NORDIC FIBRES: LOCAL DIVERSITY AND NEW POSSIBILITIES

Final report on the project NorNa - Nordic Natural Fibres in Circular Economy

NOVIA
UNIVERSITY OF APPLIED SCIENCES

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Contents

1. Introduction: Why natural fibres?

Ulrika Dahlberg

Welcome to the final report of the project NorNa – Nordic Natural Fibres in Circular Economy! Here you can find a description of project activities and our findings on the current situation of the natural fibres sector in the Nordic countries. With natural fibres we mean fibres extracted from plants or sourced from animal hair. We focus mainly on flax, hemp, nettle and sheep wool, because these are possible to produce in the Nordic countries - and are produced in varying quantities.

Why do we want to promote fibres that have been used for thousands of years, when there are modern man-made fibres available? One answer is because natural fibres have unique qualities readily available – no need for extensive chemical processes, in other words. These qualities are, for example, breathability, fire-resistance (for wool), durability, resistance to dirt and microbes, and a beautiful shine. Another reason is that they do not emit microplastics. Third, all these fibres are connected to agriculture, and can in an ideal case support food production and profitability of the whole sector. Including hemp or flax in the crop rotation can improve soil health and structure and increase farm scale diversity. Nettle can be cultivated on plots not suitable for grain production and give an additional income. As it is a perennial plant, the need for tilling and other machine work in the fields decreases compared to annual crops. Wool is generated as a by-product of meat production and using it instead of throwing it away is reasonable from a circular economy perspective. A viable Nordic sheep industry supports biodiversity through grazing, and genetic diversity through preservation of native breeds. When the whole supply chain works, from farm to product, local economies are strengthened. Local economies and Nordic collaboration are especially important in times of global instability.

In addition to that, some fibre crops can be produced on rewetted peatlands, as *Professor Kristiina Lång* from the natural Resources Institute pointed out at NorNa:s seminar in Turku in 2025. Rewetting results in a large reduction in greenhouse gases per hectare (10-30 t CO2e/ha). Some of the crops that thrive in wetlands are Cattail, Peat moss, Common reed, Reed canary grass and Willow. The biomass from the plants can be used, for example, as construction materials or for making paper. This would also lessen the pressure on our forests. Despite digitalization, paper and wood use is still increasing, which endangers forest carbon sinks. Before the 19th century, paper was made from rags and other plant fibres. When humans noticed that wasps process wood into paper, wood pulp quickly outcompeted other materials. There are also many other initiatives to replace fossil materials with bio-based materials, where fibres from agricultural production could play a role instead of forest biomass.

In short, natural fibres are not a simple miracle solution to everything, but developing the supply chain in small steps could help support biodiversity, carbon sequestration, farm profitability, and lessen the environmental impact of the textile industry, which is one of the most unsustainable industries in the world. Textiles made from natural fibres are durable and last for years, compared to fast fashion garments that are only meant to be used a few times. There is also potential for replacing other polluting materials, such as plastic and peat, with natural fibres.

2. The project: What was done and where did it lead?

Ulrika Dahlberg

Purpose of the project

The project NorNa – Nordic Natural Fibres in Circular Economy was executed at Novia University of Applied Sciences, Faculty of Bioeconomy, during the time 1.4.2023-31.3.2026. The funder is Henrik Nysténs fond, within The Swedish Cultural Foundation in Finland. Except for Nordic natural fibres, the name NorNa refers to the Norns from Norse mythology. The Norns are female beings who decide upon everyone's faith. They are often depicted weaving the threads of life.

The purpose of the project was to spread information about natural fibres in different ways. We wanted to look at using natural fibres in a broad range of different industries: textiles, construction, paper and packing materials as well as biocomposites, without forgetting the side streams generated from fibre extraction. They can be developed into e.g. animal bedding or gardening products. Nettle leaves can be used as food, while the stalk is used as a source for fibre, while hemp and flax have nutritious seeds. Also, landrace grains with high straw yield as well as natural grasslands and grazing have been within the project's area of interest. NorNa:s aims were to promote biodiversity in agricultural settings, diversify the farm production and bolster agricultural resilience against adverse weather conditions and rising input costs in the Uusimaa region in Finland.

Events and study visits

The project arranged visits in Finland to flax and hemp producers and natural pastures, the natural building showroom Werstas Petraamo in Helsinki, and to Mustiala research farm to see fields, machinery, laboratory, local gene bank for heritage grains, and a mill and flake press. Trips abroad were also made. The first one was to Germany to visit ICA Bremen, a laboratory analyzing natural fibres, and one of Europe's largest wool logistics centers Bremer Woll Service. A trip to Denmark was also arranged to see one of the largest design and business academies in Scandinavia at VIA University in Herning and to hear about recent developments in the biotextiles sector. The participants were students, farmers or other external stakeholders, or selected experts who travelled together with the project leader.

A brochure presenting natural fibres was created. Photo: Heidi Barman-Geust

Seminars about different aspects of fibres were organized: scouring (washing) and how to get wool from native breeds on the market, about the role of natural fibres in the green transition and in arts and design, and about natural pastures and grazing. We held an online workshop about circular design, in collaboration with Novia's faculty of arts and humanities. We also attended and gave presentations at different events related to agriculture and sustainability, for example Science for Sustainability in Helsinki in 2025, gave a lecture about natural fibres and local economy for students at Novia and led a workshop at the high school Karjaan lukio. A brochure presenting fibres, their properties and areas of use, and a folder with fibre samples was published in Swedish and Finnish. Brochures have been available at events organized by the project and at external events where Novias fibre projects have been presented.

An important collaboration partner for the project has been the Fibershed organization in Finland. Fibershed is a non-profit organization developing regional fiber systems. The network started in the United States, and now there are local organizations around the world. In the Nordic countries Fibershed also exists in Norway and Denmark.

Involvement in Bioeconomy education

Interns from Novia did a valuable input in the project by collecting data from entrepreneurs and sheep farmers. Project work was also offered to groups of students as a part of their courses. Agriculture students (Sandberg, Lindén & Ström 2023) made an investigation about potential areas of use for straw on request of the project. The conclusions were that straw is a very versatile and environmentally friendly material. In many other countries, straw is used more than in Finland, for e.g. tissue paper, disposable cutlery and building materials. One reason why it is not used as extensively here is the forest, which makes up the raw material in many products. For the farmer to receive a fair price for the straw, it becomes quite expensive to buy, and the processed product must generate profit. There is potential to develop sustainable products with straw as raw material, if the

loss of nutrients in the field is accounted for. If a straw harvest of 4 tons per hectare is obtained, the following nutrient losses can be expected: 40 kg potassium, 4 kg phosphorus, 6 kg sulfur and 5 kg magnesium (Jordbruksaktuellt 2006).

One of the most significant experiences concerning education was the involvement in the Open UAS course module "Production and processing of natural fibers" (15 credits) funded with means from the project Pro Bioekonomi 2. 0 in 2022-2023. Although the number of participants was small, the implementation of the module provided many useful insights into how natural fiber courses can be realized in the future, and those who completed the module showed a solid interest in producing natural fibers and developing products. Something that was discussed during the planning process was whether courses should be divided according to different natural fibers or according to different stages in the supply chain. The latter option was chosen, which was good for providing a broad overview, but did not leave room to delve deeper into specific fibres. Focusing on a specific fibre and a few areas of use could be a winning concept in the future, as well as shorter courses that are easier to commit to for people in working life.

Impact

The most important long-term result of the project was the networks created during seminars and travel. Many of these networks resulted in new projects and collaborations. Projects that have been particularly closely connected to NorNa are Novias' nettle project NyNässla – Nettle for fibre and food in Uusimaa, the Nordic-Baltic project F.E.L.T. WOOL – Future Emergence of Local Textiles Based on WOOL, and the fibre flax project Nordic Flax Futures. The networks around wool have become particularly extensive, and new wool projects are planned together with the established contacts, especially in Sweden and Estonia. The focus on grazing brought new funding for Novia from Henrik Nysténs fund for the project AgriBete aimed at integrating grazing animals in crop production, starting in April 2026. Novia also got involved as a partner in the project Sweet Oats - Vitality from Heritage Grains, where also the potential of using oat straw is investigated. In addition to new projects emerging from NorNa collaborations, the project events have brought together farmers, entrepreneurs, artists and designers, researchers and developers, and these contacts live on after the project ends.

Reference group

NorNa had a reference group gathering a couple of times a year to discuss current affairs regarding natural fibres. The group members were:

Ulrika Dahlberg, project leader for NorNa
Marianne Fred, Head of RDI in Bioeconomy, Novia
Lars Fridefors, Lecturer at Novia
Kristiina Lång, Research Professor, Natural Resources Institute Finland (Luke)
Leena Pesu, Entrepreneur, Linen Stories
Samica Sadik, Doctoral researcher, University of Helsinki
Anu Pentti, Wool expert
Rannvi Wallen, Entrepreneur

The reference group gathered at the museum Chappe in Ekenäs, where the project held a seminar about natural fibres in arts and design. From the left Leena Pesu, Marianne Fred, Samica Sadik, Rannvi Wallen, Ulrika Dahlberg and Kristiina Lång. (Photo: Ulrika Dahlberg with help from Chappe personnell).

3. A review of the natural fibres sector in the Nordic countries

Chanika Jayawardana, Samica Sadik, Ulrika Dahlberg

Acknowledgements for assistance in data collection: Ijeoma Omeoga, Martina Schmidt, Enow Lowet, Jean-Baptiste Dri, Maja Wikström

Here the current situation of natural fibres in terms of projects and research in the Nordic countries has been mapped using desktop research, previous studies, a survey and targeted interviews. Information about wool markets has been collected through study visits and discussions with experts and through participating in the NordPlus financed project *F.E.L.T. WOOL – Future Emergence of Texiles based on WOOL:*s trips to Nordic and Baltic countries and an ERASMUS-funded trip to Iceland, complimented with a separate study trip to Denmark. The report does not cover all existing projects or businesses but offers some insights into ongoing activities in the sector.

The survey was created and distributed with the help of project interns and students from the Natural Resource Management master's program. In total, the survey was sent to 54 companies, of which 10 responded. Eight of the responses came from companies in Finland, one from Sweden and one from Denmark. As the number of responses was so small, no statistically significant conclusions

can be drawn. Nevertheless, the responses provide some insight into the current situation for companies working with natural fibres, especially in Finland.

The companies that responded to the survey were founded between 1974 and 2023. Majority of the respondents were smaller, <50 employee companies while one represented larger, 50-250 employee organization. The companies process materials such as hemp, flax, wool, nettle, cattail, reed, reed canary grass, willow, conifer fibre, jute, sisal and paper, as well as cellulose fibres. Four of the companies use domestic raw materials, three use imported raw materials and three use both. The companies produce fibres for spinning, various yarns and cords, knitted woolen clothing, mattresses, interior products and bedding, wool products dyed with willow, bedding for pets and growing media, fibre composite mugs, Ioncell fibre made from cellulose, and hempcrete, a building material made from hemp. One company mentioned side streams, such as short fibres for insulation and shives (chips from flax stalks) for compost, as experimental products. Six of the companies state that their products are intended for textiles and textile filling, two for arts and crafts, two for agriculture and horticulture, one for the construction industry and one manufactures vessels.

For complimentary interviews, a total of ten stakeholders across the Nordic region and Germany were contacted for this study. These included flax and hemp producers, managers of development projects, operators of small-scale fibre cultivations, representatives of national fibre associations, spinning mills, designers, textile companies, international fibre traders, producers of bio-based materials and researchers with practical farming experience. They were based in Finland, Sweden, Denmark, Norway, Iceland and Germany, covering different stages of value chain from raw material production and processing to design, research and distribution.

3.1. Flax

Flax is an important traditional fibre in the Nordic region and is now gaining renewed attention as a sustainable material. This revival is supported by community projects, commercial initiatives and research exploring its potential for both textile and other technical users. While industrial scale production and processing remain limited there is a clear foundation for development across the region.

The *NordGen* project Nordic Flax is preserving the genetic diversity of flax through seed banks, field trials, and fibre characterization. The aim of the project is to evaluate and characterize all NordGen's active core accessions of Nordic flax and find the best accessions for fiber respectively oil production with potential to be used by the fiber-flax growers in the Nordic countries.

In Finland, Linen Stories is a leading effort to rebuild the flax value chain. The initiative works with mainly organic farms to test cultivation methods suited to Nordic conditions and to strengthen local processing expertise. Their mission is to reestablish flax production and processing in Finland while building cooperation networks within the Nordic countries. Lapuan Kankurit, a Masters of Linen™ certified company that demonstrates the commercial potential of high-quality flax-based textiles for both local and global markets.

Flax in a hackle. Photo: Leena Pesu

In Norway, the Norges Linforening (Norwegian Flax Association) promotes flax cultivation through education, hands-on trials, and community engagement projects such as One Square Meter of Flax (1 KVM Lin). Research institutions like NIBIO (Norwegian Institute of Bioeconomy Research) and NORSØK (Norwegian Centre for Organic Agriculture) support fibre crop research, while the University of Bergen explores natural fibres for composite materials.

In Sweden, Holma-Helsinglands AB operates a spinning mill producing flax and linen yarns for textiles and currently imports its flax from other countries due to lack of Swedish production. Although flax is not grown in Sweden today because of climate changes, high labour costs and market changes. However, there is growing interest in restarting Swedish flax production. This interest is reflected in ongoing development-oriented projects and stakeholder discussions. As part of these initiatives, digital tools and software solutions are being explored to improve supply chain coordination, traceability, and quality control. In parallel, the University of Borås studies the potential of flax fibres in textiles and bio-based technical applications as an alternative to fossil-based fibres, for example in the ReFlax project.

Denmark's flax sector is closely linked with research and design innovation including projects at the Royal Danish Academy, which co-operates with other educational institutions involved with plant fibre materials.

The flax sector is also represented at the European level through the Alliance for European Flax-Linen & Hemp, which showcases innovations at events such as JEC World 2025 and connects Nordic stakeholders to the wider European market for bio-based composites.

Helsieni, a Finnish mushroom farming company has tested flax shives in substrate recipes. While hemp shives performed better in water retention, flax shives were functional and contributed to substrate structure. This highlights potential for flax byproducts in agricultural and circular bioeconomy applications beyond textiles.

However, interviews highlighted the sector's main bottleneck such as the absence of modern processing infrastructure, which limits scaling and profitability. Farmers are interested in growing flax

but investments in processing facilities, training in fibre grading and regional supply chain development are essential to move from the small scale and craft based to an industrial sector.

Overall, flax in the Nordic countries is at a promising turning point with opportunities to develop a modern new sector around the traditional material. It proves sustainability advantages and increasing interest from researchers, designers and farmers. With targeted support for infrastructure, education and cross broader collaboration flax has potential to become a key material not only for sustainable textile and new bio-based applications but also construction and composites and eco-friendly interior products.

3.2. Hemp

Hemp is emerging as a promising fibre crop in the Nordic region, driven by research projects, startup businesses and interest in sustainable materials for constructions, textiles and circular economy applications. While the sector remains small and fragmented, it is supported by ongoing innovation, farmer interest and potential for regional collaborations.

In Finland, hemp development is led by projects such as FIBSUN (Novel Fibre Value Chains & Ecosystem Services from Sustainable Feedstocks) which explores new fibre chains for hemp and other alternative crops. Earlier initiatives, such as Hamppueristeet Oy which focused on hemp-based insulation products for construction industry, have ceased operations, highlighting the economic and structural challenges faced by Finnish hemp fibre industry. Hempea Oy produces hemp textiles and home goods for the Finnish and European markets. Helsieni (also mentioned in the flax section) reported that hemp shives are one of the best-performing materials for mushroom substrates because of their excellent water retention (absorbing 5–6 times their weight in water). Hemka Fiber Oy had contracts with Finnish farmers to produce bio-based plastics, construction materials, bedding for animals and textiles from fibre hemp, however the future of the company is currently unclear.

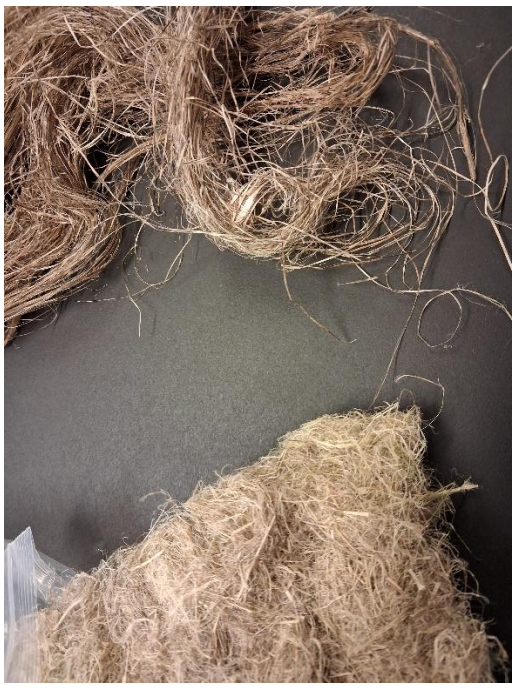
In Sweden, Ekolution shows industrial hemp innovation using hemp fibres to produce materials for constructions, textiles, automotive, acoustics, packaging and pulp industries. Sweden also participates in cross-border projects like Baltic Hemp to Biochar which focuses on converting hemp waste into textiles and biochar focusing circular economy goals.

Norway has limited hemp production due to legal restrictions that have historically constrained cultivations. However, research institutes such as the Norwegian Institute of Bioeconomy Research (NIBIO) and the Norwegian Centre for Organic Agriculture (NORSØK) include hemp in their studies on sustainable agriculture, bioeconomy and plant-based fibre.

In Iceland, hemp development is in its early stages. The Icelandic Hemp Association and Hemp4Future provide a platform for knowledge sharing and annual conferences focused on hemp innovation, industrial applications and policy development. Companies like Geislar cultivate Finola hemp and use hemp residues for livestock feed for sheep. The agricultural University of Iceland conducts field trials and research. Entrepreneurs are exploring opportunities for geothermal powered fibre processing for short seasons. In addition, cultivation trials are underway focusing on perfecting the retting process by testing temperature, acidity and airtight conditions.

In Denmark, hemp is still in the early stages of development but is gaining attention for its durability, strength and potential as a sustainable plant fibre. While past efforts to use hemp in textiles were limited by unreliable supply, high costs and prevalence of short fibres, ongoing research like Hemp4Tex focus on improving local capacity and supply chain reliability with growing interest in hemp's role in circular economy. The project works on the whole supply chain from cultivation,

harvesting, processing, and extraction of hemp fibres to practical production, spinning, weaving, and knitting of fabrics. The project partners are e.g. studying such as how cultivation decisions affect fibre quality and usability, as well as developing methods to pre-treat hemp stalks in a controlled environment.



Hemp fibre. Picture: Ulrika Dahlberg

To unlock the potential, the hemp sector will need dedicated investment for new technologies and infrastructure, clear and supportive legal requirements in countries where cultivation is limited. Practical training for farmers and processors and closer Nordic collaborations also needed to share knowledge and create a strong regional value chain.

3.3. Nettle

Nettle is the least developed natural fibre crop in the Nordic region. Its role is small compared to flax and hemp. Most activity is limited to research, craft and small community-based projects.

In Sweden, the University of Borås and the Swedish School of Textiles are exploring nettle fibre in research contexts. Their work focuses on understanding fibre properties and testing small-scale applications, including experimental use in technical textiles and composites. However, there is no industrial-scale production or commercial supply chain for nettle.

In Denmark, Earth Weavers is one of the few identified initiatives that include nettle. They cultivate and process nettles on a craft scale, focusing on education, traditional hand-processing methods and circular fibre practices.

In Finland, NyNässla project tests commercial cultivation of nettle for both fibre and food. The project aims to develop sustainable farming methods suitable for small scale use and to engage local growers in product innovation. The project has made progress in finding suitable cultivation methods, by following up transplanted wild nettles in a small-scale field experiment, and in mapping European businesses using nettle as raw material. A project by The Natural Resource Institute of Finland (Luke) "ARKNOKK" studied nettle cultivation in northern hemisphere. The project is continued

to "SEEDINET" where nettle seed preparation and germination is studied to enable easier start for nettle cultivation.

Nettles at the NyNässla project site. Photo: Ulrika Dahlberg

Across the Nordic region, nettle faces major challenges. Fibre extraction is labor-intensive and there is no processing infrastructure or established market for nettle fibre. However, nettle could complement other fibre crops in diversified local systems and niche applications. Continued research, pilot projects will be necessary to build knowledge and create future opportunities.

3.4. Wool

In the Nordic countries, sheep are raised primarily for meat production. Simultaneously, a significant amount of sheep wool is generated: both finer and coarser quality, as well as cleaner and dirtier wool, depending on the breeds and other prevailing conditions. Wool production is spread across numerous relatively small farms, making logistics and collection difficult.

In Finland, there is unused capacity in existing spinneries, but much of the wool produced in the country is standing still at sheep farms or at the spinneries because the demand of knitting yarns from Finnish wool is not as high as for example during the pandemic. Product development for other purposes than handicraft yarn is a new possibility. Larger manufacturers of yarn and other woolen products in Finland do not use native wool, although Finnsheep wool is known to be very soft and suitable for next to skin products. There is also potential for developing products from second-class wool not suitable for textiles. Innopelletti Oy is producing chopped, hygienized wool, sourced from local farmers, for gardening use, and recently also wool for window insulation. KIJAKO produces woolen products for pets and Porin Villa ja Peite manufactures blankets and pillows filled with domestic wool from mainly texel sheep, a wool often considered too coarse for garments.

Many sheep farmers experience that logistics for sending wool for processing is expensive, collecting and sorting wool is time consuming and therefore selling wool is not profitable. Some spinneries are

only accepting wool from contracted producers. Except for selling wool to spinneries or selling their own knitting yarns, Finnish sheep farmers use wool for treatment of feet or horses' legs, in gardening or to keep deer away from planted trees. A significant amount is still dug into the ground, composted, burnt or thrown away (Wikström 2025).

Sheep in Raseborg, Finland. Photo: Olga Angove

Norway is one of the few countries that has stations to collect wool. The wool is collected using meeting points, drop-off points or truck transport. The government supports the wool stations and requires that they have staff trained in wool classification. Local spinneries like Selbu Spinneri near Trondheim have played a big role in developing the use of local wool from native breeds, developing custom made yarns for other local businesses. The project F.E.L.T. WOOL – Future Emergence of Local Textiles Based on WOOL, led by Selbu Spinneri (NordPlus) was working to find ways to reduce the volume of wasted wool throughout the entire value chain of wool production, together with partners from Estonia, Finland, Sweden and Lithuania. Felting as a technique was explored from different perspectives during trips to the partner countries. According to Nina Alsborn (2022), who participated in the project, potential from the Nordic past can be realized when using tog (the long, coarse, water-resistant outer coat) and/or thel (the short, soft, fine inner coat that offers insulation and warmth) in products that have their features based on the natural properties of the wool. Both types of fibres can be used, in order not to lose contact with the natural ecological value of the wool. Wet felted textiles, for which spring wool from different Norwegian breeds was used, showed a great variety. The coarser tog plays an important role in durability aspects but so does the way the wool is prepared before felting.

In Denmark, most of the sheep are cross breeds, which makes product development and branding more difficult than in countries with larger amounts of native breeds. There are two wool spinning mills and some remaining knitting factories processing endemic wool but sometimes mixed with e.g. imported merino wool. The raw wool is sent to England for washing and dyeing, since there are no

professional scouring facilities. For example, Skall Studio produces knitwear from Danish wool mixed with merino wool from the Falklands. The brand Guðrun & Guðrun has been one of the most successful in reviving the use of Faroe sheep wool in fashion.

Iceland has succeeded in branding its woolen yarns, which are known all over the world. Except for knitted sweaters, mittens, hats, blankets etc., wool is used in many other products. There are machine-knitted clothes and blankets, and felted decorations. ICEWEAR: s outdoor jackets are filled with Icelandic wool, instead of down or synthetic materials. Most farmers sell their wool to Istex, which is the largest manufacturer of Icelandic yarn in the country. The company processes about 99% of all the wool in the country and Icelandic farmers own more than 80% of the business. This is why, for example, textile artists have trouble finding local wool for their crafts.

Currently, the only industrial scale scouring mills in the Nordics are located on Iceland and Gotland. In mainland Sweden, product development with larger brands using local wool has been established by The Swedish Wool Initiative. Also, a common Swedish Wool Standard has been developed, to make communication and wool business easier. The standard has been successfully used by the European Wool association to classify almost any other European wool than that from the Faroe sheep. Piloting of wool collection and sorting hubs is under development. Scaling up in its second phase, the initiative aims to increase resource efficiency in the Swedish wool value chain and enable the creation of circular products in sectors such as construction, furniture, fashion, outdoor, and home decor. Future areas for wool use that are under development in Sweden are construction materials and materials for the armed forces.

The Nordic Wool Initiative focuses on developing the value chain, from regenerative farming and processing to real use cases for different types of wool. The project builds on insights from e.g. the Norwegian wool collection system and will strengthen the Nordic wool value chain. The project network reaches across Norway, Finland, Sweden and Denmark.

A challenge for future use of wool by businesses in Europe is the environmental labelling on apparel in the European Union the Product Environmental Footprint (PEF), that would rate synthetic fibres made from fossil fuels better for the environment than natural fibres like wool. Wool producers around the world are working to highlight concerns and address the weaknesses of PEF methodology and highlight the environmental benefits of wool.

4. Ways forward

Chanika Jayawardana, Samica Sadik, Ulrika Dahlberg

The Nordic countries share a small, fragmented natural fibre sector with strong sustainability ambitions and local characteristics. There are development opportunities regarding skills, infrastructure and coordination across the value chain throughout the region. Designers and design schools play an important role in driving experimentation, especially in Denmark designers are leads in sustainable design. However, they often struggle to access consistent and quality-controlled fibre. This highlights the need for closer collaboration between farmers, researchers and processors. Legal uncertainty around hemp cultivation and processing in some countries adds risk and slows down investments.

Flax and nettle face different challenges. These crops mainly suffer from the loss of practical know-how in cultivation, retting and fibre grading, as well as from the lack of modern decortication and processing lines.

Climate change is reshaping production of natural fibre crops. It may favor some northern regions, but it also increases weather variability. This reinforces the importance of agronomic research and region-specific best practices. Nordic wool, especially from Iceland and Norway, is well known and appreciated. However, low profitability on sheep farms, lack of scouring facilities and logistics, sorting and grading systems pose challenges for the local wool industry. Overall, projects and research on natural fibres are doing well in the Nordic region, with different focus in different countries.

Plant fibers have a share of around 24% of the global fiber market, cotton taking up the largest share (~19 %), and wool counting for 0,9 % of global fibre production. Synthetic fibres have dominated the market since the mid-1990s. Now their share is 69 %, and polyester, usually derived from fossil petroleum, makes up the largest part (Materials Market Report 2025). Countries like China are dictating the conditions on the market, and Nordic or European countries cannot compete in the same league with them when it comes to mass scale production. Instead, focus has to be on quality, identity, self-sufficiency and collaboration. We need to recognize how small we are globally as natural fibres producers and turn this to a benefit. There is a lot of work to be done, both with producers and consumers, developing supply chains and products, and there are many already working with this. Nordic producers share much in common, and working together within the existing networks and companies the whole sector can benefit and possibly create something unique and new.

Some conclusions on what is needed to move forward on the natural fibres sector in the Nordic countries are:

- Gaining solid knowledge about fibre quality and what quality is suitable for which product. Quality has to be ensured all the way from cultivation of fibre crops (e.g. effects of density) and sheep breeding.
- Making sure all the components of the supply chain are connected and harmonized: a scouring facility for wool cannot function if wool collection and logistics do not exist on the right scale or if the scoured wool is not the right quality for buyers.
- Creating a common language between sellers and buyers of fibre, so the provider knows what the buyer wants, the buyers know what they get, and similar quality can be ensured in the future. See e.g. the Swedish Wool Standard.
- Preserving native sheep breeds by creating local markets for their wool and identifying areas of use for wool from imported sheep breeds (e.g. filling material).
- Stepping out of the puritanic view that there is only one right way to use a fibre. Opening up to mixing different natural materials and trying new things – at the same time taking care not to create “monstruous hybrids”, i.e. products that are impossible to recycle because they consist of too many different materials.
- Changing attitudes when needed: Can other businesses be collaborators instead of competitors?
- Brands utilizing fibres participating in building local infrastructure for production.
- Creating farm scale solutions for processing fibres. This applies especially as long as regional and national logistics systems are missing. Decentralized systems enhance local economies, and small-scale investments are less risky than larger ones. Also, selling further processed materials could be more profitable for farms.
- Focusing on niche products that can only be produced in the Nordic region, instead of trying to compete with bulk from large producer countries with cheaper labor.

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Appendix

Natural fibre survey for businesses

1 : **What year was the business started?***

2 : **The business is currently** : *Closed / Active*

3 : **What year was the business closed, if it is no longer active?**

Please answer rest of the questions according to the situation when the business was active.

4 : **What led to the closure of the business?**

5. How many people are working in the business?* *1-10 / 10-50 / 50-250 / More than 250*

6 : **Which country your business is located in ?** *Finland / Sweden / Norway / Denmark / Iceland*

7. How important is the part related to natural fibres for the business?*

Please click on the scale. 1 means it has low importance and 10 that it is the most important part.

8. What kind of fibres does the company use?*

If you use the by product of fibre processing, please choose the plant of origin.

Wool/ Hemp / Flax / Nettle / Cattail / Common reed (phragmites australis) / Reed canary grass (Phalaris arundinacea) / Straw / Willow / Other

If you chose other, what ?

9 : **How much vegetable raw material does the company acquire annually (approximately, in tonnes)?** *

10 : **Is the raw material produced in your country of origin ?*** *Yes / No / We use both from our country and imported materials*

11 : **If no, or third answer, where are the materials coming from ?**

12 : Please choose the top three most important factors affecting the desicion to buy raw material from a producer or supplier* *Price / Even quality / To get large enough quantities from one supplier / Overall quality of the raw material / Organic production / Domestic Production / Other*

If you chose other, what factor ?

<u>Products and production</u>

13 : Which natural fibres products are sold ?

14 : Which sector are the products intended for ? T*extiles and textile fillings / Construction / Agriculture and gardening / Arts and crafts / other*

If you chose other, which one ?

15 : **The market for the products are** : *Local / National / International*

16 : **What are the biggest challenges in production ?** *Low profitability / High Energy and production costs / Difficulty in getting enough of the right kind of raw materials / Difficulty in finding the right*

machinery / Low interest among producers / Low interest among consumers / Challenges in product development / Other

If you chose other, what ?

17 : **In the coming five years, do you plan to** : Increase production / keep the production on the same level / decrease production

Sustainability and development

In the following section we want to know your opinion about three different statements, on a scale from "Strongly disagree" to "Strongly agree". If you don't have an opinion, please choose "Neutral".

18. Circular economy is important for the business*

E.g. finding use for by products, minimizing amount of waste, circulating nutrients.

Strongly disagree / Disagree / Neutral / Agree / Strongly Agree

19. The business is important for the local economy.*

E.g. creating jobs, enhancing consumption of local products, developing the region.

Strongly disagree / Disagree / Neutral / Agree / Strongly Agree

20. The product/products are intended to replace products made from fossil materials (including peat).*

Strongly disagree / Disagree / Neutral / Agree / Strongly Agree