo](#) on CBD FiberFacts PDF

[Bamboo Fiber - an overview](#) on ScienceDirect Topics

## Ecological and social costs of animal hair based fibre - Wool

- ❖ Wool is popularly regarded as one of the most sustainable sources of fibre in the world. It is a natural biodegradable fibre.
- ❖ However, sheep farming has a quite big carbon footprint and wool production may lead to deforestation.
- ❖ When disposed of, wool helps to fertilize the soil by releasing valuable nutrients and carbon back into it.
- ❖ Production methods may release toxic chemicals.

- ❖ Aspect of animal cruelty and ethicality of animal fibres is to be noted.



Wool transported for spinning in Finland, photo by SusTexEdu

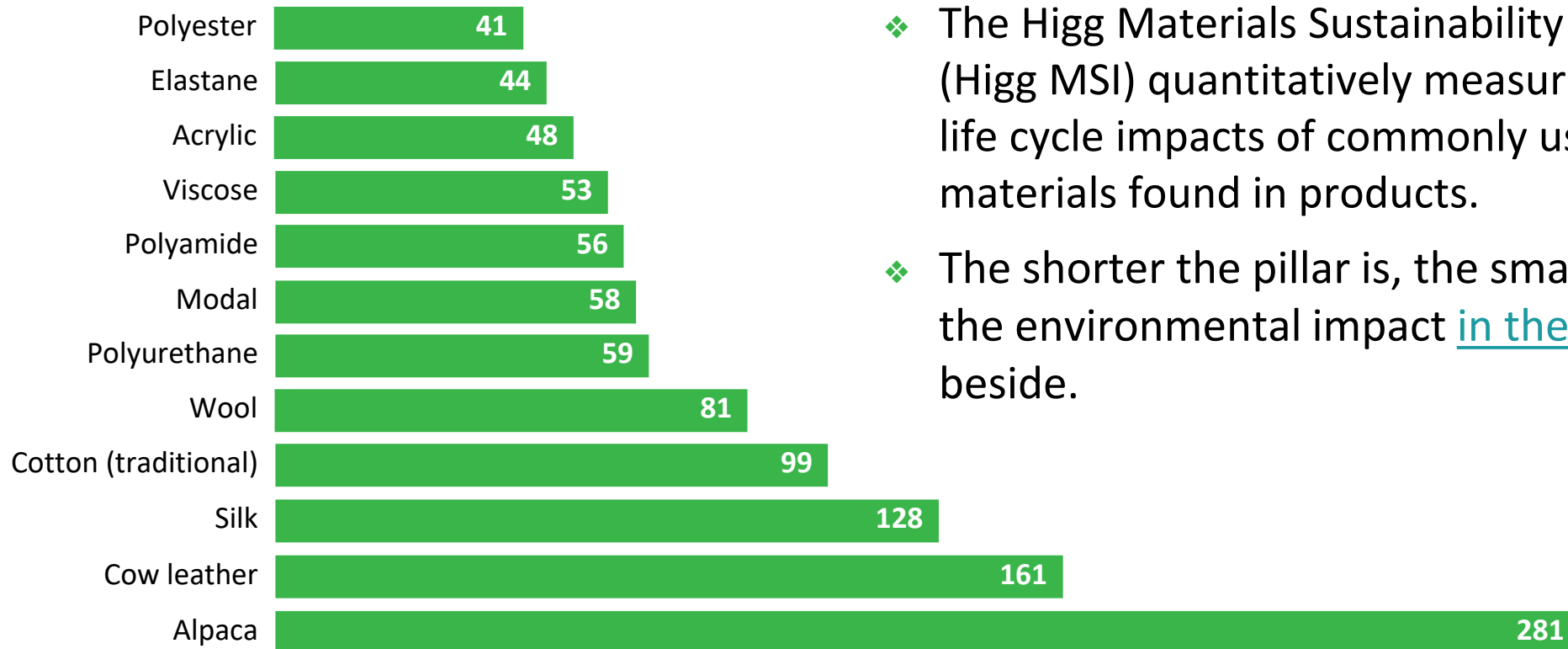




## Ecological and social costs of fibre secreted by glands - Silk

- ❖ Sericulture is extremely important in the socioeconomic context in Asia and South America. Production of silk has had a big role in certain cultures for centuries, especially in India and China.
- ❖ Silk has quite high environmental impact, due to the amount of energy used to maintain a certain temperature and humidity in silk farms. Fossil fuels are used chiefly in the reeling and processing stages.
- ❖ The cultivation of silk needs relatively small land area. Mulberry trees that sustain most silkworms require only few pesticides or fertilisers.
- ❖ Child labor is found to be used in the silk industry in India. Although the amount of child labor is decreasing in India, it is still on unacceptable level.

# Tools for measuring textile fibres' sustainability - e.g. HIGG MSI



- ❖ The Higg Materials Sustainability Index (Higg MSI) quantitatively measures the life cycle impacts of commonly used materials found in products.
- ❖ The shorter the pillar is, the smaller is the environmental impact [in the diagram](#) beside.





# Learning material

[ETC-CE Report 2023/5 The role of bio-based textile fibres in a circular and sustainable textiles system.](#)

J. Deckers, S. Manshoven, L.F. Mortensen. Einoet Porta (europa.eu) 2023

[Sustainable fibres and fabrics: Natural Fibres.](#) University of the Arts London

[Natural Plant Fibers.](#) Premiere Vision 2023

[Wool Processing.](#) Woolmark.com

[Cotton: From Field to Fabric.](#) Cotton.org



# Tips for learning more

[The impact of textile production and waste on the environment \(infographics\)](#) | News | European Parliament (europa.eu)

[Textiles and the environment: the role of design in Europe's circular economy](#) — European Environment Agency (europa.eu)

[Global normalisation factors for the Environmental Footprint and Life Cycle Assessment.](#)

Serenella Sala, Eleonora Crenna, Michela Secchi, Rana Pant. JRC Technical Reports 2017 PDF

[Natural Fibers And Manmade Fibers](#) - Textile Magazine, Textile News, Apparel News, Fashion News (textilevaluechain.in)

[Natural or synthetic – how global trends in textile usage threaten freshwater environments](#)

C.Stone, F.M.Windsor, M.Munday, I.Durance 2019

[Social and environmental impacts of a T-shirt: A life cycle approach](#)

Franziska Eisfeldt, Franziska Möller - GreenDelta GmbH 2017

[Automatic processing of natural fibres for industrial manufacturing of fibre reinforced Earth plasters.](#)

J. Rintamäki, E.Keskinen, T. Tamm, T. Mäuring 2007 PDF

[How Sustainable Are Cotton Fabrics? A Life-Cycle Analysis](#) | Impactful Ninja

[Pineapple Fiber / PINEAPPLE LEAF FIBRE\(PALE\)](#). textilecoach.net

[Bamboo Fiber | Properties | Processing | Applications.](#) textilesphere.com

[Social and economic aspects of the uses of animal wool and hair in western Mongolia.](#) Anna O. Portisch. openedition.org 2019





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Visit [the project website](#) to see all the intellectual outputs of the project.



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