



# Design Guide

THE SWEDISH WOOL INITIATIVE

How to Work with Swedish Wool in a  
Sustainable and Circular Way



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# Contents

<b>5</b>	Introduction	<b>22</b>	Collaborate
<b>6</b>	<b>Facts about Swedish Wool</b>	<b>24</b>	Ecodesign for Circularity
<b>6</b>	Characteristics	<b>24</b>	Selecting the Right Wool For the Right Application
<b>6</b>	The Swedish Wool Standard	<b>26</b>	Resource Efficiency
<b>8</b>	Value Chain	<b>30</b>	Reuse
<b>8</b>	Application Areas for Swedish Wool	<b>30</b>	Repair
<b>10</b>	Interview – Filippa K	<b>31</b>	Repurpose
<b>12</b>	<b>Sustainability Parameters</b>	<b>31</b>	Recycle
<b>14</b>	How Sustainable is Wool?	<b>31</b>	Deal with Conflicting Objectives
<b>14</b>	Climate Impact	<b>32</b>	Visualize the Entire Life Cycle
<b>14</b>	Biodiversity	<b>34</b>	Interview – Tiger of Sweden
<b>14</b>	Animal Welfare		
<b>16</b>	Interview – Klippan Yllefabrik	<b>36</b>	<b>Handle With Love – Care Instructions for Wool</b>
<b>18</b>	<b>How to Work with Swedish Wool in a Sustainable Circular Way</b>	<b>38</b>	<b>Contacts</b>
<b>20</b>	From a Linear to a Circular Economy		
<b>20</b>	Making Circularity Part of Corporate Strategy		
<b>20</b>	Transparency and Traceability		



*The textile and fashion industry are in a transition to a circular economy and, from a circular system perspective, Swedish wool is a valuable resource. Used in the right way, it is a natural and sustainable alternative for the textile industry. With this guide, The Swedish Wool Initiative aims to share insights and provide inspiration to everyone who wants to work with Swedish wool. As design, materials, and business models are tightly intertwined, this guide covers both practical steps related to design and product development, as well as generic aspects of circular business models. And last but not least, the guide shares valuable lessons learned from brands at the forefront.*

## **The Swedish Wool Initiative**

Via The Swedish Wool Initiative, run by Axfoundation, actors across the value chain collaborate to build system capacity, scale up the use of Swedish wool, and contribute to the transition to a sustainable and circular industry for fashion, outdoor, and home textiles. The initiative brings together companies that normally would be competitors, but who in this context collaborate on a joint sustainability issue. Together with the project's academic partners and expert group, solutions are developed based on both research and practical experience. The project is supported by Sweden's innovation agency Vinnova's program area Sustainable Industry.

### **The Initiative contributes to:**

- A climate-neutral and circular industry for fashion, outdoor, and home textiles through the development of circular products based on the residual flow of Swedish wool.
- A resource-efficient and resilient value chain for Swedish wool.
- Increased competitiveness for the raw material and products of Swedish wool.
- A socially sustainable textile industry in transformation into a circular economy, e.g., through increased knowledge of circular design and product development.

# Facts about Swedish Wool

**Wool is a fantastic natural, renewable, functional, and versatile material. It can be used for anything from clothing to building insulation. Its fibers are naturally stretchable and elastic, allowing the wool fiber to be bent over 20,000 times without its breaking. Wool remains comfortable and warming even when wet and can absorb up to 35% of its own weight in water. It is also partially naturally flame retardant and dirt repellent. Furthermore, wool is sound-absorbing and heat-equalizing and it counteracts bad odors and static electricity. Moreover, wool has the potential for long-term use and recycling.**

## Characteristics

Wool fibers mainly consist of the protein keratin and are biodegradable within a reasonable time under the right conditions. Important characteristics to consider when aiming for the best products using Swedish wool are fiber diameter, fiber length, crimp, color and vegetable matter.

*Fiber diameter or fineness* is measured in microns ( $\mu$ ). The spread between different breeds of sheep is large, from 14 microns to over 50. The fiber diameter can also differ depending on which part of the fleece the fibers are coming from and if it is wool hair or coarse hair. The diameter is of decisive importance for the properties of the final product. For example, a finer micron is softer and less itchy in direct contact with skin. Coarse fibers are durable when it comes to hydrophobic properties.

*The fiber length* depends on the breed of sheep, and of course, on when the shearing takes place. The length of the wool fibers is a crucial factor in the spinning process as the overlap affects the strength.

*The crimp* or curliness of the fibers affects, among other things, how well the fibers hold together in a sliver (the strand) between carding and yarn spinning, and how hairy the yarn will be in the end. Crimp is also essential when it comes to the bulk of the yarn. The greater the crimp, the bulkier the yarn gets. But here, it is important to also take the spread of fiber diameter into account as the larger the range of different fiber diameters, the bulkiness in the yarn increases.<sup>1</sup>

*The color* of the wool can vary primarily depending on the breed and is defined as either white or pigmented. If the wool is pigmented, the color should be described, e.g. medium brown or black. Samples can be sent for objective quality control. The International Wool Textile Organization (IWTO) offers a standard for Wool Color Measurement, specifically IWTO 56 (y-z).

*Vegetable matter (VM)* is the amount of unwanted organic materials in wool, such as wood, hay, straw, seeds, chips, and similar substances. The amount of VM is categorized as low, medium, or high. Samples can be sent for objective quality control. IWTO offers a method for analyzing the percentage of vegetable matter.

As in many European countries, the Swedish wool market is characterized by several different sheep breeds with a wide variety of wool types. In 2022, according to the Swedish Sheep Breeding Association, a little bit more than 1,000 tons of wool were produced in Sweden, distributed among more than 40 different breeds.<sup>2</sup> The largest breed is Gotland sheep, which accounts for roughly a quarter of the wool production, followed by two types of cross breeds, one consisting of at least 50% Texcel, the other of at least 25% Gotland or Leicester sheep.

## The Swedish Wool Standard

The Swedish Wool Initiative has, together with stakeholders across the entire value chain, developed a set of working methods and the first classification system for Swedish wool. The Swedish Wool Standard standard aims to increase the quality of Swedish wool and support the trading of wool on an industrial scale by creating a common language among the actors in the value chain, from farmers and shearers to wool brokers and buyers.<sup>3</sup> A notable advantage is that brands can now acquire larger quantities of precisely the desired quality of Swedish wool. Through classification, even smaller quantities of wool from small-scale farms spread across the country can be gathered, classified collectively, and subsequently matched with the demands of buyers. Arena Svensk Ull oversees the management and further development of the Swedish standard.

<sup>1</sup> "Specifying wool yarns – a comparative study of wool yarns for carpets" Att specificera ullgarn – en jämförande undersökning av ullgarn för mattor, Jenny Borg, Silje Sagen och Sara Tivell, Examensarbete för Teknologie Kandidatexamen 2019, Textilhögskolan vid Högskolan i Borås

<sup>2</sup> "The Wool Treasure Map" Ullskattkartan, Svenska fåravelsförbundet, 2022, <https://faravelsforbundet.se/ullskattkartan/>



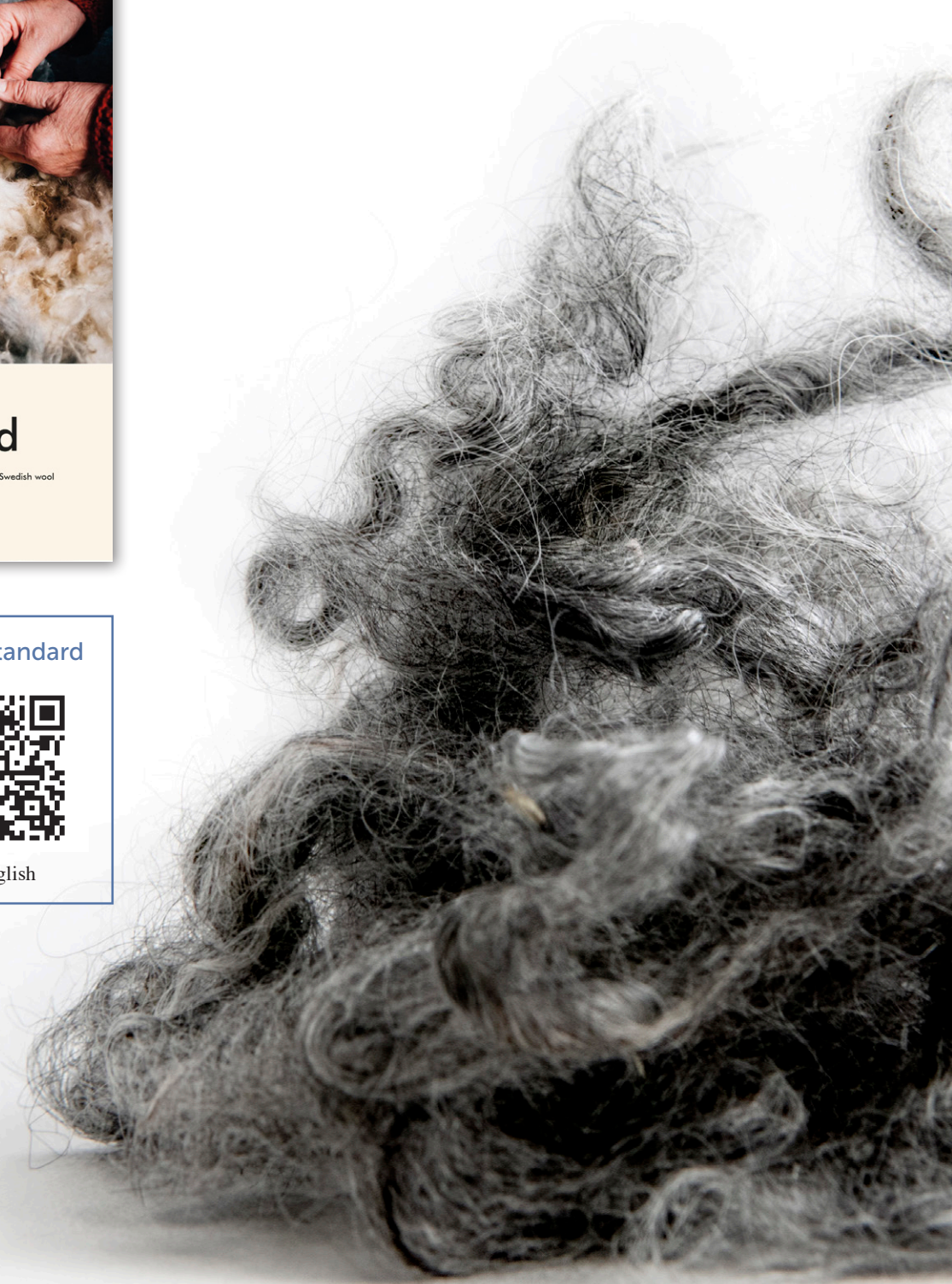
Read the Swedish Wool Standard



In Swedish



In English



<sup>3</sup> The Swedish Wool Standard – Practical work methods and value-creating classification system for Swedish wool, Johanna Olofsson Behrman (Axfoundation) Linn Lindfred (Circularista AB), Axfoundation 2023

## Value Chain

The value chain (or supply chain) for wool products could look very different depending on product requirements and production methods. Below is a simplified sketch describing a scenario with scouring in Sweden before export for further processing. Sweden currently has three main actors taking the role as wool brokers: Ullkontoret, Väst kustens Ullinsamling, and Ullcentrum.

### Learn more about Swedish wool brokers:

- Ullkontoret: [ullkontoret.se](http://ullkontoret.se)
- Väst kustens Ullinsamling: [vastkustensullinsamling.se](http://vastkustensullinsamling.se)
- Ullcentrum: [ullcentrum.com](http://ullcentrum.com)

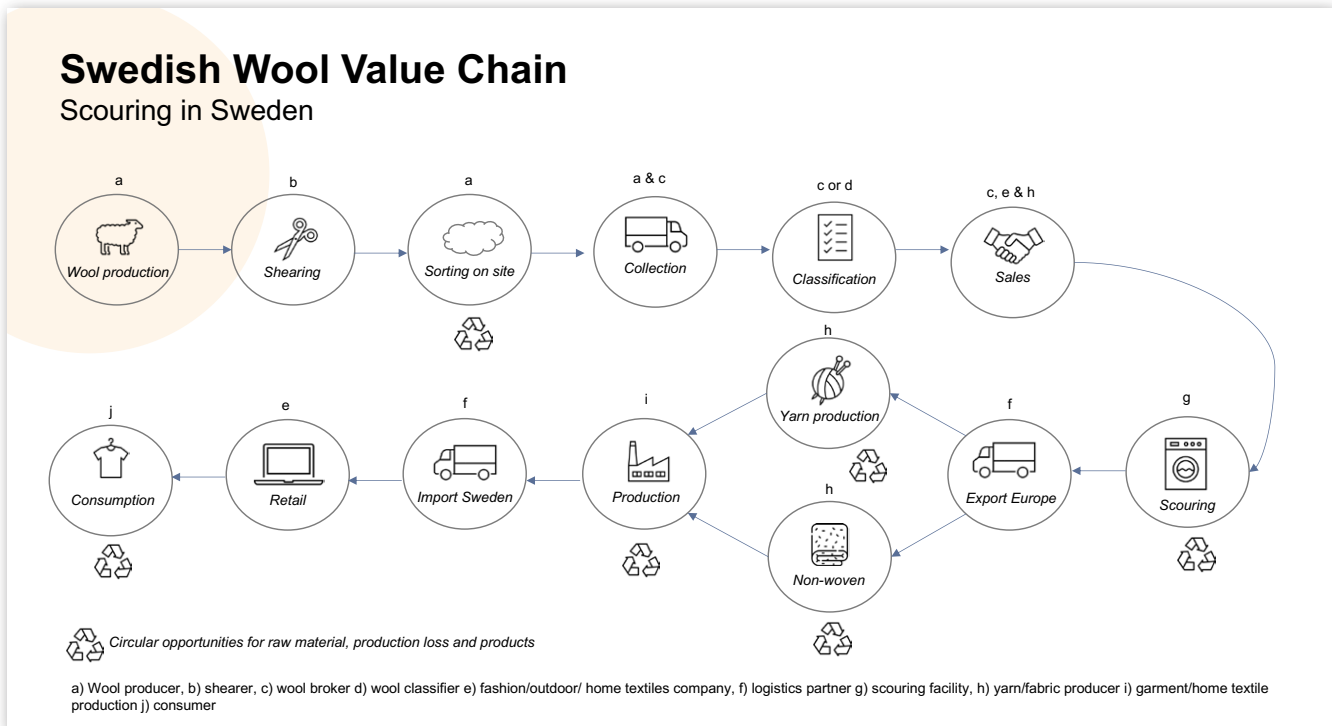


Fig. 1. The value chain for wool with Swedish origin. Sketch: The Swedish Wool Initiative, Axfoundation

## Application Areas for Swedish Wool

Textiles have been made from wool for thousands of years and several different processing techniques have been developed and continue to evolve. In general, wool is suitable for knitting, weaving, as well as nonwoven processes like needle punch and air lay. The unique characteristics of the fibers provide excellent properties for milling (felting). Examples of application areas for wool include interior design, clothing, animal equipment such as horse blankets, and technical textiles like insulation. New applications are being explored constantly. The processing steps from fiber to finished product vary depending on the choice of textile technology. Swedish wool is suitable for most processing methods if you have the right equipment and choose the appropriate type of fiber for your intended product.

Read more about application areas for different wool classes on page 24. [↗](#)



# Filippa K

Filippa K is one of the initiators behind The Swedish Wool Initiative and has been working with Swedish wool since 2018. After learning that the sheep farmers in Sweden lacked ways to put their wool to use, the fashion company decided to start using Swedish wool in their products to increase the traceability of the materials. In order to do so, the company had to piece together a whole new supply chain, says Josephine Norris, Senior Product Developer at Filippa K.

**With your long experience as a frontrunner in the fashion industry, what are the main challenges associated with Swedish wool?**

“We need to set up the infrastructure to be able to collect, sort, classify, and distribute Swedish wool. There are a lot of actors (and experts!) involved at each step, but systems thinking is necessary in order to set things up in an efficient and scalable way. We have come quite far with identifying the key actors and with creating a classification system and soon we will be able to test these on our actual production of outerwear for the next collection.”

**What insights has The Swedish Wool Initiative given you?**

“We have learned that connecting and collaborating with each other in the production chain can produce endless possibilities. Often in this industry, one stakeholder doesn’t talk to the other, but when you start to open up and become transparent, the possibilities are much greater. You find people who have so many different talents and ideas along the way who are happy to share their knowledge to create a stronger outcome.”

**How does Filippa K use circular design principles?**

“Circularity is one of our sustainability pillars and we try to consider it at all stages of the product life cycle. It starts with design, so the purpose and intended lifespan of a garment are considered up front. We’ve held workshops with our design and product development teams to discuss the principles of circular design and to look at specific products that we have collected or been given as a claim from customers in order to see how we can improve our design for longevity and/or reparability going forward. It’s important to talk not only in terms of principles and theory but to be hands on with the products and brainstorm ways to implement circularity together. We also started to give a ‘circularity score’ to our products (based on information from the Ellen MacArthur Foundation) so that our teams can easily see the products that have a need for improvement.”

**From a circularity perspective, what are the biggest advantages of Swedish wool?**

“It is of course biodegradable, but also, it’s such a durable and long-lived material that garments made with wool can be used for a long time and passed on to another person for second and third lives before ultimately being recycled. And with Swedish wool, we also have full traceability back to the farm to ensure that the farming practices are organic and regenerative.”

**What are your best tips and tricks working with Swedish wool?**

“Be patient! We have worked with Swedish wool in many different forms and it doesn’t always go our way the first time. It is worth putting in that extra effort because it is surely possible. Swedish wool is not like other wool fibers that people or machines are used to working with, so sometimes it takes a little extra time to figure out what works best. It is worth the wait!”



PHOTO: VALERIA HERKLOTZ FOR FILIPPA K



# Sustainability Parameters





## How Sustainable is Wool?

Sustainability encompasses environmental, social, and economic dimensions, and these are closely interconnected. A responsible and transparent supply chain, where aspects such as circularity, social conditions, climate, water consumption, wastewater treatment, resource efficiency, chemicals, biodiversity, and animal husbandry are optimized, provides the best conditions for environmental and social sustainability. Collaboration and conscious choices are the way forward. So, how environmentally sustainable is wool, really? As always, the answer is: it depends.

## Climate Impact

Measuring the climate impact of wool is complex due to several factors, some of which include:

- Difficulties in comparing measuring methods and availability of primary data.
- Sheep are ruminants and emit methane gas, which is considered to make a higher contribution to climate impact than carbon dioxide. Over time, methane is broken down into carbon dioxide. However, it is biogenic carbon dioxide, which means that it comes from renewable biomass.
- The climate impact is different if the wool fibers are a by-product of raising sheep for meat consumption or if the purpose is primarily to produce wool.
- Textile processes, especially the wet processes, require energy, so the climate impact of producing the textile is highly dependent on the energy mix.

The climate impact of sheep production should be allocated among the different products it comprises, including meat production, hides, and wool. From a resource efficiency perspective, it is crucial to ensure the proper handling of all wool, irrespective of the purpose of sheep production, since shearing the sheep is necessary at least once a year.

## Biodiversity

According to the World Wildlife Fund (WWF), the biggest threat to biodiversity in the Swedish agricultural landscape is overgrowth and the cessation of grazing and mowing. In Sweden, less than five percent of the natural pasture that existed in the middle of the 19th century is still grazed. The species-rich forest pastures have almost completely disappeared.<sup>4</sup> A minor survey in Region Västra Götaland conducted by the *Knowledge Node for Local Bio-Based-Fiber Raw Materials*<sup>5</sup>, found that keeping landscapes open as well as improved biodiversity were important reasons for keeping sheep, particularly among sheep farmers with smaller herds.

### Did you know...

Conventional farms in general consume more energy than organic ones, mainly due to the production of harvested feed and use of synthetic fertilizers. Wool clothing production requires a significant amount of land for raw materials and energy usage rises during processing and washing. Understanding these impacts on land use and energy consumption can guide the adoption of sustainable practices in sheep, wool, and clothing production.<sup>6</sup>

## Animal Welfare

Particularly noteworthy when it comes to Swedish wool is Sweden's high standards in animal welfare. Sweden ranks at the top of the World Animal Protection Index (API), which ranks countries based on their animal welfare policies and legislation. Sweden's high ranking is attributed to strict legislation and regulations, providing welfare for both animals and farmers. For example, during the summer months, Swedish sheep and lambs graze, while in the winter season, they are kept in stables. In Sweden, the practice of dipping animals in insecticides, which can occur in some other parts of the world, is prohibited. Castration without anesthesia, mulesing, and tail docking are also prohibited in Sweden. Animal protection standards extend also to sheep transport, marking, and health, and sheep must be sheared at least once a year. Last but not least, Sweden has one of the lowest antibiotic usage rates for animals within the EU.<sup>7</sup>

<sup>4</sup> Living Planet Report 2022 - Vägen ut ur naturkrisen, Svensk sammanfattning, WWF Sverige

<sup>5</sup> Coordinated by Science Park Borås, <https://scienceparkboras.se/2022/09/kunskapsnod-for-lokal-biobaserad-fiberravara/>

<sup>6</sup> Sustainability Assessment of Swedish Wool, Emma Moberg, Elvira Molin, Lovisa Källmark and Michael Martin, IVL Swedish Environmental Research Institute and Hushållningssällskapet, ISBN 978-91-7883-498-3, 2023

<sup>7</sup> Sales of veterinary antimicrobial agents in 31 European countries in 2022, Thirteenth ESVAC report, European Medicines Agency, Luxembourg: Publications Office of the European Union, 2023, ISBN 978-92-9155-072-2



PHOTO: SCIENCE PARK BORÁS



PHOTO: SCIENCE PARK BORÁS

# Klippan Yllefabrik

Klippan Yllefabrik is a historical Swedish wool spinning factory founded in 1879. Swedish wool was utilized in production until the late 1940s, thereafter being replaced by imported materials. In the last five years, the company has started to work with Swedish wool again. Gösta Magnusson is Board Chair and Senior Advisor at Klippan Yllefabrik.

**With your long experience working with wool, which are the biggest challenges you have faced?**

“Without a doubt, the biggest challenge is to obtain large enough quantities in the qualities we need.”

**What is the best way to use Swedish wool?**

“The largest amount of Swedish wool is of medium weight and is therefore ideal for many things in home furnishings. Throws and blankets, which are our products, can easily be made from Swedish wool, as well as carpets and upholstery fabrics.”

**What are your general thoughts on the future of Swedish wool?**

“It will be difficult to reach 100% utilization of Swedish wool because not all wool is suitable for further processing, but it should be possible to increase its use from today’s level. Maybe 70-75% is a realistic goal.”

**What insights has The Swedish Wool Initiative given you?**

“It has been very interesting to get deeper insights into sheep breeding and all the steps until the wool is washed and ready for spinning. In the past, it has been more that we have had ready-prepared wool, which was washed, and packed in bales, and we have not thought so much about what was ahead in the process.”

**What are your thoughts on the role of Swedish wool in a circular society?**

“Swedish wool is still considered a by-product of meat production and has largely not been used in the past. Since sheep are primarily raised for their meat, the production of wool does not require any additional resources. Therefore, every kilogram of wool that we can use instead of throwing it away contributes to a more circular society.”

**How does Klippan Yllefabrik work with circularity?**

“While working with Swedish wool, we have also worked with recycled wool and residual streams. We now recycle a large part of our own waste and buy recycled wool. The products we have developed with recycled wool have been very well-received by the market.”



PHOTO: KLIPPANS YLLEFABRIK





# How to Work with Swedish Wool in a Sustainable Circular Way



## From a Linear to a Circular Economy

The term “circular economy” refers to an economic system that uses a systematic approach to maintaining a circular flow of resources by recovering, retaining, or adding to their value, while contributing to sustainable development.<sup>8</sup>

Transitioning to a circular economy is crucial for addressing the challenges of resource depletion, environmental degradation, and waste reduction. Our current linear economic model does not sufficiently address these issues.

## A product’s sustainability and ability to be circulated is dependent on how it is designed from the start and how materials are treated throughout the whole supply chain.

Making physical products always involves the use of resources. Therefore, it is important to trace and use sustainable fibers and materials that contribute to circular cycles, both technical as well as biological. Other important aspects to consider are longevity, quality that enables reuse, remanufacturing, remaking, and service-based business models.<sup>9</sup>

A systems perspective in which business models, design, and material use are tightly intertwined is a prerequisite to a sustainable circular economy. Incorporating both ecodesign and repurposing into the business model is crucial and it’s important to include sustainability and circularity in the overall company strategy.

What is Ecodesign? Learn more on p. 24. [↪](#)

### What is a Circular Economy?

The European Parliament defines circular economy as follows:

The circular economy is a model of production and consumption that involves sharing, leasing, reusing, repairing, refurbishing, and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended.

In practice, it implies reducing waste to a minimum. When a product reaches the end of its life, its materials are kept within the economy wherever possible thanks to recycling. These can be productively used again and again, thereby creating further value.

## Making Circularity Part of Corporate Strategy

Embracing sustainability and circularity as part of your company’s DNA and business model is key to thriving in a changing landscape.

- Define and integrate these core values into your business model and make them the driving force behind your corporate strategy.
- Develop a comprehensive company roadmap for circular materials.
- Take upcoming regulatory and policy changes into account, as well as profitability, possibilities to scale business models, and maintain the highest possible value according to the waste hierarchy.
- Establish clear Key Performance Indicators (KPIs) for circularity and regularly assess and adjust them.

## Transparency and Traceability

Being transparent in one’s sustainability efforts not only contributes to a better world but also builds trust and strong relationships with customers.

Transparency and traceability are essential for identifying the appropriate channels for reuse, remanufacturing, and recycling, while preserving high levels of value.

- Map supply chains all the way to raw materials.
- Establish targets for social conditions, climate impact, water consumption, chemical usage, and wastewater treatment.
- Monitor progress toward established targets and, if needed, implement corrective actions.

<sup>8</sup> SS-EN ISO 5157:2023 Textiles – Environmental aspects – Vocabulary, Edition 1, SIS Svenska institutet för standarder, 2023

<sup>9</sup> Circular Business Toolkit, Science Park Borås, ISBN 978-91-89833-07-4 (print)

<sup>10</sup> Circular economy: definition, importance and benefits, Economy, News European Parliament, Economy, published 24-05-2023 - 11:49

PHOTO: FJÄLLRÄVEN



PHOTO: FJÄLLRÄVEN

*Fjällräven has been incorporating wool into its product range for decades. The very first product crafted using Swedish wool was a backpack, where the entire back panel was made from wool that would have otherwise gone to waste. Fjällräven aims to harness the full potential of Swedish wool, especially when it's underutilized.*



PHOTO: FJÄLLRÄVEN

## Collaborate

The world is just at the outset of the transition toward a circular economy. Numerous new business models, techniques, regulations, and innovative approaches to circularity are currently under development. To emerge as leaders in the future, it is imperative to engage proactively in partnerships aimed at sustainable circular development.

- Establish shared objectives, collaborative planning, and take action in concert with suppliers, customers, researchers, and other stakeholders.
- Ensure access to materials such as yarns, fabrics, and components from reputable suppliers who comprehend your performance criteria and can provide test reports for all components before creating a sample.<sup>11</sup>

It might be the case that spinners require a minimum quantity that is too high for one single brand. The solution to this problem is cooperation between brands where yarn and learning are shared.

### Did you know...

In The Swedish Wool Initiative, Klippan Yllefabrik created a yarn out of wool which from the start was very contaminated with vegetable matter and therefore hard to find a use for. Through a worsted spinning process, the vegetable matter was removed. The yarn was suitable for industrial knitting for several applications. Other Swedish Wool Initiative partners, Filippa K, Fjällräven, and Tiger of Sweden, have developed products from this yarn.

## Share with others – one yarn – multiple products



PHOTO: VASILIOS BARTZIOKAS



PHOTO: VALERIA HERKLOTZ



### Ecodesign for Circularity

It is estimated that over 80% of all product-related environmental impacts are determined during the design phase of a product. Given that, it is crucial to integrate environmental aspects into design and development and to plan for a long life for both the product and the material.

Ecodesign means the integration of environmental aspects into product design and development, with the aim of reducing adverse environmental impacts throughout a product’s life cycle.<sup>12</sup>

Wool maintains its quality and aesthetics over time. The key is to choose wool types and material construction that prioritize durability and functionality, aligning with the intended purpose of the product.

As is the case in other countries, wool from Swedish sheep farming exhibits significant variation, influenced by factors such as breed, age, sex of the sheep, and from which body part the wool is sourced. Besides facilitating trade, the new classification system covered in [The Swedish Wool Standard](#) can simplify the design process when selecting wool for a particular application. Wool from various wool classes is suited for specific applications in nonwoven, knitting, and weaving processes.

Another important factor to consider is the availability of wool. It’s essential to develop the product range based on the type of wool and the quantity that is accessible.

When mixing Swedish wool with other fibers, it’s crucial to assess the potential impact on other processes, such as dyeing, finishing, and recycling.

### Selecting the Right Wool for the Right Application

QUALITY TYPE	NONWOVEN	KNITTING	
		Flat	Circular
A: Fine fiber wool ( $\leq 21 \mu$ )	X	X	X
B: Fine to medium fiber wool (18-23 $\mu$ )	X	X	10gg
C: Medium to coarse fiber wool (22-27 $\mu$ )	X	X	10gg
D: Coarse fiber wool (28-34 $\mu$ )	X	X	
E: Coarse to very coarse fiber wool (30-45 $\mu$ )	(X)	X	
F: Very coarse fiber wool ( $\leq 35 \mu$ )	(X)	(X)	
G: Bulky wool (25-40 $\mu$ )	X	X	

Fig. 2. The table indicates application areas for each class in the Swedish Wool Standard.

<sup>11</sup> Clothing Longevity Protocol, Project code: REC100-008 January 2014, Written by: Tim Cooper, Stella Claxton, Helen Hill, Kate Holbrook, Michelle Hughes, Alistair Knox, Lynn Oxborrow, Nottingham Trent University

<sup>12</sup> SS-EN ISO 5157:2023 Textiles – Environmental aspects – Vocabulary, Edition 1, SIS Svenska institutet för standarder, 2023

Let the material guide you!  
 – take a comprehensive  
 approach to the lifespan of the  
 material and the product.

WEAVING						
Suits	Coats and jackets	Felted	Wraps and blankets	Surface fabric for furniture	Carpets	Stuffing and filling
X	X		X			
(X)	X	X	X	X		
	X	X	X	X	X	
	X	X	X	X	X	
	X		X	X	X	
				X	X	X
		X	X	X	X	X

### Resource Efficiency

Sweden is one of the countries in the world with the largest ecological footprint. If all people on earth were to live as they do in Sweden, approximately four globes would be needed.<sup>13</sup> One of the main circular principles is to design out waste and harmful substances. Working with efficient use of raw materials, energy, water and chemicals has a great potential to reduce both costs and ecological footprint.

One aspect of resource efficiency is how to contribute to circular material cycles by securing how the product, after a long life, should be recycled. Compared to the global average within wool production, mechanically recycled wool shows very good results regarding life cycle assessment according to a study conducted by IVL in 2022.<sup>14</sup> In Sweden, the industrial recycling of textiles is not yet that common, but producer responsibility legislation and intensive research and development will pave the way for increased opportunities for textile recycling.

**Questions to consider:**

- Do we strive for an efficient use of materials in our manufacturing processes without compromising when it comes to basic purpose and function? For example, can we minimize or eliminate waste from production by changing the pattern and/or lay plan?
- Are we using the best available production techniques to reduce energy, water, and chemical consumption?
- How can we work together in the supply chain to optimize resource efficiency?
- How can our company contribute to the restoration of biological systems?
- Resource efficiency requires continuous improvement, with ongoing monitoring and the implementation of corrective actions. Consider setting targets for areas such as material consumption, water usage, wastewater treatment, climate impact, and chemical usage.
- Regularly review production planning and sales to minimize the risk of overproduction. Limited collections can help address the issue of overproduction.
- Explore opportunities for industrial symbiosis, where waste materials are used as raw materials in new processes.

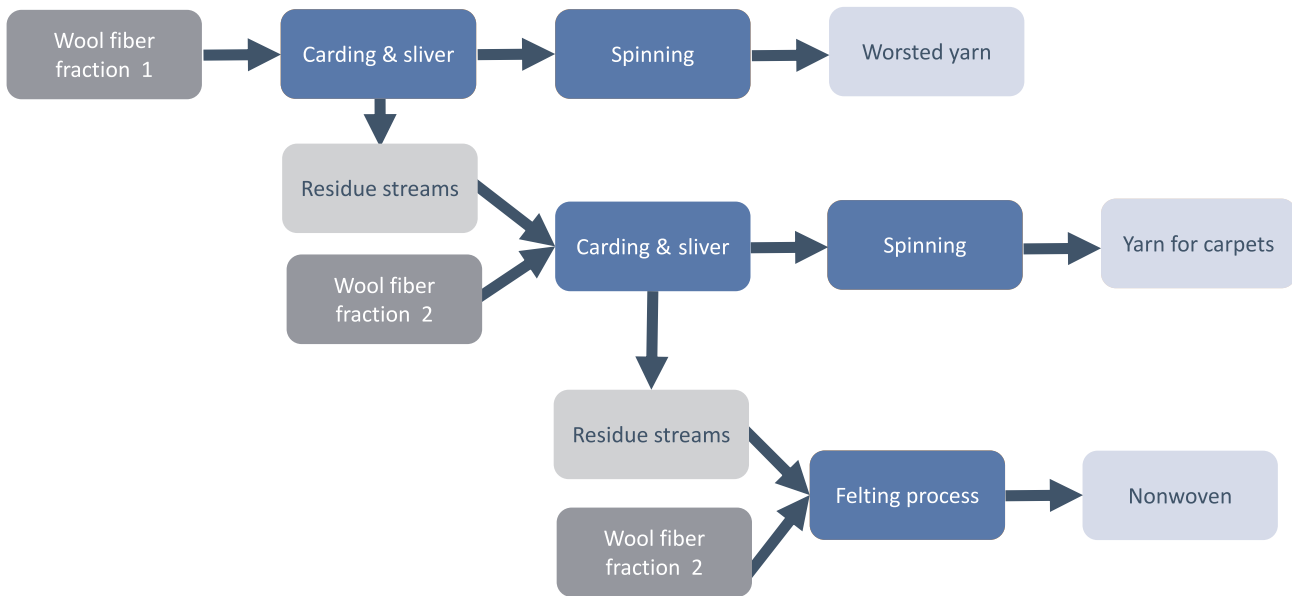


Fig. 3. Example of using residue streams in yarn manufacturing

<sup>13</sup> WWF web site 2023-11-01 <https://www.wwf.se/klimat/ekologiska-fotavtryck/>

<sup>14</sup> Siptex WP5 report: Life cycle assessment of textile recycling products, Report No C718, Matilda Lidfeldt, Maja Nellström, Gustav Sandin Albertsson, Lisa Hallberg, IVL Swedish Environmental Research Institute Ltd, ISBN: 978-91-7883-446-4

PHOTO: VASILIOS BARTZIOKAS



*From the worsted yarn, a fabric for furniture was manufactured, giving an old stool a new surface material. The carpet is made from the residues of the first spinning fraction.*

PHOTO: SCIENCE PARK BORÁS



*Spinning at Wålstedts Ullspinneri*

### Lessons Learned in The Swedish Wool Initiative: Going from Production Waste to Resource

In The Swedish Wool Initiative, partners jointly explored if wool waste from one actor in yarn production could be someone else's resource. The case was built on the fact that different applications require different qualities and yarn thickness. It started with one wool fiber fraction which was spun to a yarn suitable for furniture. The residue streams were blended into another wool fiber fraction and a yarn for carpets was produced. Even in this process, some fibers became separated. Those were blended with a third wool fiber fraction and by needle punching (felting), a fabric was manufactured. The process is described in Figure 3.

## Water

In general, Sweden is considered a low-risk country when it comes to water resources; therefore, Swedish sheep farming typically does not contribute significantly to freshwater stress.

Some steps in wool are, however, highly dependent on water such as scouring, dyeing, bleaching, carbonizing, and wet felting. Depending on wet processes techniques and geographical context, water consumption and wastewater treatment might be a risk factor. In areas with water shortages, it is important that the process water can be treated on-site and reused to save groundwater.

### Questions to consider:

- Is the process necessary and does it justify the final product's environmental cost? What can be done to minimize the environmental impact?
- How can we collaborate across the whole supply chain to optimize water consumption and wastewater treatment?

## Energy

Swedish sheep are housed indoors during the winter season and eat harvested feed during that period. This causes higher energy consumption than in countries where sheep are kept outside all year. Nevertheless, the energy mix in Sweden comes mainly from renewable resources, which makes it difficult to compare carbon footprints between countries.

Energy consumption in the later stages of the wool value chain also need to be considered. For example, most processes in textile manufacturing require heat.

### Questions to consider:

- Which processes in our supply chain consume the most energy and where are they conducted?
- The energy mix is crucial for climate impact. What can be done to improve the energy mix?
- Which processes bring value to the fabric? Can something be excluded without losing aesthetics or function?
- Can waste heat be recovered?
- What can be done to reduce transports and/or make transportation more energy efficient?

## Chemicals

Reducing the use of harmful chemicals at all stages of the wool value chain has a significant impact on the final product's sustainability footprint. For instance, conventional wool farms generally use a higher quantity of chemical pesticides compared to organic farms, as pesticides are prohibited in organic production within the European Union. The majority of pesticide use is typically associated with crop cultivation for concentrate feed, whereas the need for pesticides in Swedish grasslands is low. In addition to on-farm pesticide use for crop production, chemicals may also be used on sheep to prevent insect bites and parasites.<sup>15</sup> It's worth noting that in Sweden, it is forbidden to "dip" sheep in insecticides, while in many other countries, this practice is still allowed.

Regarding textile processing, the use of chemicals is closely tied to water and wastewater treatment. Chemicals are often introduced to eliminate impurities or achieve specific functions such as coloration, anti-felting, wrinkle resistance, flame retardancy, and others.

### Questions to consider:

- What types of treatments are needed to fulfill the purpose and function of the product?
- Which chemicals are used? Could they be substituted with less harmful alternatives?
- Instead of carbonizing to get rid of vegetable matter such as straws, seeds, and similar in the wool, can worsted yarn be an option?
- Could the products emit pollutants, such as harmful substances, during the use phase?
- Do the dyes and functional chemicals hinder material recovery, e.g. recycling?



PHOTO: AXFOUNDATION

<sup>15</sup> Sustainability Assessment of Swedish Wool, Emma Moberg, Elvira Molin, Lovisa Källmark and Michael Martin, IVL Swedish Environmental Research Institute and Hushållningssällskapet, ISBN 978-91-7883-498-3, 2023

### Actions to Keep Products and Material in Use

To maximize the sustainability of textiles, the key is to ensure that products remain in active use for an extended period. Due to the unique qualities of wool, woolen products are often regarded as long-term assets. During the design process, these favorable attributes can be further enhanced by enabling reconditioning or upgrades to extend the product's lifespan.<sup>16</sup>

Additional strategies include introducing new customer offerings that prolong product use, such as through secondhand sales or repair services. It also involves crafting products designed for extended usage, emphasizing quality, function, aesthetics, and emotional value.

Moreover, consider specifying the relevant technical requirements for materials associated with desired functions and ensure they are met, all while providing inspiration and information on how to use the garment in more versatile ways.

For users buying firsthand, offering customization solutions that engage the customer in design decisions can create an emotional connection to the product and thus enhance its longevity in a positive way. Other suggestions to create emotional value include offering upgrades during the user phase or offering exclusive, limited production items.

When it comes to aesthetical aspects, classic products and materials that age with grace and might have neutral colors and simple

prints can prolong the lifespan. Iconic designs where uniqueness makes something so special that it will be interesting to wear for many years could also be a strategy.

The versatility of the product can also be enhanced by ensuring it can function in various contexts and meet different needs. In the case of garments, achieving a good and comfortable fit is one of the most crucial factors for longevity. In addition to the cut, consider ways to make the garment adjustable, which could involve providing greater seam allowances, for instance.

#### Questions to consider:

- Is the product designed to function in various contexts and meet different needs?
- Is it possible to address or design out weak points, for example, by constructing the garment to resist wear and tear?
- How can we design the product to extend its lifespan?
- What services can be offered during the user phase?
- Can the product be upgraded during the user phase?
- How can a resource-efficient user phase be facilitated for the customer?



PHOTO: AXFOUNDATION

<sup>16</sup> Mind the gap(s), Science Park Borås, Kairos Future, Editor Bigitta Losman, June 2023

## Reuse

To extend the product lifespan after the initial product utilization, it is crucial to take the product's entire life cycle into consideration already at the design phase. Ensure that the product incorporates high-quality materials, functionality, and aesthetics to enable reuse within circular systems and to maintain a high resale value. Minor treatments, such as cleaning and refreshing colors and functionality, may still be necessary.

### Questions to consider:

- Do we proactively work to promote the reuse of our products?
- Have we ensured that the product will last for the intended use and that the product's aesthetic condition and function will not be impaired by normal use?
- How can we provide knowledge and inspiration about how to restore the garment's condition and/or function? Is this a service that can be offered to the customer?

## Repair

Repairability, which involves access to spare parts and the ability to disassemble and replace or repair damaged components of the product, extends a product's lifespan. Future upgrades can be enabled through, for example, thoughtful redesign, construction, and component selection.

### Questions to consider:

- Can spare parts be provided?
- Do we use constructions that enable efficient disassembly so critical parts can be replaced when worn out or upgraded?
- Is repair a service we should offer our customers?



PHOTO: ANNA SIGGE

## Repurpose

After an extended period of use and reuse, products can be repurposed to maximize the utilization of the materials. While pure wool is biodegradable and can, under specific conditions, be composted, remaking is an important step within the circular wool system to ensure the most efficient use of the material.

Remake aims to create a new or different version or form of a previously used or unsold product. It also includes replacing a damaged component that cannot be repaired. Consider exploring remaking practices as a method to enhance the quality and appeal of discarded products.

### Questions to consider in the design and redesign phase:

- Do we proactively promote the remanufacturing and recycling of our products that cannot be reused?
- Can the product be disassembled and partially or entirely reassembled into new products?
- Does the construction of the product allow for the easy and efficient disassembly of, for example, zippers and buttons?
- Is modular design or fewer parts an option?
- Could we minimize use of trims such as glued interlining?

## Recycle

Wool recycling has a long-standing tradition, particularly in the Prato region of Italy. The most common method for recycling wool involves mechanically shredding pieces of wool fabrics into fibers. The quality of these recycled wool fibers depends significantly on the construction and design of the original textile product. Some choices that can improve recyclability include using textiles made from a single material or designing products for easy disassembly. Maintaining traceability and transparency throughout the supply chain enables high-value recycling.

### Questions to consider:

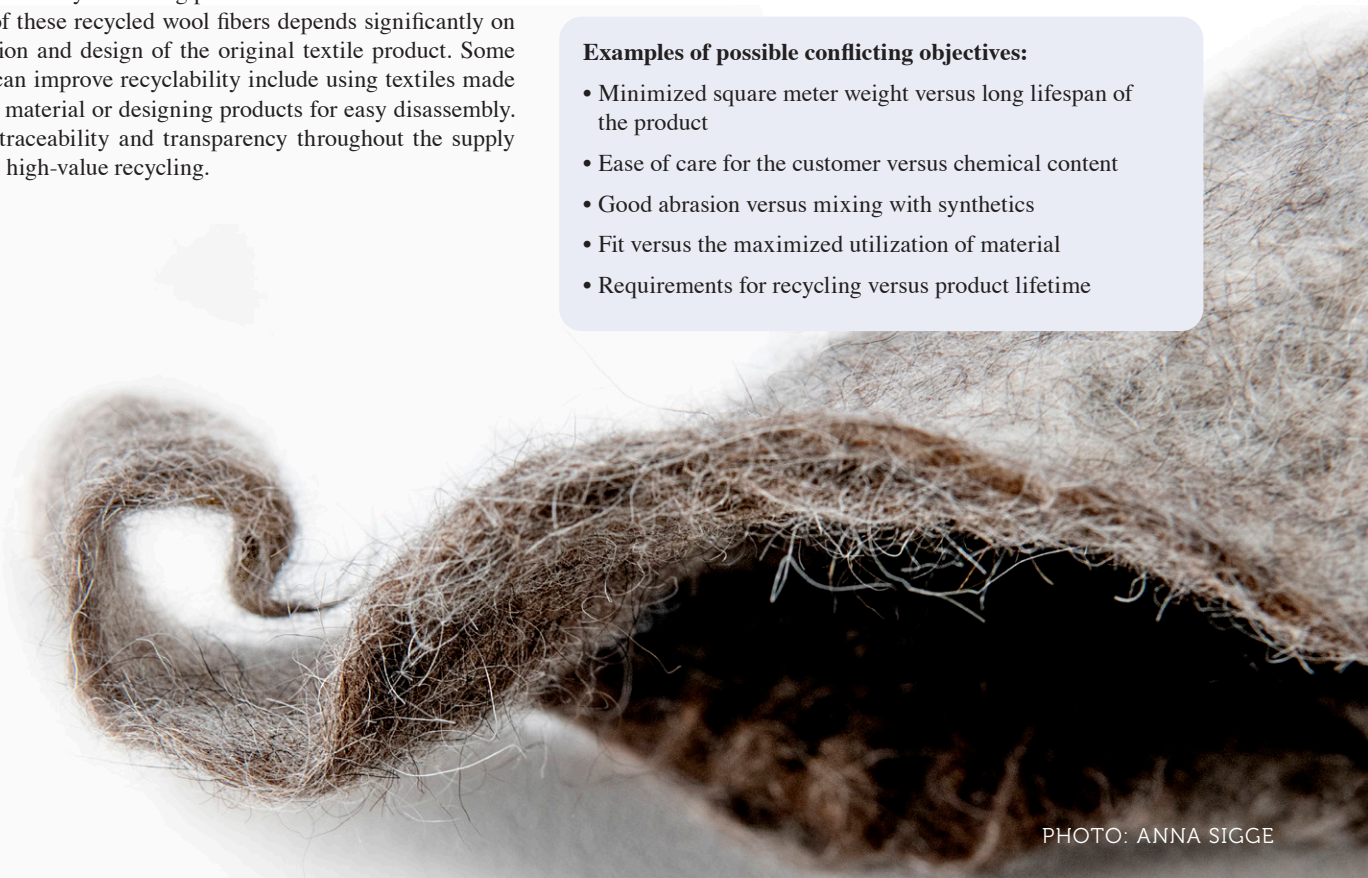
- Have we ensured that any functional chemicals used in the product do not hinder material recycling?
- Is modular design (allowing the separation of the parts that are problematic for recycling) an option?
- Can the product be recycled into a high-value material when it reaches the end of its life and can no longer be reused in any other way?
- Is mixing with other fibers, especially synthetics, necessary?
- How do we facilitate the recovery of valuable materials at the definitive end of the product's service life?
- What technical requirements must the product meet and which assembly technologies can be used?
- Regarding metal parts, zippers, buttons, embroideries in other materials, and interlining – are they easily removable?
- How are the used textiles collected for recycling?
- Industrial waste, such as cuttings, could they be collected and recycled?

## Deal with Conflicting Objectives

Some of the advice provided and questions posed in this guide may appear incompatible. However, achieving a balance between conflicting objectives through wise and knowledge-based decisions from a holistic perspective optimizes circularity and sustainability.

### Examples of possible conflicting objectives:

- Minimized square meter weight versus long lifespan of the product
- Ease of care for the customer versus chemical content
- Good abrasion versus mixing with synthetics
- Fit versus the maximized utilization of material
- Requirements for recycling versus product lifetime



## Visualize the Entire Life Cycle

In the design phase, numerous considerations and decisions are essential to optimize circularity. Creating a visual representation of the product's or material's life cycle can provide an overview and be helpful in identifying relevant questions for a specific case.

When visualizing the life cycle, use as many boxes as you find relevant. Consider embarking on this journey alongside your supplier and/or customer, depending on your position within the supply chain.

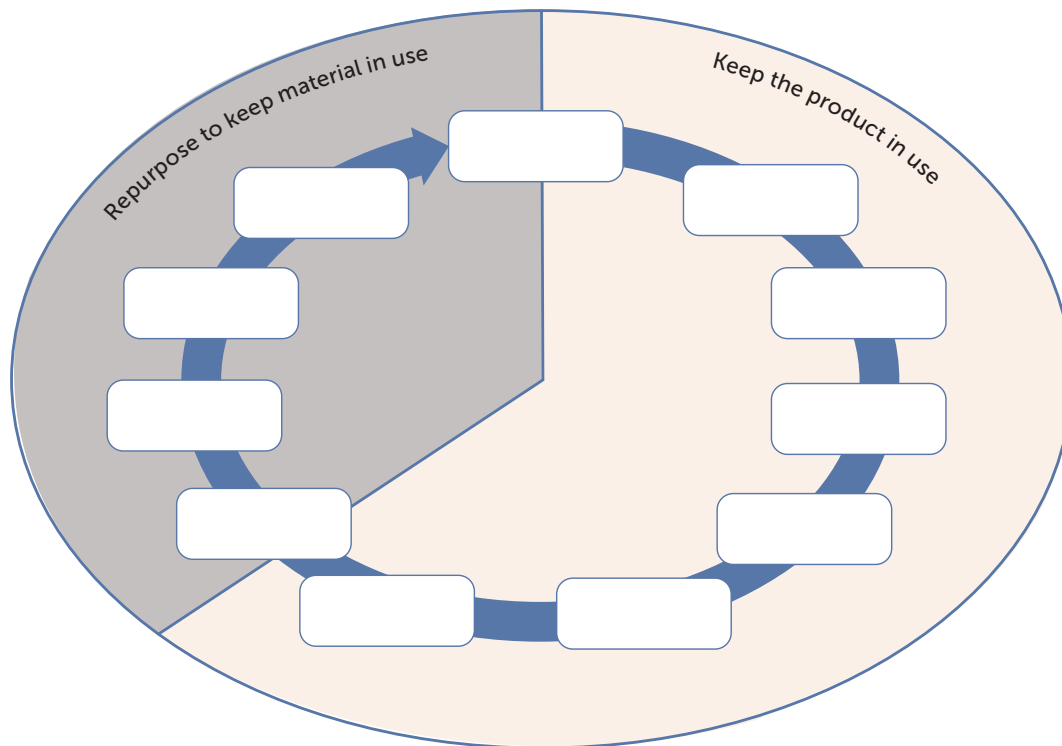


Fig. 4. Visualize the Entire Life Cycle. In this context, the product life cycle refers to the interconnected stages of a product system, from acquiring raw materials or generating them from natural resources to the final disposal.

### Questions to consider regarding the product's purpose and function:

- What is the purpose of the product?
- Who is the customer? What is important to them?
- What properties and details are essential for the product's practical and aesthetic functions?
- What opportunities or limitations does wool pose from a circular perspective?
- What functions does the product serve within the range? Is there already an existing product that fulfills the same functions?
- In what variants (colorways, patterns etc.) is the product offered? Are all the variants necessary, looking at the range as a whole?

### Questions to consider regarding the product's life cycle:

- Describe the product's life cycle: Who is the first customer?
- What is happening during and after the initial user phase?
- How long will the product last?
- How is the product affected by current trends?
- What will it take to ensure a long lifetime for this product?
- Where does the product end its phase as a product and become a material?
- What is happening at the end of the product's life cycle?



PHOTO: AXFOUNDATION



PHOTO: SCIENCE PARK BORÅS

# Tiger of Sweden

Tiger of Sweden has been working with Swedish wool since 2020, with their first products on the market in the fall of 2021. Since then, the fashion company has continued to integrate Swedish wool into their collections. Madeleine Kawasaki is Sustainability and Innovation Manager at Tiger of Sweden.

**What are your general thoughts on the future of Swedish wool?**

“The outlook ahead is highly optimistic, particularly given that brands must enhance transparency by divulging information about their supply chain, aligning with the new EU legislation. Our next step would be to map out a solid process for implementing this fiber across our supply chains.”

**The fashion industry plays an important role in the transition to a circular society. How do you think using Swedish wool could contribute?**

“By utilizing an unused, high-quality fiber, we can capture the value of existing resources and make long-lasting products that can be worn for many years. The enhanced durability will also enable the pieces to be passed on to another owner, extending the garment’s lifespan.”

**From a circularity perspective, what are the biggest advantages with Swedish wool?**

“Firstly, we know that the animals have been treated well under Swedish law, ensuring high animal welfare standards and best practices. Using Swedish wool not only fosters local production but also supports small-scale farming, providing us with precise information about the wool’s origin.”

“Moreover, Swedish wool has demonstrated a capacity for emitting fewer greenhouse gases, in contrast to conventional wool fibers. In order to meet our global emission reduction goals, it’s imperative to ensure that all resources are valued and cared for.”

**Best tips and tricks working with Swedish wool?**

“Tailor the product to align with the qualities of Swedish wool rather than molding the fiber to conform to the product.”



PHOTO: TIGER OF SWEDEN



PHOTO: TIGER OF SWEDEN

# Handle with Love – Care Instructions for Wool



**Wool is a durable material that can last even longer with proper love and care. To further enhance the durability of a textile product made from wool, it's essential to consider care and washing already during the design phase and continue to address it until the product reaches the customer.**

Effective care instructions offer several benefits, including reducing the number of quality claims, extending the consumer's use of the textile product, and reducing its environmental impact. Think of care instructions as a user manual for the textile product, potentially leading to more satisfied customers. Utilize tools such as [Clevercare](#) and [Cleanright](#) to share important information with your customers.

### Careful and Loving Handling of Wool

Wool fiber is relatively easy to care for as it is naturally self-cleaning. This arises from the composition of wool, which creates continuous movement and friction, resulting in a mechanical self-cleaning effect. The keratin in wool breaks down odor-causing bacteria from the skin, effectively neutralizing unpleasant smells.

Below are some pieces of advice and tips to consider. Keep in mind that different types of products may require varying care methods.

- Air wool products after wearing them and wash them only when they are dirty; this extends the product's life and saves energy and resources.
- Use a specialized wool detergent for washing, as it features a neutral pH and is enzyme-free to prevent fiber degradation and weakening.
- Avoid fabric softeners.
- Turn your product inside out before washing to minimize mechanical tears on the surface.
- Use the hand wash program in the machine or utilize the wool care program, set to a maximum of 30°C if no other temperature is specified on the care label. Check the spinning cycle and ensure you select the lowest available setting.
- Hand washing is also suitable, but be careful with the temperature and the soaking time. Additionally, exercise caution with mechanical processing; do not wring it out. Lay the product flat on a towel, away from direct sunlight, to dry it.
- To remove stains, take a look at [Woolmark's Careculator](#).
- Make sure that wool products are clean before storing them.
- Wool fiber is a delicacy for moths and silverfish so storing garments correctly is very important for enjoying them as long as possible. There are many natural moth repellents available to prevent damage.
- Woolen products can be easily repaired through sewing, needle felting, patching, and various other methods, and there are also numerous tips available for extending their lifespan through redesign.

## Further Reading on How to Care for Your Products

Sustainable Fibre Toolkit: [teko.se/hallbarhet/boken-sustainable-fibre-toolkit-pdf](https://teko.se/hallbarhet/boken-sustainable-fibre-toolkit-pdf)

Clevercare: [clevercare.info](https://clevercare.info)

Cleanright Laundry room: [cleanright.eu/en/rooms/laundry-room](https://cleanright.eu/en/rooms/laundry-room)

General care instructions for wool (Woolmark): [woolmark.com/care](https://woolmark.com/care)

General care instructions for wool (IWTO): [iwto.org/sustainability/wool-care](https://iwto.org/sustainability/wool-care)



PHOTO: ANNA SIGGE

# Contacts

## Science Park Borås

Science Park Borås works cross-sectorially across borders to develop future solutions where new technology, new raw materials, and new business models interact and lead to new products and services on the market. We show what is possible; we inspire others to do the unexpected. Science Park Borås offers an innovative environment and meeting place for business and industry, civil society, academia and public actors, which encourages co-creation and challenges established business models and consumption patterns.

With the UN's sustainable development goals as a starting point for change and based on our three areas of Textile, Consumption, and Community Development, we at Science Park Borås want to contribute to a better world by creating and promoting sustainable and innovative solutions to societal challenges.

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## Textile & Fashion 2030

Textile & Fashion 2030 is a neutral arena and enabler of new, sustainable solutions and business opportunities for the textile and fashion industry. We unite the industry's actors and create a dynamic, strong community to reduce the environmental impact on a national and international level. Textile & Fashion 2030 challenges, educates, and offers tools in the transition to a more sustainable textile and fashion industry.

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**Contact:** Anett Aldman, Project Coordinator, [anett.aldman@hb.se](mailto:anett.aldman@hb.se)



## Arena Svensk Ull

Arena Svensk Ull works for increasing the use of Swedish wool and aims to strengthen the Swedish wool supply chain and involve all actors active in the wool industry. From the sheep farmer to the processing of the wool all the way to the finished product with the consumer, Arena Svensk Ull is a gathering point for the exchange of experiences in the development and innovation of Swedish wool. The arena manages the Swedish Wool Standard.

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**ARENA  
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ULL**

## Axfoundation

Axfoundation is an independent, non-profit organization working practically and concretely towards building a sustainable society. Believing strongly in business as a driving force for change, Axfoundation often initiates and runs projects together with both the private sector and academia. Together with over 300 partners across sectors and industries, Axfoundation tackles local and global sustainability challenges based on practical issues related to the things we buy, the food we eat, and the resources we use. The mission is: Act to inspire & Inspire to act.

Axfoundation is the project leader for The Swedish Wool Initiative.

**Website:** [axfoundation.se/en](http://axfoundation.se/en) 

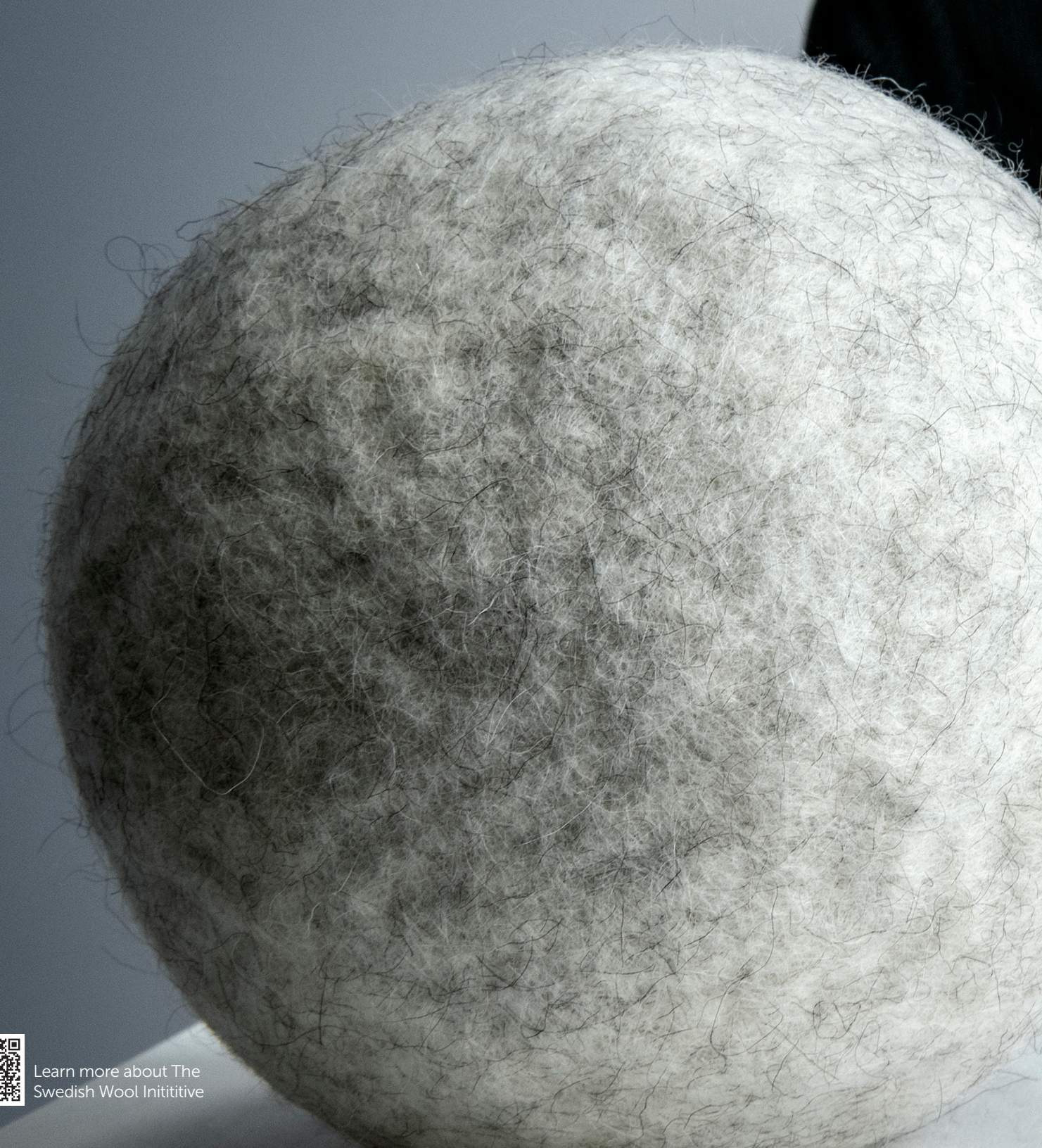
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Learn more about The  
Swedish Wool Initiative