



European Union  
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# Hemp, a fiber source of the future

How to create a sustainable new value chain for hemp, fitting in the circular economy of the textiles and clothing industry

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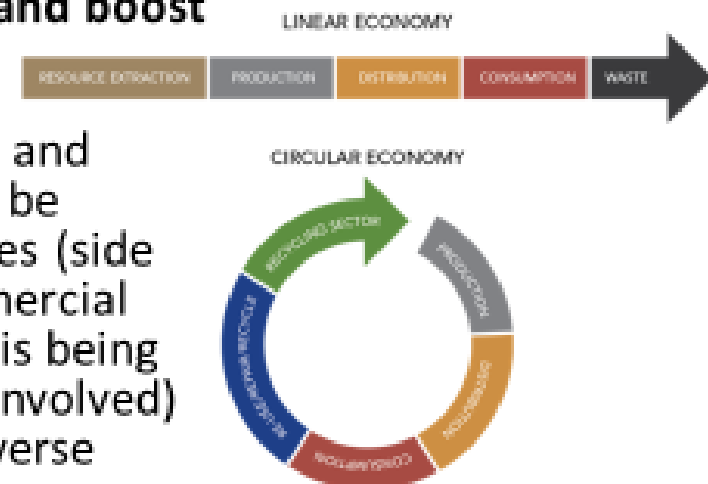
- Owner of Alcon Advies
  - Consultancy on innovation in textile processing,
  - Based on > 20 yr applied R&D in textiles at TNO
  - Involved in many EU and national funded projects
  - Member of Saxion knowledge circle Smart Functional Materials (prof. Ger Brinks)
  - Co-founder of ..
- Texperium, Open innovation centre for advanced textile recycling
- Partner in REMO, the Recycle Movement
  - Track & trace of recycled content in textiles
  - Connecting companies using sustainable (recycled) fibres to circular systems





# Circular economy

- The Circular economy offers an opportunity to **reinvent our economy, making it more sustainable and competitive**. This will bring benefits for European businesses, industries, and citizens alike. With this new plan to make Europe's economy cleaner and more competitive, the Commission is delivering ambitious measures **to cut resource use, reduce waste and boost recycling**. (Source: EU circular roadmap [http://ec.europa.eu/environment/circular-economy/index\\_en.htm](http://ec.europa.eu/environment/circular-economy/index_en.htm))
- In a circular economy, prices act as messages, and therefore need to reflect full costs in order to be effective. The full costs of negative externalities (side effects or consequences of industrial or commercial activities that affects other parties without this being reflected in the cost of the goods or services involved) are revealed and taken into account, and perverse subsidies are removed. A lack of transparency on externalities acts as a barrier to the transition to a circular economy.





# Hemp

- Most versatile plant for textile fibers
- Grown in large parts of Europe
- Needs little water, no pesticides and herbicides
- High fiber yield per ha
- Many potential applications
  - Hemp fibers used for ages for clothing, sails and tents
    - weaving of hemp fiber began over 10,000 years ago! Carbon tests have suggested that the use of wild hemp dates as far back as 8000 B.C.
  - Technology needs updating to be able to compete with cotton and synthetic fibers
    - Agriculture, harvesting, fiber processing, product development
    - Hemp fibers fit very well in circular textile systems

## HEMP 50,000 USES & BENEFITS

Hemp is the only annually renewable plant on Earth able to replace all fossil fuels.



**GOOD FOR YOU!  
GOOD FOR THE PLANET!**

[www.hemp.org.uk/industry](http://www.hemp.org.uk/industry)

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# Opportunities for hemp fibers

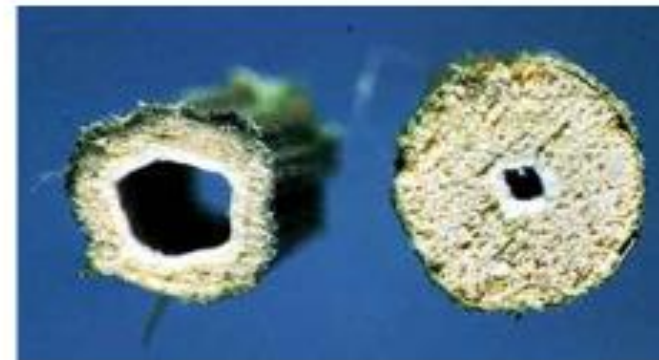
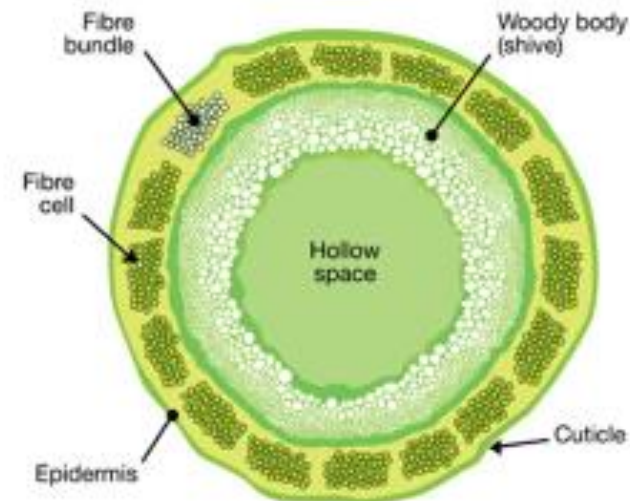
- Hemp is one of the most sustainable renewable fibers
- Hemp improves the soil and is to be used in crop rotation (agriculture)
- Hemp plants offer many potential applications; when one can combine uses, this will contribute to a sustainable business plan
  - Fibers, seeds (oil), wood, cattle feed, ...
- High yield of biomass (and CO2 capturing)





# Hemp as a plant

- The outside of the hemp stalk is covered with skin (epidermis), underneath it there are bast fibres whereas in the centre the stem there is a wood-pulp core (shive), the proportion of which in the hemp is between 60 to 80% of the total mass of the stem. The main chemical components of the shive like in spruce wood are cellulose (34-48%), hemicellulose (21-37%) and lignin (16-28%). The difference in chemical composition is determined by the variety, the soil type, the climate conditions





# Growing of hemp

- Selection of the right hemp varieties for optimal fiber quality
- Improve the growing of hemp with respect to yield and fiber quality (soil preparation, number of plants/m2, time of harvesting, ...)
- Improve harvesting methods
  - Separation of different parts of the plants
  - Chopped stems (short fibers) vs whole stems (long fibers)
- *Harvesting Fiber Hemp ( Source: <http://innvista.com/health/foods/hemp/harvesting-hemp/>)*
- *Fiber hemp is ready to harvest about the time the plant is finished producing pollen and the first seeds start to develop. However, this does vary with the variety and maturity of the fiber desired.....*
- *Because hemp is sensitive to light, early planting will produce taller crops and thus more fiber. Stems must not be chopped or broken too much in the harvesting process since long fibers are more desirable.*





# From hemp plant to fiber

- Hemp processing in order to separate fibers from other parts of the plants; includes breakdown of pectins that keep fiber bundles together
- Potential methods
  - Dew retting
  - Enzymatic treatment
  - Chemical treatment
- Mechanical methods
  - decortication
  - Steam explosion and other physico - mechanical technologies for cottonization of the hemp fibres
- with the aim to obtain fine fibers in a reproducible way which can be spun in a (cotton) spinning mill
  - ring spinning for longer fibers;
  - open end spinning for shorter fibers;
  - very long fibers might be spun on a linen spinning system







# Retting methods

- Dew retting occurs when the stalks are left in the field so that rain, dew, or irrigation is used to keep the stems moist. This may take up to 5 weeks and produces a coarse fiber with a light brown color.
- Water retting occurs when stems are bundled and then submerged in water so that bacteria break down the pectin. This takes 7-10 days and produces a **better quality fiber**.
- Warm water retting occurs when bundles are soaked for 24 hours after which the water is replaced. Heat is then applied to warm the batch for the next two or three days. This gives a **very uniform, clean fiber**.
- Green retting is an all mechanical process that separates the components and used when the fiber is needed for textiles, paper, or fiberboard products.
- Chemical retting occurs when chemicals are used to dissolve the pectin, allowing the components to be separated. This shortens the time to as little as 48 hours when the next process can then be instigated. This produces a **very high quality product**.





## Combination of hemp and recycled fibers

- Most sustainable combination esp when recycled fibers are sorted on colour
- Soft hand but strong and abrasion resistant
- Blending and spinning of the fibers
  - Spinning preparation: mixing hemp fibers with recycled textile fibers and produce a regular sliver
  - Spinning of the hemp / recycled fiber mixture (open-end and/or ring) different yarn numbers needed
  - Testing of the yarns on strength, elongation, hairiness, thick/thin





# Production of fabrics

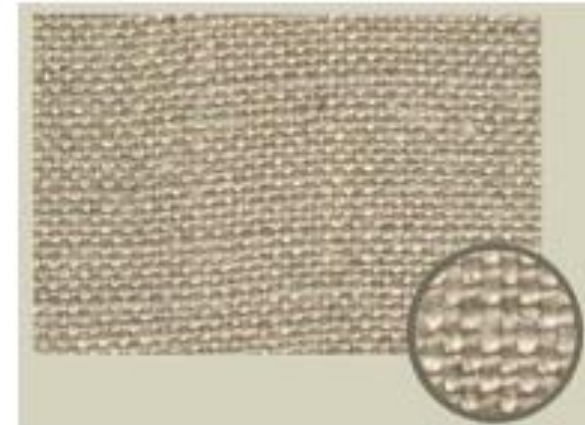
- Knitted fabrics for pullovers
- Circular knitted fabrics for T-shirts and polo's
- Woven fabrics for jeans, trousers, interior fabrics, bed and bath linen
- Dyeing (optionally) and finishing of the produced fabrics
  - Pretreatment (scouring, bleaching) optionally (depending on retting/cottonisation method)
  - Dyeing with natural dyes in a few shades (or use the original color of the recycled fibers)
  - Finishing of the fabrics by mechanical and chemical methods to control the crimp and make them crease resistant, flame retardant, water repellent, softer, .... Chemicals used should be of renewable sources.





# Product development

- Design of fashionable high added value products based on the fabrics produced
  - Design of a number of attractive products, applying recycling in design rules (make use of the imperfections of the fabrics) and design for recycling rules
  - Products must fit in a circular system
    - Mechanical recycling as preferential end of life scenario







# Marketing and storytelling

- Create awareness of the opportunities hemp and recycled fibers can offer to the European textile and clothing industry
- Feed-back from potential buyers of the products produced
- Engage companies to invest in technology and infrastructure to process hemp fibres to high end products (all stakeholders)
- Engage retail companies to take up hemp-collections in their product portfolio





# Skills and infra-structure

- Make list of required skills for workers for each step of the production chain
  - Make tentative list of required skills
  - Overview of institutions where skills can be learned (specified by the skill needed)
  - Develop specific courses for hemp processing
- Infra structure needed for experiments
  - Facilities needed (pilot plants for treatment of 50-100 kg of fibers/day)
    - Laboratory for testing fibre properties in all stages of processing (fineness, strength, length, .....)
    - Retting and cottonization technologies for reproducible fiber quality
    - Spinning equipment for spinning hemp and hemp-recycled cotton mixtures





# Circular Economy

- Business plan for industrial circular chain in hemp and recycled textiles
  - Based on a profitable activity for all stakeholders in the circular hemp chain (from farmers to retail)
  - Based on shared risk /reward
  - Based on durable relations between stakeholders
  - Based on transparency with respect to all costs involved and margins added.

