



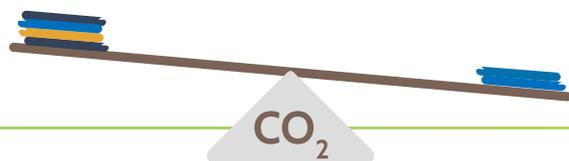
THE
Sustainable
Fabric
Guide

Autron Sustainable Team



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Introduction



One of the most common issues that people face in the ecofashion space is picking the right fabric. There is an array of eco fabrics and new ones are popping up on the market every day. It can all be a bit overwhelming.

So how do you pick a fabric that's green, affordable, available and right for you?

This guide has taken the eight main used fabrics in North America and created a scoring chart that allows you to find the right fabric for your company. This guide is perfect for brands to better understand their current fabrics and be informed about other options. For any eco consumers, this guide provides insight into environmentally-friendly fabrics that will allow you to make better purchasing decisions in the future.

Here are the 8 fabrics we looked at:

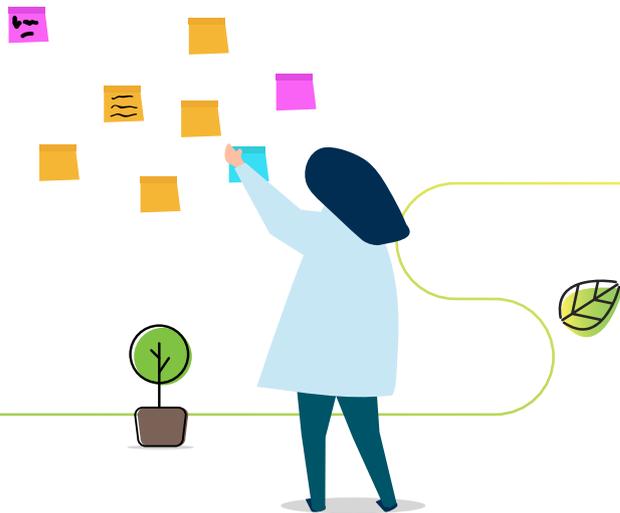
- Linen
- Tencel
- Recycled Polyester (rPET)
- Bamboo
- Cork
- Recycled Wool
- Organic Cotton
- Hemp



There are a lot of things we haven't looked into such as design and application, offsetting, dyeing, colour fastening and certification availability. While the final scores of each fabric can be used to determine the best, there is lot of subjectivity involved. For example, you might be more concerned about price than emissions, so you'd weight that score more.

We hope you will utilize the guide to make the best decisions for yourself and your business.

Methodology



When it comes to materials, there is so much to think about. So here in Green Story, we've created five main categories that you can use to assess the sustainability of a specific fabric. We've judged each category out of 5, with 1 being the lowest and five being the maximum a fabric can receive.

Our five categories are:

1. Carbon dioxide equivalent (CO₂e) emissions
2. Water consumption
3. Cost
4. Availability
5. Other

Carbon dioxide equivalent (CO₂e) emissions

As the name suggests, this category judges each fabric on the CO₂e emissions it releases during its production: from the cultivation of materials, yarnning, fertilizer use, and production energy. In both this category and in water consumption, we have mostly excluded use phase. The rating for CO₂e followed this table:

Rating	Range (kgCO ₂)
★★★★★ 5	0 - 10
★★★★★ 4	10 - 20
★★★☆☆ 3	20 - 30
★★★☆☆ 2	30 - 40
★★★☆☆ 1	40+



Water Consumption

One of the key points in favour of green fabrics is that they save significant amounts of water compared to conventional materials. That doesn't mean that all green fabrics are created equal. Some manage to save more water than others. Fabrics scoring 5 points in this category consume anywhere from 0 to less than 100 liters of water per 1kg of fabric produced. The full ratings table is below.



Rating	Range (L)
★★★★★ 5	0 - 75
★★★★★ 4	76 - 300
★★★★★ 3	300 - 500
★★★★★ 2	500 - 1000
★★★★★ 1	1000+



Cost

While campaigning for green is our number one goal, the reality is, not many of us can afford to be 100% green. Brands and consumers alike can't purchase the most expensive materials and products or their pockets will be feeling the damage. Keeping this in mind, Green Story has judged each fabric on its relative cost compared to cotton.

Availability

The ability to have local production is a major factor in how green a material can be and how green a brand is. Therefore, from a North American perspective, we look at how accessible sourcing this material is and whether manufacturing outside major fabric production hubs is possible.

Other

The umbrella category. Here we list some cons and pros that were missed from the above categories that give you a much more holistic view of the respective fabric.



Linen

Other than your lightest and most summery outfit, linen is a natural and biodegradable fabric made from flax plants. It is one of the oldest used materials yet is now only 1% of the global apparel fibers in use. It has the ability to absorb 20 times its weight without being damp hence is considered highly breathable and moisture-wicking, well suited for hot climates and those sun-kissed days. Flax being a hardy plant, its cultivation and production is often organically done and can be third-party certified. This is increasing its demand as an eco-fabric.

CO2 Emission



Linen production is better than most fabrics when it comes to emissions. However, the production process of extracting fibers is mechanically intensive. The crop must firstly be retted (soaked in water) to dissolve the outer bark of the plant and then scutched (beaten) and hackled (combed) in order to separate the fiber from the straw and split up the fiber bundles into fibers ready to be combed and spun into yarn. The naturally sturdy composition means linen is much more susceptible to breakage when weaved, leading to more losses during fabric production and so slightly more emissions at this stage compared to other fabrics.

Water consumption



Flax crops are highly resilient and can grow in poor soil, making them excellent for non-food crop fields. This also means far less irrigation water is required in comparison to other crops. As well, linen production is rather mechanically focused and uses very little water.

Cost — 3



Often dubbed a 'luxury fabric', linen is pricier than most natural fibers as it is more difficult to produce. This is particularly in yarn and fabric production from its inelastic nature this yarn is very susceptible to breaking. For this reason, machines must run at slower speeds and have lower yields which increase the costs.



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Availability

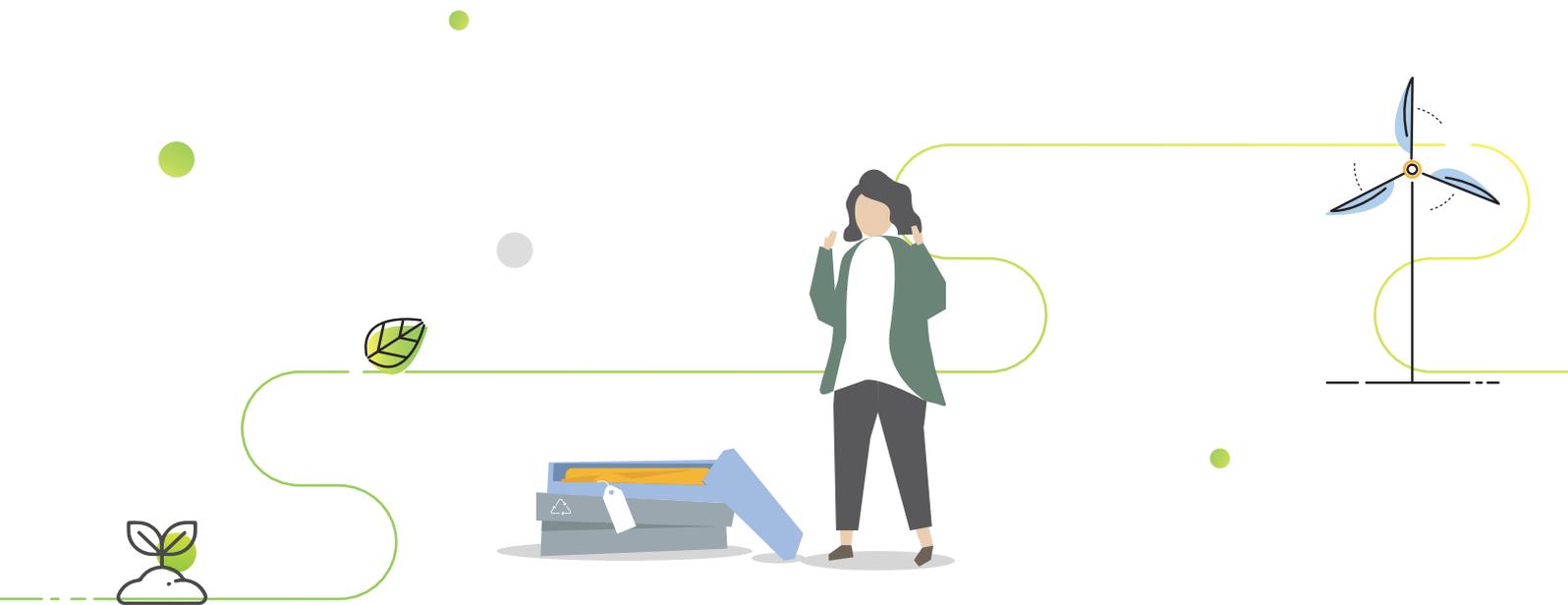


Linen has been around for thousands of years and is present worldwide. The resilience of the crops allows them to grow in most countries, with best yields in cooler regions with a long period of daylight. Canada and the United States are major suppliers of flax fiber, making this fabric a great option for local production.

Other



Linen is very high yielding, far greater than cotton which makes it a favored option for organic cultivation. Flax crops are often grown without the use of toxic fertilizers or pesticides. The bleaching and dyeing process does require chemicals in production, but many brands have chosen to stay with natural toned linen colours in order to avoid this step. It is also lightweight and great at absorbing moisture without holding bacteria, becomes softer with time and washing and is great for sensitive skin due to its hypoallergenic properties.



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Tencel is a relatively new green fabric on the market. Invented by Lenzing AG in Germany 40 years ago, Tencel is the brand name of lyocell. This material comes from the pulp of trees and is comparable to rayon and modal in its physical properties. Its production process is specifically engineered in order to alleviate environmental concerns in textile production.

CO2 Emission



The biggest pro of Tencel in comparison to other cellulosic fibers is its production of wood pulp to fiber. Lenzing has specifically redesigned this process with sustainability in mind and hence has a very high resource efficiency, low waste, and minimal impact. Harvesting eucalyptus trees needed for Tencel for production is done almost 80% by hand with the remainder harvested by machines. This saves emissions compared to beech trees harvested being only machine-harvested. As a bonus, Lenzing also avoids harvesting wood from old growth forests.

Water consumption



The production of this material only requires one-third of the process water needed for viscose and it is done with a closed-loop process. This is extremely water-efficient, being able to capture, recycle and reuse over 99% of water and solvents. Apart from the production, the natural and managed forests from which these come from only use rain-fed water to grow, and thus zero additional irrigation is needed.

Cost



Due to its modern and environmentally-friendly production, Tencel is among the higher priced fabrics on the market. However, this fabric has longer durability compared to cotton and so can equal out value for money.

Availability

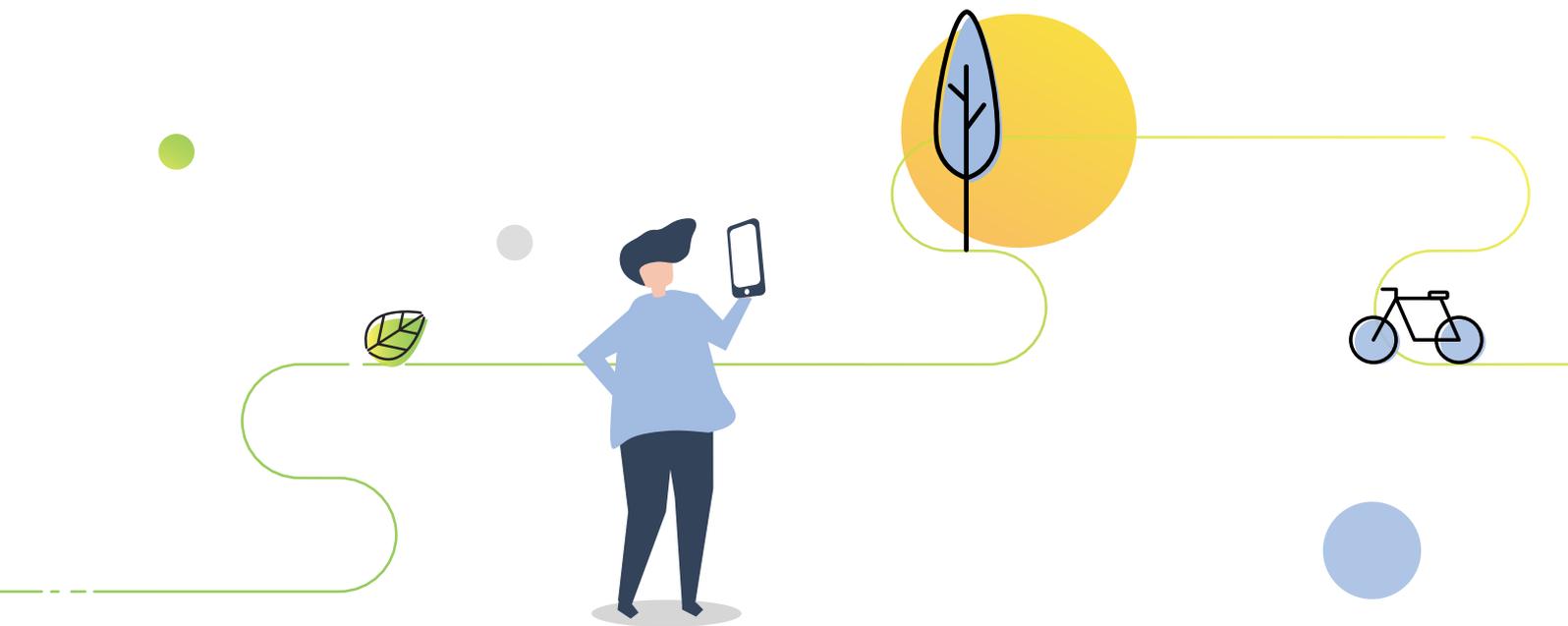


Having only been invented four decades ago, Tencel is currently not as available as cotton in terms of worldwide production, but it is constantly growing and to date has production sites in Europe, China, Indonesia, and the United States.

Other



Tencel is made from certified and controlled forests. Similar to the viscose method, the pulp from Eucalyptus trees must be broken down into a slurry, in order to be spun into yarn. While the viscose method uses many toxic chemicals for this process, Tencel uses a solvent called amine oxide, which is non-toxic. That means that 99.5% of (non-toxic) chemicals used get recycled allowing for no waste to enter our ecosystems and no need for new solvents. Tencel has a silk-like feel, is extremely strong (even when wet) and is more durable than cotton, linen, and its main comparative, viscose as well as being biodegradable and recyclable.



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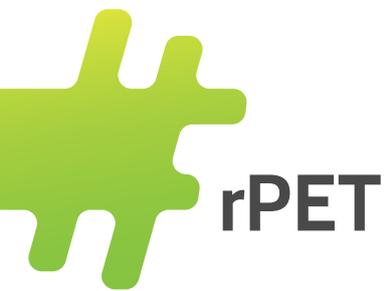
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Recycled polyester or rPET falls within the synthetic family of fabrics. Synthetics are the largest category with polyester holding 49% of the global fiber production. With more than 62 million tonnes of polyester produced annually, rPET is a great sustainable alternative. Although it is a synthetic fabric, rPET doesn't have emissions from oil extraction and processes that virgin polyester does. Currently, the largest portion of recycled material is post-consumer PET bottles. These materials get sorted by colour, cleaned, melted, and spun into yarn through polymerization.

CO2 Emission



The most critical and environmentally-friendly aspect of rPET is the fact that it bypasses the oil extraction required to make virgin polyester. This reduces the CO2 emissions of rPET significantly compared to virgin polyester and makes it a great alternative. However, the mechanical process of breaking down and extruding as well as dyeing synthetic fabric is energy intensive and releases on average more emissions than natural fabrics.

Water consumption



The production of rPET saves significant amounts of water by avoiding virgin polyester production — 35% to be precise. However, the dyeing of synthetic fabric is water-heavy and must still be performed for the recycled fabric.

Cost



rPET does well at pricing due to the current large supply of PET. Currently, virgin polyester is cheaper than conventional cotton. rPET's additional recycling makes this fabric about 15 to 20% more expensive than polyester, but relatively inexpensive when considering its alternatives.

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Availability

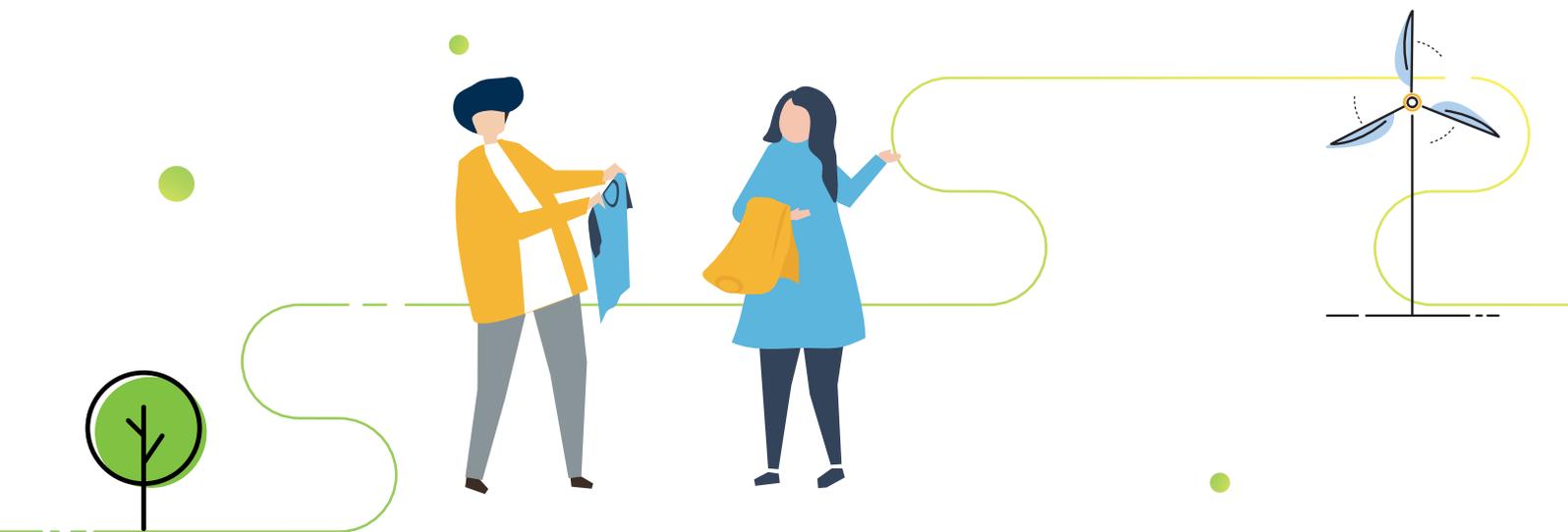


There is currently an abundance of PET available worldwide as well as recycling and production plants which makes this fabric readily available and a good option for local production. While this does lead to significant variations in quality, it's not difficult to find a verified supplier.

Other



rPET's most important environmental benefit is that it provides a solution to our plastic problem and prevents further need for raw material extraction. Five PET bottles can be taken from a landfill and recreated into a t-shirt. When a t-shirt is formed out of 100% polyester, it can be broken down again and respun several times before starting to impair its quality. However, as it's pretty much the same as virgin polyester yarn, rPET yarn also leads to microfibre pollution especially during the wash and use stage. This does tend to make brands think twice before using the fibre.



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Bamboo

Bamboo fabric is an eco-friendly material in the cellulosic family of fabrics and is often compared to viscose/ rayon. Bamboo fabric is made from the stem and leaves of Moso bamboo plants, which grow at a much quicker rate than any other cellulosic-based material and have a high yield. While bamboo can be created via two methods (mechanically or chemically), it is currently mostly made with the chemical viscose method, and the ratings below reflect that.

CO2 Emission



The production of bamboo is identical to that of viscose, but rather than extracting the cellulose from wood pulp, the fibers come directly from the bamboo culm or stem. In order to extract these fibers, bamboo must be mechanically crushed and chemically treated. Due to the same production, bamboo in fact has very similar CO2 emissions to conventional viscose. However, this production method has a relatively small carbon footprint, with the majority of impacts coming from extracting the fiber from the stem and extruding it to yarn.

Water consumption



Bamboo crops use far less water than for example cotton and other crops to grow. Since bamboo is produced using the viscose method, the process of fiber extraction and turning it into a slurry to be spun into yarn requires a lot of water. During production, bamboo stems must be soaked in water to extract fibers and the use of solvents requires the fibers to be thoroughly cleaned with water. However, due to the great crop growth and high yield, bamboo still saves a lot of water.

Cost



While still slightly pricier than cotton, bamboo and viscose are often equally priced and very good in relation to other eco-friendly materials. Bamboo labeled “Lyocell Bamboo” is bamboo made with the Tencel production process which will be more expensive.

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Availability

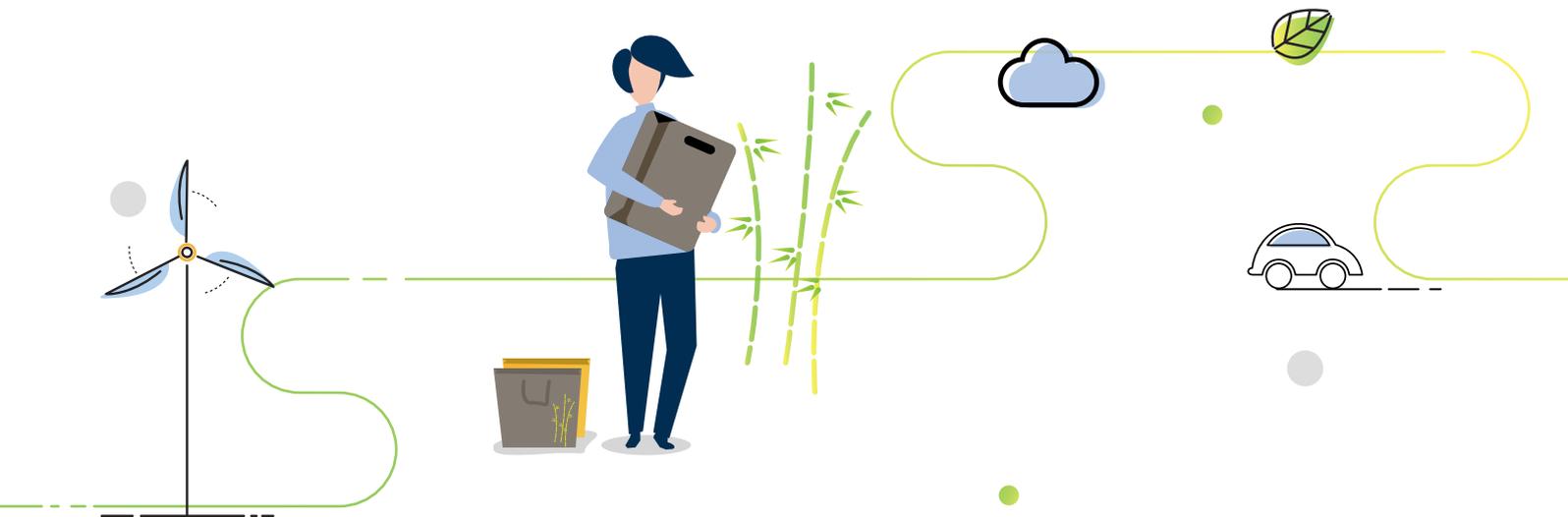


Bamboo scores low on this category since the plant only grows in China and Taiwan, making it difficult for local production in North America. However, this is balanced by the strong bamboo industry in these regions, and easier access to the Chinese market in recent years.

Other



This plant is exceptionally fast growing and very pest resistant, thus not needing any pesticides or herbicides. Being a type of grass, this plant is a quick grower without requiring replanting or chemical fertilizers. Bamboo is natural-based and biodegradable, strong, durable, and great for moisture absorption. It is could also be produced with the Lyocell method from Lenzing, which would make the fabric highly sustainable. Additionally, brands may also wish to get the Oeko-tex certification which ensures that bamboo has been certified by the Organic Crop Improvement Association.



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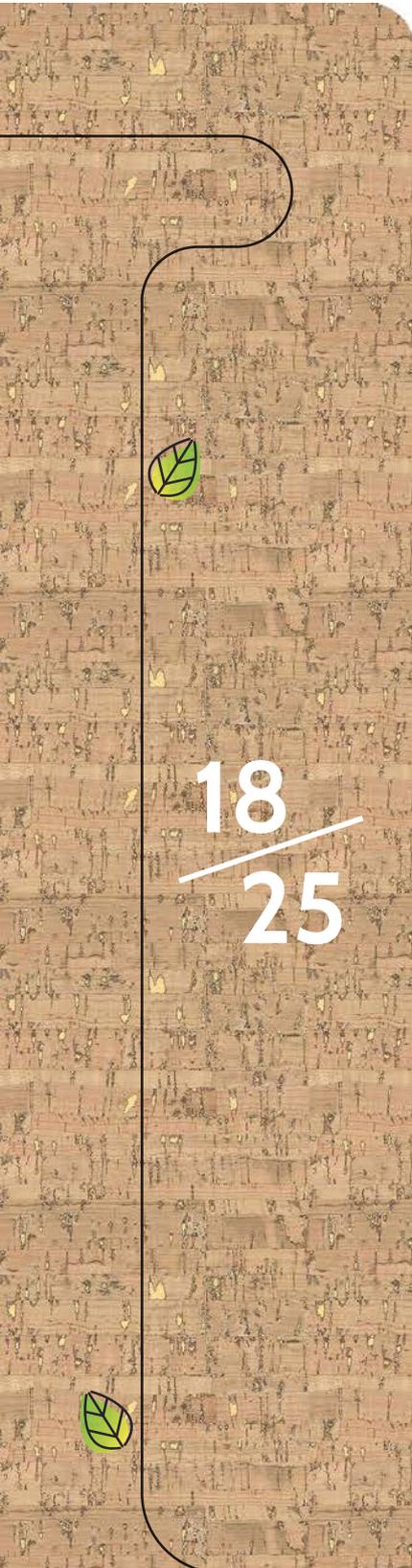
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Cork



Cork is an ultralight, ultradurable sustainable fabric option. Currently, it is used in shoes and accessories since it is most comparable with leather. Cork is natural, recyclable, and biodegradable. This material is made from the bark of cork oak trees, boiled for cleaning and handling, and either made into tissue-thin strips for fabric or fabricated in a spongy shock-absorbent material.

CO2 Emission



The sourcing is highly eco-friendly as only the outside bark of the tree is cut, without cutting down the tree. This is even more beneficial as harvested trees absorb 2-3 times more CO2 emissions than non-harvested trees. The harvesting of these trees is done manually by skilled workers. Cork needs to be compressed with the use of heat and pressure, but overall, its straightforward production results in very low emissions. As a bonus, its honeycomb-like structure gives it an extremely low density and makes it exceptionally light. This allows it to save much more CO2 emissions during transport.

Water consumption



As part of its production process, cork must be boiled in water in order to be cleaned from impurities, for the material to expand, and become more flexible for production. Cork is most often sold in its natural, unique colour, but brands may wish to have coloured cork. This will lead to more water use but cork fiber plants use natural dyes.

Cost



Cork oak trees grow in the western Mediterranean region and the Iberian Peninsula and are harvested manually by skilled workers. This leads to slightly higher prices for brands and consumers. However, cork is known to last 15+ years which makes the price worth the value.



Availability

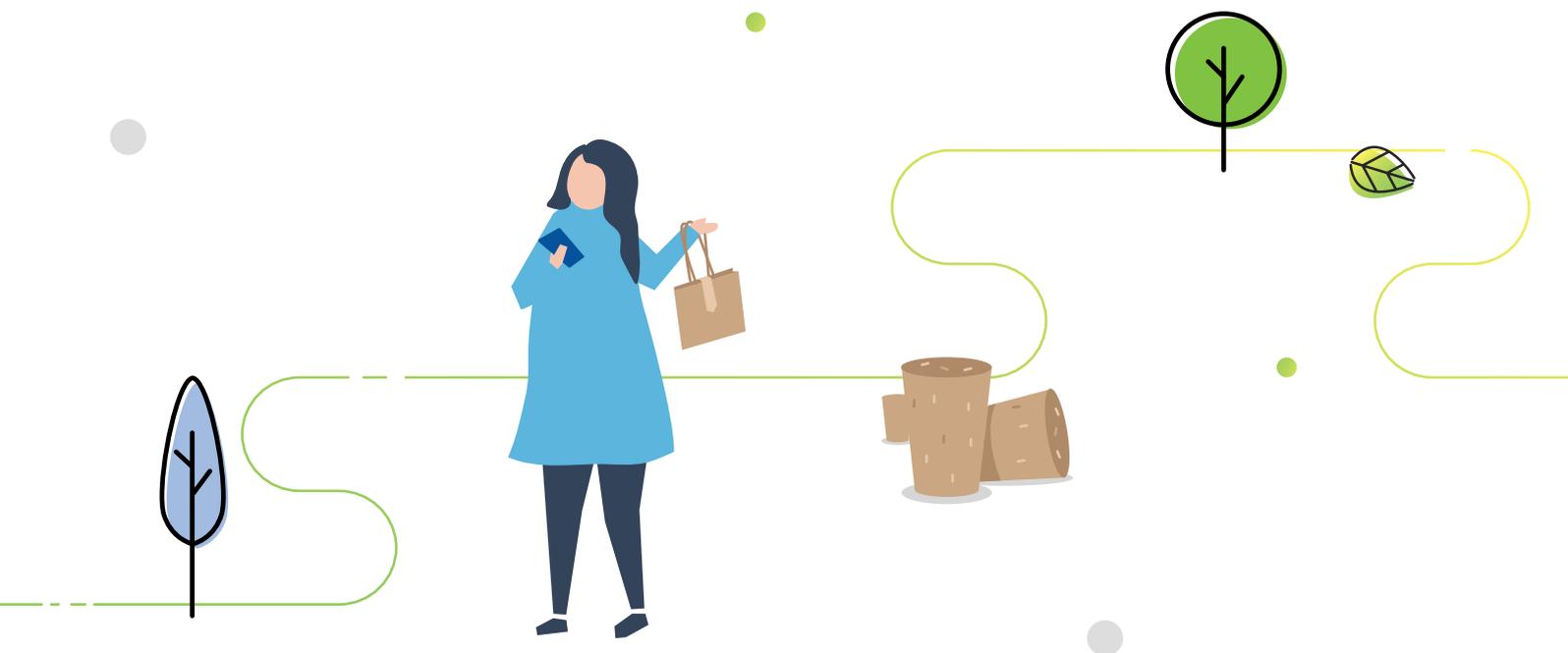


This fabric is very limited in availability due to the current natural location of trees. As well, the expertise in production has also flourished within the region it is sourced, making both sourcing impossible and production difficult in North America.

Other



Cork is most often compared to leather, in terms of applications and durability. It has a similar lifespan to leather without fading, while also being waterproof, hypoallergenic, and naturally stain and dirt-resistant. Apart from having minimal eco-impacts, it also has virtually no waste. Any extras simply reenter the production again. Its production process is completely free of toxic chemicals, and the sealant coating applied for stains resistance being non-toxic and using only natural dyes. It is also 100% recyclable, and supply chain traceable.



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Recycled Wool

Recycled wool, also known as reclaimed wool, reused wool or shoddy wool, by-passes the most environmentally harmful stages of wool production thus making it the sustainable alternative to virgin wool fabric. This production avoids all impacts from sheep raising, fiber production, and chemicals and water needed for dyeing—not to mention the waste taken out of landfills.

CO2 Emission



Recycled wool is among the least CO2 pollutant fabric on the market. It skips the most unsustainable step: sheep raising. Recycled wool also skips the emission-prone scouring process which cleans the wool of impurities and separates lanolin to be further sold.

Water consumption



By bypassing water-intensive stages of wool production like sheep raising and wool scouring, the process of recycling wool for knitted fabrics becomes less water intensive. Additionally, knitted fabrics wastes save even more water as the process of breaking them down into fibers is through a purely mechanical process. Water is further saved since recycled wool (most often) doesn't need to be dyed. Fibers are well sorted and mixed to achieve desired colours. This also decreases chemical use and wastewater pollution.

Cost



Before early 2000, when recycled wool became a fabric alternative for green businesses, it was often bought by multinationals as a way to stay economically competitive due to recycled wool being cheaper than virgin wool. This comes from the slightly worse quality of yarn of recycled wool from being torn apart and respun. The quality of recycled wool fabric will often be slightly harsher and shed more than virgin wool. As wool is more expensive than cotton, recycled wool could be a great alternative to implement wool into a brand's designs while being cheaper and more environmentally friendly than virgin wool.

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Availability



Recycled wool was highly popular during World War II but has since significantly dropped in production. Today, there are only a few hubs which specialize in recycled wool production, like Prato, Italy, and Panipat in India, being among the largest. This may lead to more transit cost and less possibility of local production. However, interest in recycled wool is growing due to its environmental benefits and we hope to see more hubs opening up in the next few years.

Other



Using this recycled fabric taking wool waste out of landfill and reduces the need to create virgin wool. As a fabric, wool is a staple for most consumers due to its inherent breathability moisture-wicking capabilities. This fabric can absorb up to 35% of its own weight in moisture due to its hydrophilic core and helps regulate body temperature for cold and hot temperatures. Wool has a much longer lifespan than other natural and synthetic, averaging at around 2 -10 years versus 2-3 years for cotton. While recycled wool has a slightly lower lifespan, it surpasses most other fabrics. Additionally, less customer care is needed in terms of washing from wool's natural ability to stay clean longer. Recycled wool is slightly less durable than virgin wool but can be blended with other fibers for strength and stretch.



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Organic Cotton

Organic cotton is possibly the most popular eco-friendly fabric in the market today. Once awareness was brought onto the number of pesticides that were used on cotton crops during its production along with its impact on the environment and worker health, new methods of production were put in place.

CO2 Emission



Organic cotton has a reduction of 46% in terms of CO2 emissions compared to cotton. This comes from the lack of production needed for irrigation, chemical fertilizers, herbicides, and pesticides. The fabric, however, does not reach a top score due to the energy required and the considerable amount of losses at the ginning stage. The separation of fiber and cleaning is an energy intensive process.

Water consumption



Compared to cotton, organic needs around 85% less water because of natural crop treatments. These treatments allow for the soil to retain significantly more water and so crops need much less irrigation. Cotton crop still requires a lot of water to grow, although this is being reduced as some regions are focusing on using only rain-fed water.

Cost



Since organic cotton only uses natural methods of production, the yield of cotton during cultivation is much lower than that of conventional cotton. That translates to more cost per ton of fabric for manufacturers and consumers. As well, organic cotton should be certified by a third party ideally for cultivation and production which leads to slightly higher cost for manufacturers.

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Availability

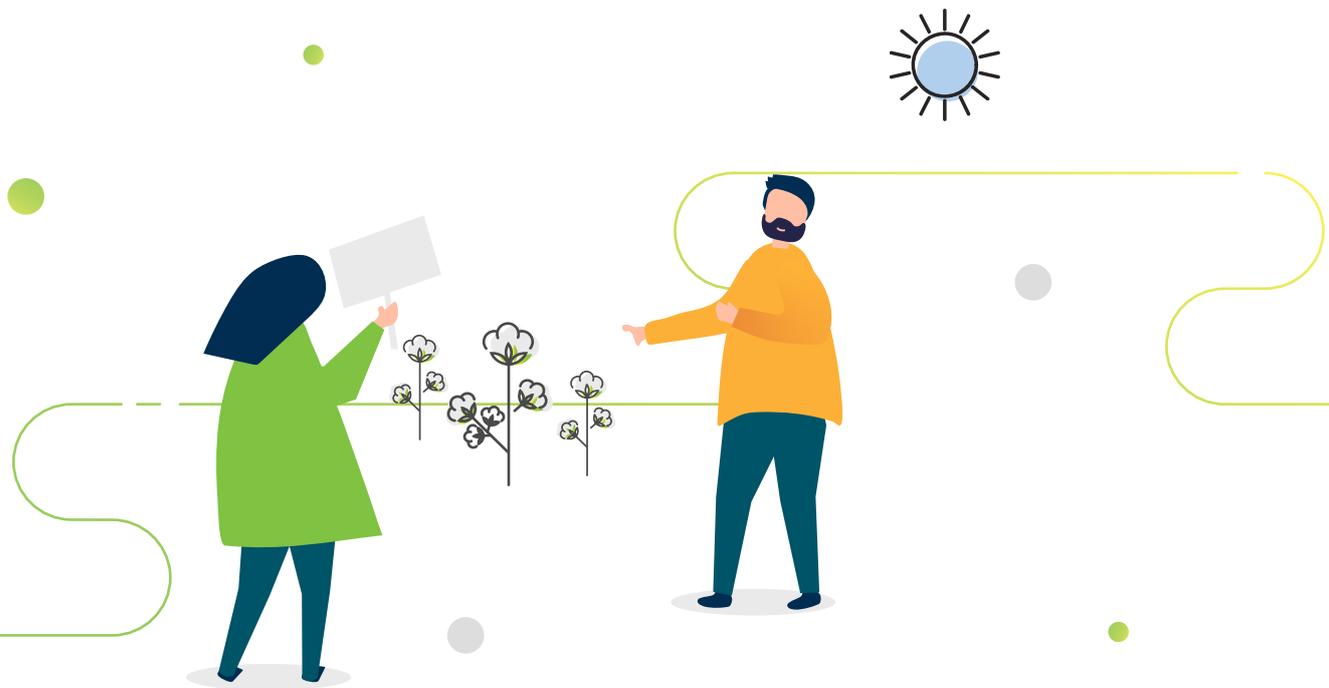


Organic cotton is grown in 35 countries worldwide. While the crop must grow in hot climates, cultivation is possible on each continent. This fabric also scores high in availability because the cotton fabric production process has been extensively developed worldwide and apart from dyeing, production is identical for conventional and organic cotton fabric production.

Other



The great aspect of organic cotton is that the characteristics are identical to cotton minus the toxic chemicals. Organic Cotton uses natural dyes with indigo, onion shells and turmeric being the most popular. These colours sometimes lack some of the vibrancy compared to synthetic dyes. Organic cotton is said to be of better quality as they are hand-picked vs. cotton being machine-cultivated. This ensures that long fibers are not damaged, leading to smoother yarn and fabric.



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Hemp

A fabric that has been used for thousands of years and made from cannabis sativa fiber (otherwise known as industrial hemp). Although absent for a while due to legal regulations, hemp is making a comeback with loosening regulations and as information of its eco-friendly properties' surfaces. As a fabric, it is almost identical to linen.

CO2 Emission



Hemp production process is similar to linen, where the sturdy crop is retted to separate fibers from the stalk, scutched to separate the fibers from the hemp wood and hackled to split up the fibers. While similar, the machinery used, and methods are different than linen. Hemp also has an intensive degumming process which removes impurities like waxes, lignins and other chemical impurities before the fiber can be spun into yarn. This requires a lot of energy use and gives off more CO2 than cotton production.

Water consumption



Hemp is an extremely durable fabric and is known for being a quick growing crop faster than some weeds. These sturdy plants require minimal irrigation in order to grow as well as having a mechanical focused production that does not require much water. Overall most water inputs are needed during the dyeing phase of this fabric.

Cost



Unfortunately, Hemp is more expensive than any other natural fiber due to the lack of supply and strict country regulations. More often than not, companies blend hemp with other fibers in order to reduce pricing.

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Availability

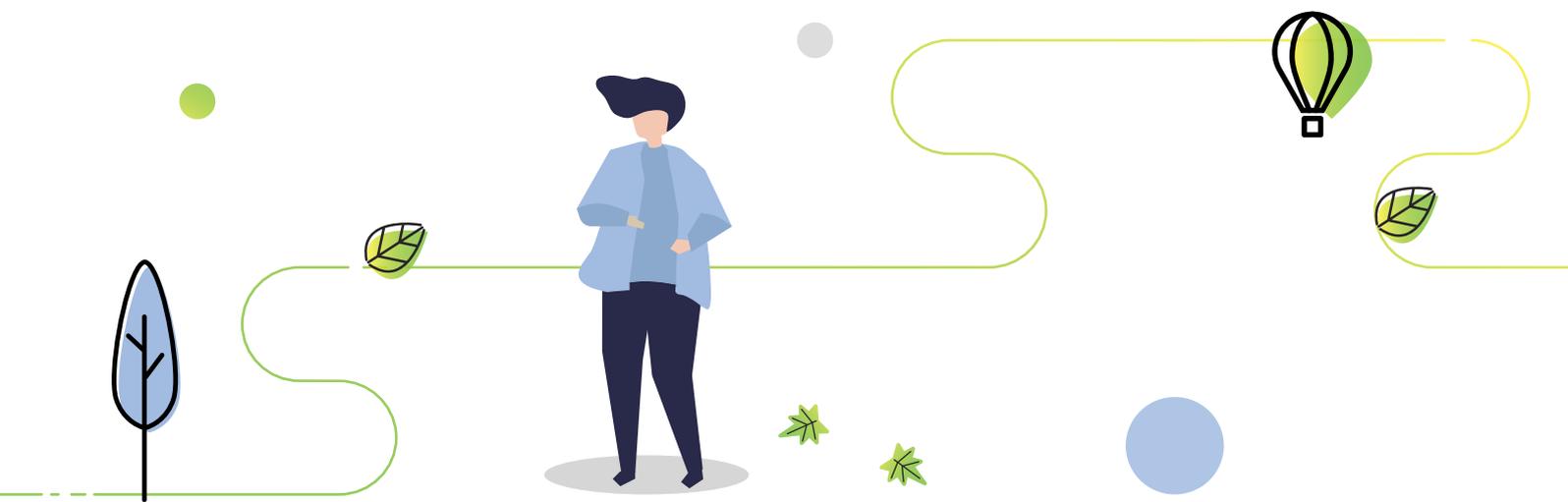


Hemp can grow in most climates and is mainly found in Europe, Asia, and the Western Hemisphere. This makes it great for local production. However, it is currently not widely available as other crops due to its resemblance to marijuana. Although not exactly the same plant (very low THC in industrial hemp crops), the two look identical. That makes our eco-friendly fabric very limited due to national regulations. Canada is now in the clear for crop growth but lacks the expertise of the degumming processes for local production.

Other



Hemp grows quick and well with a high yield, requiring only about 100 days to grow after planting while also being a great regenerative rotational crop. It's the strongest natural fiber (after spider-silk) thus allowing clothes to last longer, stay in shape longer while holding its strength when wet. Not to mention it's breathability in hot climates, and it's the best natural fiber for anti-bacterial properties. Growing this crop cleans toxins from soil and groundwater and is a natural CO2 sink. Each ton of hemp cultivated takes 1.63 tons of CO2 out of our atmosphere. However, it's not as colour-fast as cotton and it's quick to wrinkle. Additionally, hemp yarn is very rough and so is often blended with softer fibers to give it a nicer feel and for versatility in apparel.



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How to Apply this Information

As you might have guessed from the scores given, our scoring system is a mix of objective measurements and subjective selection. These scores then should be used as a guideline based on your needs. For example, do you value water use? Then pick the most water efficient fabric, or if cost is the issue, weight the cost score more.

The objective rankings for CO2 and water were based on global LCA data analysis conducted through the GaBi software and third party LCAs.

When it comes to availability, a North American point of view was considered. How easy is it as an American manufacturer to source these fabrics? The cost, although it could be an objective measure, varied so much between different sources that we did a standard comparison against cotton based on primary interviews with clients. The “other” section was a catch-all to talk about things like micro-plastics, versatility, and durability.

There are a lot of criteria we didn’t fully consider, as the needs for each brand will be different. For example, an active wear brand might think about elasticity and moisture wicking capability as being important. It’s important as a brand to map out what are the key criteria for yourself, weigh them and then look at the scores given in this book.

While looking at fibres through the lens of this book is good, it’s also important to know your own supply chain and sourcing. Rather than compare each material against each other, one should also look at reliable certification (such as GOTS). Production from a reliable company is also important. As one industry contact said, “There’s a lot more organic cotton being sold than there’s organic cotton being produced.” A good starting point for finding reliable suppliers is the Textile Exchange: <https://textileexchange.org/integrity>. GOTS also has a database for producers and products: <https://www.global-standard.org/public-database.html>

Finally, if you’re really serious about reducing your impact, look at good design. If you can design for sustainability by ensuring durability, low maintenance and repairability, you will reduce the biggest impact factor the supply chain: usage and care.





The Cheat Sheet

Over the course of this book, we've reviewed 8 eco-friendly materials and rated them. The scoring system is intended as a loose guide and not an absolute rule. Each company will have its own needs and should pick fabrics based off that. The complete summary table is presented below.

Fabric	Co2e Emissions	Water Consumptions	Cost	Availability	Other	Total Score
Linen	4	5	3	5	4	21
Tencel	4	5	2	3	5	19
rPET	3	4	5	4	2	18
Bamboo	4	4	4	2	4	18
Cork	5	4	3	1	5	18
Re.cycled Wool	5	5	4	2	3	19
Org. Cotton	4	3	4	5	5	21
Hemp	3	4	3	3	4	17

