Eco-profile of a linen shirt
and comparative analysis of linen and cotton shirts

Context and objectives

France has a long tradition of flax/linen production and is currently one of the most important producers of linen fibres in terms of both quantity and quality.

Linen, “the oldest textile of the world”, is considered as an environmentally friendly material. But is this image justified? What are the true environmental characteristics of linen clothes?

The objectives of this eco-profile are threefold:

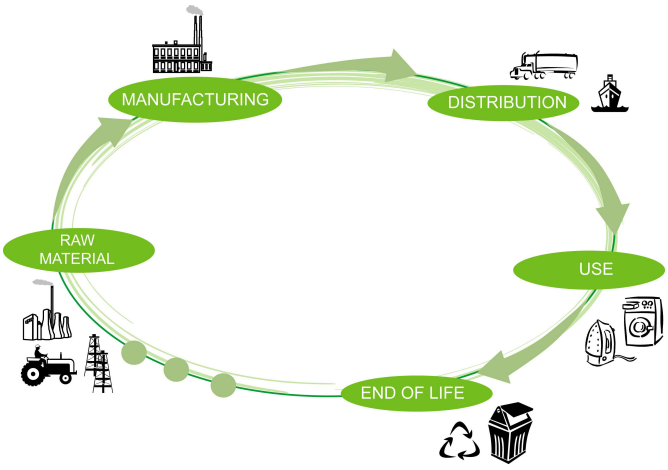
- to present the environmental impacts generated by a linen shirt along its life cycle,
- to compare these environmental impacts to those generated by a cotton shirt, cotton being the most common textile fibre,
- to raise the users’ awareness of the environmental quality of the clothes they wear and to demonstrate how environmentally friendly behaviour can reduce the environmental impacts of their shirt.

Bio Intelligence Service S.A.S • 1 rue Berthelot • 94200 Ivry sur Seine • France
Tél. +33 (0)1 56 20 28 98 • Fax. +33 (0)1 58 46 09 95 • bio@biois.com • www.biois.com

Société par actions simplifiée au capital de 202 410 euros - RCS Créteil B 950 576 405 - Siret 950 576 405 000 43 - APE 221A - TVA FR 37950576405

Methodology

This document is an eco-profile, in other words, a synthesis of environmental information on a given product, obtained through a Life Cycle Assessment (LCA).



An LCA is a "cradle-to-grave" approach aiming to assess the environmental impacts of a product over its whole life cycle: from raw material extraction to waste treatment, via manufacturing, transport and use phases.

An LCA quantifies the consumption and emissions of materials and energy in each stage of the life cycle. These flows are either directly assessed as such (e.g. water and energy consumption) or are further converted into environmental impact indicators such as global warming potential, eco-toxicity, etc.

Indicators

12 indicators were taken into account in the LCA in order to evaluate the environmental impacts of linen and cotton shirts over their life cycle.

With the aim of simplifying and enhancing the readability of this eco-profile, 5 indicators are presented. They were selected based on :

- the magnitude of the product's contribution to the environmental impacts,
- current environmental concerns.

Indicators	Descriptions
Primary energy consumption	Primary energy consumption refers to the use of crude energy, that is, energy that has not been subjected to any conversion or transformation process. The main types of primary energy carriers are: oil, coal, natural gas, nuclear energy and renewable energies. It is expressed in Mega Joules (MJ).
Water consumption	This indicator reflects the water consumption associated with the life cycle of the shirt (potential irrigation during the cultivation stage, water consumption in the shirt manufacture, water consumption in washing). It is expressed in litres of water.
Global warming potential	Global warming refers to the increase in the average temperature of the Earth's surface, due to an increase in the greenhouse effect, caused by anthropogenic emissions of greenhouse gases. It is expressed in grams of CO_2 equivalent (g CO_2 eq).
Eutrophication	This indicator reflects the proliferation of algae, favoured by an excessive concentration of nutrient in water (in particular phosphate and nitrate). It is expressed in grams of phosphate equivalent.
Freshwater aquatic ecotoxicity potential	This indicator quantitatively assesses the risks due to the emission of chemicals to aquatic ecosystems. It indicates when chemical releases are likely to result in toxic doses that exceed acceptance levels. It is expressed in grams of 1,4 – dichlorobenzène equivalent (g 1,4-DB eq.).

Functional unit

In order to compare the different types of shirts and use patterns, a common reference unit called the "functional unit" is used. All elementary flows of materials and energy that occur during the life cycle are scaled to this common reference.

The functional unit chosen for this eco-profile is:

"Wearing a shirt for a day"

This referential unit allows the quantification of all the potential environmental impacts that occur over the complete life cycle of linen or cotton shirts and takes into account the shirts' lifetimes.

Products and scenarios analysed

This environmental balance is representative of the use of a linen or cotton shirt in France.

In the analysed scenario, the linen is cultivated in France and the cotton is cultivated in China. (For cotton, the data come from the USA but are adapted to the Chinese context). The shirts are manufactured in China and then transported to France. (For the textile industry, the data are based on the current European processes but are adapted to the Chinese context.)

The linen and cotton shirts are of the same weight (253 grams, including 240 g of linen or cotton fabric, 10 g of polyester yarn and 3 g of plastic buttons).

The shirts are worn on average sixty times by their first user prior to being either disposed of with the household waste (30% of the cases) or sent to reuse (70% of the cases). Hence, the average total lifetime of a shirt is around hundred uses.

The shirts are washed and ironed after each use but under different conditions. While both are washed at 40℃, the linen shirt is ironed 9 minutes compared to 7 minutes for the cotton shirt.

Use conditions	Linen shirt	Cotton shirt
Lifetime per user	60 uses*	
Washing frequency	After each use	
Washing	In aashing machine at 40℃	
Ironing	9 minutes	7 minutes
End-of-life	30% to municipal solid waste, 70% to reuse (second hand clothing)	
Average Lifetime per shirt	100 uses	

** As 70% of the shirts are reused (second hand), 60 uses per user gives on average a lifetime of 100 uses per shirt (60 uses during the first life and 70% of 60 uses during the second one).*

Results

What is the environmental imprint of a linen shirt?

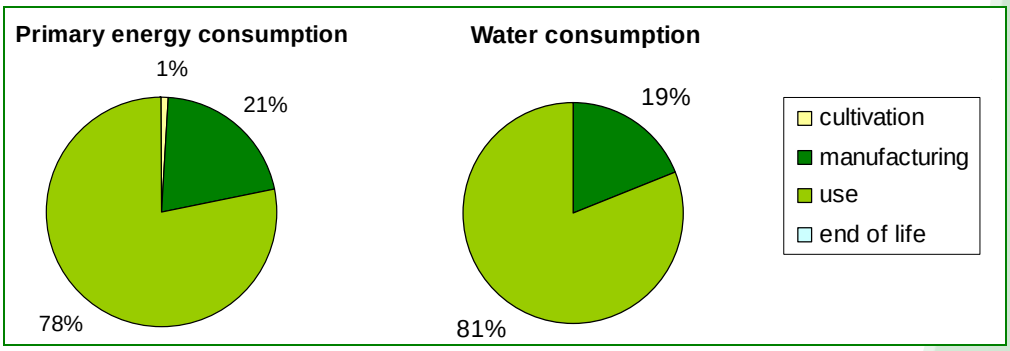
The environmental impacts linked to the functional unit “wearing a shirt for a day” are presented in the following tables in the units normally used in Life Cycle Assessment.

In order to help understanding these results, the impacts of a shirt over its lifetime, i.e.wearing it a hundred times, are also presented and expressed in easier-to-understand equivalent units.

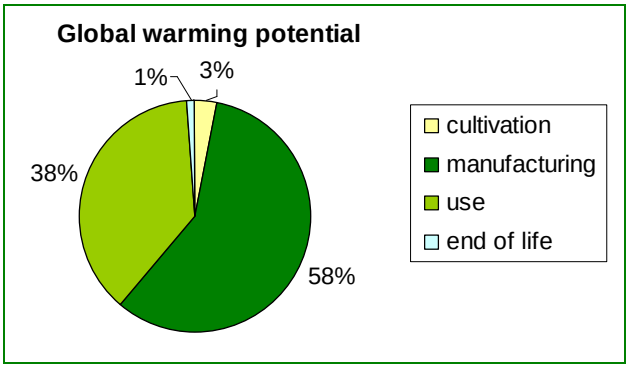
Indicators	Résults of LCA "Wearing a linen shirt for a day"		What does it mean if one wears a linen shirt 100 times?	
	results	units	results	units
Primary energy consumption	**6.0**	Mégajoules	850	hours of lighting with a 60 W bulb
Water consumption	**6.4**	litres	430	days of human daily drinking water needs
Global warmin potential	**130**	g CO_2	85	km by car
Eutrophication	**0.10**	g phosphate	100	g of nitrate emitted to water
Freshwater aquatic ecotoxicity potential	**11**	g 1,4 dichlorobenzène	250	mg of mercury emitted to water

Which stages have the most important environmental impacts?

The following graphs present the distribution of the impacts along the linen shirt life cycle.



For the resources depletion indicators, namely **water consumption** or **primary energy consumption**, almost 80% of the impacts are generated during the **use phase** in **washing** and **ironing** the shirt**.** The manufacturing stage is the second most impacting phase for these indicators, as spinning, weaving and finishing linen are resource intensive processes. The cultivation stage has hardly any impacts in terms of resource consumption, owing in particular to the fact that in the regions where linen is traditionally cultivated, natural precipitation satisfies linen’s water requirements. Thus, no irrigation is needed.

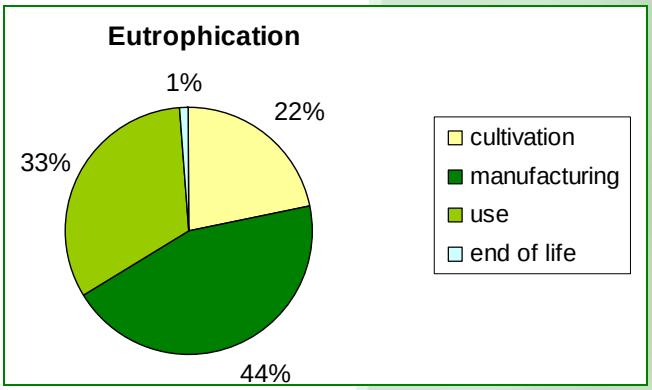


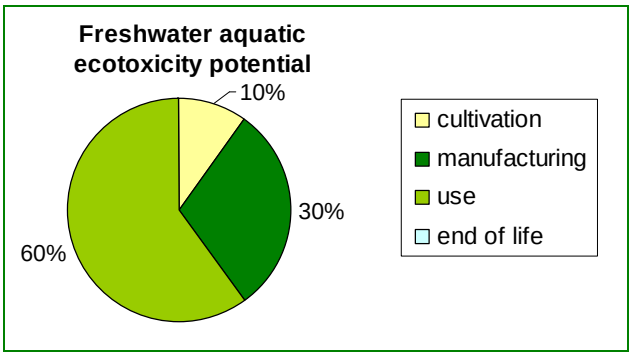
Greenhouse gas emissions are essentially linked to the consumption of electricity and heat produced by fossil energy sources (coal, natural gas, heavy fuel).

Greenhouse gases are mostly generated in the manufacturing stage, which often takes place in China or in other Asian countries. In this region, the electricity production relies essentially on the use of coal.

The electricity consumption during **washing** and **ironing** is the second source of greenhouse gas emissions. Even if 78% of the energy is consumed in the use stage, the use represents only 38% of the total greenhouse gases emissions. This is due to the fact that electricity in France comes mostly from nuclear energy which has low greenhouse gas emissions.

For the **eutrophication** indicator, the impacts are dispersed over the life cycle. During the cultivation stage, eutrophication is due to phosphate and nitrate emissions caused by the use of fertilisers. In the manufacturing phase, eutrophication is linked to **wastewater disposal from the textile plants.** In the use stage, it is the use of **washing powder** that contributes to eutrophication.





For the **freshwater aquatic ecotoxicity potential** indicator, the use of **washing powder** and the **electricity** consumption in the **use stage** are the most important contributors. During the cultivation phase, the impacts are essentially due to the application of **pesticides**. One can notice that the impact at the cultivation stage is low thanks to a limited use of pesticides for the linen crop.

Summary of the main conclusions

Washing and ironing the linen shirt are the main sources of environmental impacts over the life cycle.

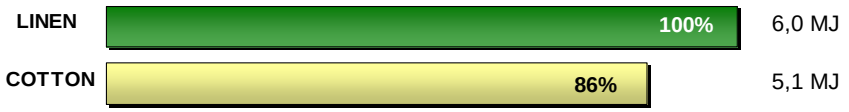
Compared to the use phase, the cultivation of linen and the manufacturing of the shirt have a moderate contribution to the overall impacts. The end-of-life stage has nearly no impact compared to the other stages of the life cycle.

What are the differences between a linen and a cotton shirt from an environmental point of view?

The following figures present the results of the comparative LCA between a linen and a cotton shirt for the functional unit of "wearing a shirt for a day".

In the comparative diagrams, the results for the linen shirt are taken as a reference and are set to 100%. The results for the cotton shirt are scaled accordingly. Absolute values are also presented.

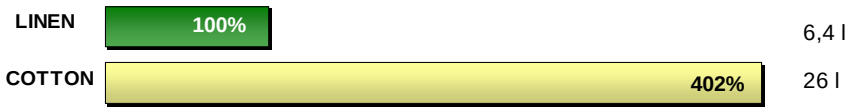
Primary energy consumption



The primary energy consumption indicator is mainly linked to the use phase and in particular to the **ironing**. Ironing a shirt consumes around 7 times more energy than **washing**. As linen shirt takes longer to iron, the energy consumption is slightly higher for linen than for cotton.

The world energy consumption increases each year by 2%. However, the main energy sources used in the world (oil, coal and natural gas) are non-renewable.

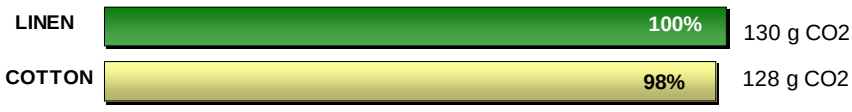
Water consumption



The water consumption is much more important for the cotton shirt than for the linen shirt. The difference comes from the cultivation stage. Cotton requires **intensive irrigation** (around 7100L of water for each kilogramme of harvested cotton) while the water needs of linen are satisfied by natural precipitation.

Fresh water available for humans represents only 1% of the water volume on Earth. The water resources are precious and becoming increasingly scarce due to the overconsumption for farming, industrial, household and urban activities.

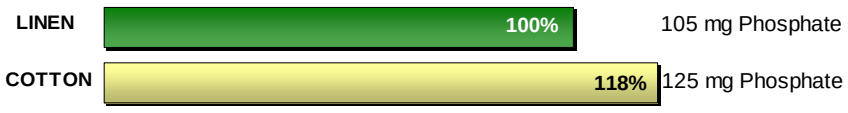
Global warming potential



The greenhouse gas emissions are almost equal for the linen and cotton shirts. These emissions are dispersed over the shirts' lifecycles.

For two centuries, human activities and in particular the CO_2 emissions have amplified the greenhouse effect. This phenomenon may have important consequences on the climate and Earth ecosystems.

Eutrophication



Concerning eutrophication, the difference between the linen and cotton shirts comes mainly from the cultivation stage. The fertilisers used for linen cultivation cause globally lower emissions of nitrate and phosphate than the cotton cultivation.

Eutrophication is a phenomenon caused by the increase of nutrients in the aquatic environment. This phenomenon may lead to asphyxia and death of aquatic ecosystems.

Freshwater aquatic ecotoxicity potential

The freshwater aquatic ecotoxicity is much more important for the cotton shirt than for the linen one. This difference comes from the cultivation stage, as more pesticides are used in the cotton production. In addition, toxic chemicals such as **defoliants** are used for cultivating cotton but not for linen. (On average around 2395 grams of pesticides per hectare are used for linen compared to 5020 grams per hectare for cotton, including 1370 g of defoliant).

The freshwater aquatic ecotoxicity potential describes the toxic impact that the emitted substances have in the aquatic environment. A reference molecule is used as a unit to evaluate the potential toxicity of each substance emitted.

Main conclusions

For the most relevant environmental indicators, such as the freshwater aquatic ecotoxicity potential or water consumption, the impacts of the linen shirt are up to 7 times smaller than the impacts of the cotton shirt.

Concerning indicators of secondary importance for textile shirts such as the global warming potential or the primary energy consumption, the environmental impacts of the linen shirt are either equivalent to those of the cotton shirt or 10% to 15 % higher.

How to improve the environmental performance of a linen shirt?

As the impacts of a linen shirt are dispersed over the shirt's lifecycle, each stakeholder along the lifecycle has a role to play in limiting the environmental impacts of the shirt.

As a professional of the linen sector, how can you act?

During the **cultivation** stage, the linen producers pay attention to improving their practices. They limit the use of fertiliser and adapt quantities to the real needs of the plant, taking into consideration the soil type and the previous plants cultivated on the field. Concerning pesticides, the most toxic substances are progressively phased out and systematic pest treatments are more and more replaced by punctual remediation adapted to each case.

In the **textile industry**, production processes of fabrics are continuously improved in order to limit water pollution and wastewater treatment is integrated in the manufacturing plants. The energy consumption of manufacturing processes is also optimised in order to limit resource depletion (coal, natural gas, fuel) and greenhouse gas emissions. Lastly, the textile sector aims at improving the quality of the clothes in order to limit the need for ironing, which leads to energy savings at the use phase.

And you, as a user, how can you act?

The linen shirt **use** stage generates the most important environmental impacts. By adopting **environmentally friendly behaviour**, the user can significantly reduce the environmental impacts of his shirt. For instance, he can try to wear the shirt two times before washing it. He may also reduce the ironing time by limiting the duration and speed of spinning. It is also preferable to use air drying instead of an electric dryer.

Finally, increasing the lifetime of the shirt by giving it to someone else for second use also reduces the overall impacts of the shirt.

The environmental benefits of these choices are illustrated below:

Eco-friendly behaviours	Influence on the results of the LCA "wearing a shirt for a day"	What are the benefits if the shirt is worn 100 days?
Ironing time	**Primary energy consumption** 9 min: 100% — 6,0 MJ 7 min: 86% — 5,1 MJ	Saves 115 hours of lighting with a 60 W bulb.
Washing frequency	**Water consumption** Washed after 1 use: 100% — 6,4 l Washed after 2 uses: 58% — 3,7 l	Saves 178 days of human daily drinking water needs
	Freshwater aquatic ecotoxicity potential Washed after 1 use: 100% — 11 g 1,4 DB Washed after 2 uses: 70% — 8,1 g 1,4 DB	Avoids the emission of 78 mg of mercury

References to standards

This eco-profile was realised in compliance with international standards guidelines: the **ISO 14 020** series on environmental labels and declarations and the **ISO 14 040** series on Life Cycle Assessment. This eco-profile and the LCA report were **peer-reviewed** by two independent experts: a life cycle analysis expert and a textile expert.

Contacts

Presse :

Cosi Communication
Dimitri Soverini
Tel : +33 (0) 1 55 34 34 34
dimitri@cosicom.net

Masters of Linen
Julie Pariset
Tel : +33 (0) 1 42 21 89 76
julie.pariset@mastersoflinen.com