

Wool innovation action plan to support a circular and sustainable future

Circular Economy Innovation Network

Dr Jo Gosling, Knowledge Transfer Manager - Aquaculture and Livestock
Debbie Tully, Knowledge Transfer Manager - Food



Contents

03	Introduction
04	Aims and Community Vision
05	Circular Economy opportunities - Why Wool?
06	Key Wool Sector Drivers: Environmental
10	Key Wool Sector Drivers: Social and Economic
12	Wool Value Chain & Stakeholder Summary
19	Action Plan
24	References
25	Looking Ahead
26	Contact

Introduction

In the UK most of what we use and consume flows through a take, make, waste linear economy. By contrast, in a Circular Economy, products or their component parts are returned or processed so they can be repaired for reuse, resold, refurbished or remanufactured, or reduced to composite elements for recycling.

A Circular Economy supply chain can help ameliorate the upfront investments made in carbon, energy, water, chemicals, labour and money by designing out waste from the outset. By adopting a Circular Economy framework and building collaborative communities aligned to three key principles: Circular Design, Circular Business Models, and Circular Recovery; we aim to inspire industry members to come together to reduce environmental impact and achieve Net Zero goals through circular innovation.

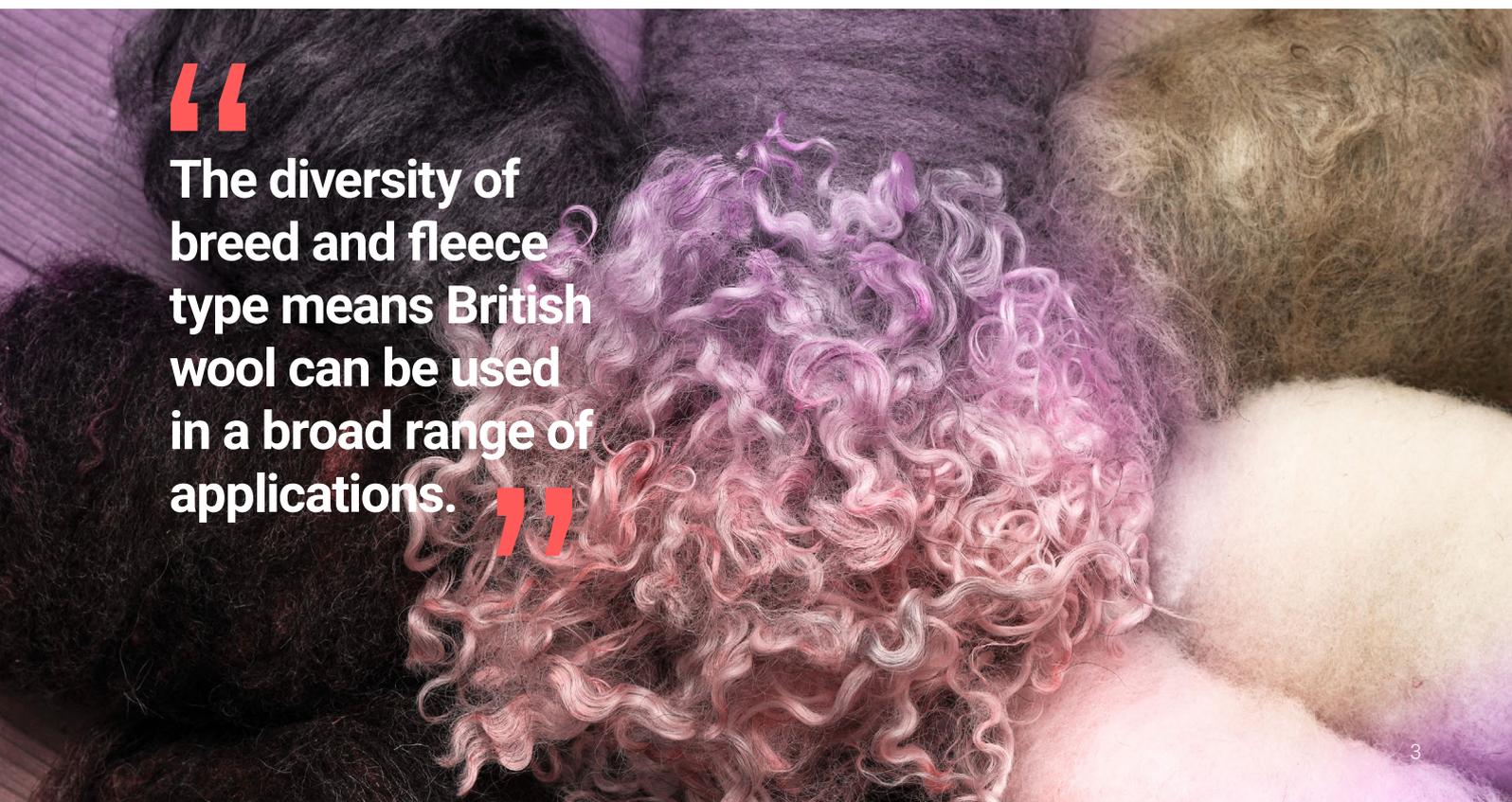
Research shows specialist collaborations produce results that wouldn't be possible when people think and work in isolation, so we are focused on convening Challenge Communities: which will collaborate and consult across the value chain to co-create a Circular Innovation Action Plan for each of the target sectors. Each of these Action Plans will identify the key barriers preventing progress towards Net Zero and highlight how Innovation for a Circular Economy can help overcome these barriers.

Our Wool Innovation Community action plan sets out the aims and vision for this natural, and often undervalued resource, to be appreciated as a smart technical fibre which can be used in many industries to reduce reliance on oil-based products.

This will encourage a shift from linear to circular and sustainable systems in which resources are re-used, by-products are reduced and nutrients are recycled.



The diversity of breed and fleece type means British wool can be used in a broad range of applications.



Aim and Community Vision

Aim

Building collaborative challenge communities focused around Circular Design, Circular Business Models and Circular Recovery.

Developing and implementing a Circular Innovation Action Plan that meets diverse industry needs, is challenge-led, and aligned with national initiatives.

Connecting end-use sectors with innovators and providing collaboration opportunities via the KTN Innovation Exchange Programme (iX) to tackle the challenges presented in the Circular Innovation Action Plan.

Create a Circular Knowledge Hub to share best practice, industry and policy insights and the art of the possible.

Community Vision

Wool to be valued as a smart technical fibre and used in multiple industries to reduce our reliance on oil-based products, encouraging a shift from linear to circular and sustainable systems in which resources are re-used, nutrients recycled, by-products reduced and what remains recycled.



No one has ever produced such a comprehensive report on the current state and misconceptions of the Wool Industry and highlighted the opportunities and innovations that will produce hugely positive outcomes for British sheep farmers.

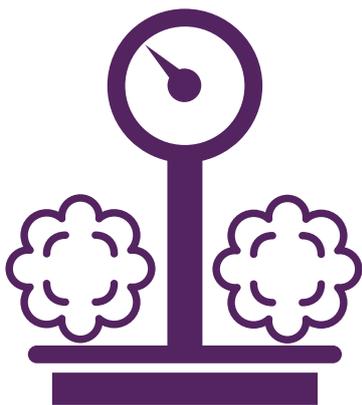
Angela Morris - WoolCool



Circular Economy Opportunities - Why Wool?

Three reasons why wool is well placed to support circular economy development in the UK

- 1 A readily available, largely wasted resource: the 32 million kg of wool produced annually in the UK, as a by-product of the sheep farming industry, is greatly undervalued and under-used as a smart technical fibre in textiles, clothing and many other industries.
- 2 It has circular properties to replace high carbon /non-recyclable /non-recoverable /non-degradable materials. Raw wool is a complex material with unique properties, including: renewable, biodegradable in soil and water, antibacterial, insulating, fire retarding, able to absorb water or oil without feeling wet, fertilising, soil stabilising and aerating. It has high potential to replace non-recyclable or non-recoverable plastics in industries such as packaging, construction, horticulture and agriculture, and is suitable for reuse and recycling.
- 3 It reduces resource and energy use. Pure wool garments can have longer lifespans, resulting in less environmental impact as all of the costs of making it are distributed over time and resources are not used to replace it. Wool textiles often last longer than those of other fibres, due to the garment quality and potentially because of the lower washing frequency. Wool can also be readily recycled and reused if not mixed with synthetic fibres. Wool garments also tend to be line-dried and are washed at lower temperatures (30.3 °C on average, compared to cotton at 41.1°C on average) to maintain optimum quality, requiring far less energy.



32
million

kg of wool
produced
annually in
the UK.



Key Wool Sector Drivers

Environmental

Key Wool Sector Drivers

Life Cycle Assessment (LCA) is a tool to quantitatively identify the environmental impacts of a product, process or service, taking into account the distinct elements of the entire supply chain, including raw material acquisition, processing, manufacturing, recycling and end-of-life disposal. It should evaluate all impacts including energy sources (eg. fossil fuel) land, water, emissions, transportation, period of use, etc.

Understanding the environmental impact is becoming increasingly important to a number of industry stakeholders, including marketing and sales departments responding to customer demands, or complying with regulations and procurement policies. There are also wider strategic considerations, including responsible manufacturing and production that avoids greenwashing and strengthens investor or shareholder relations.

It is important to note that LCA methodology for fibres, particularly wool, is at a relatively early stage, with metrics and procedures not currently considered as scientifically robust. Some wool life cycle assessments consider sections of the supply chain in isolation, or focus on a limited number of impacts, so the true environmental burden isn't holistically or accurately measured.

As a consequence, non-renewable synthetics may score above wool. This can result in wool products being viewed less positively, particularly if individual LCA metrics are the sole ratings used for feedstock decisions. The wool sector and associated industries recognise the need for a standardised, systematic approach to LCA to ensure like-for-like measurement across material types.



“

Wool is biodegradable in soil and water, antibacterial, insulating, fire retarding, fertilising and, soil stabilising.”

Current areas of variation in LCA for wool include:

1. Sheep farming produces multiple products: meat, milk, and skins, as well as wool. Where multiple products share the same process, the particular 'allocation method' used to partition the environmental impacts between products in the same system can produce significantly different LCAs for the same product.
2. LCA results can vary when based on partial life cycle impacts (for example, focusing on the fibre production stage alone).
3. There are few statistics for wool at the consumer use phase, which significantly affects environmental impact evaluation, such as frequency and type of cleaning and drying, period of use and whether the item is recycled or re-used. Evidence is largely anecdotal, not used in LCA, hence the environmental impact is often overestimated.
4. The quality and representativeness of data used in LCA for wool can be poor, often using outdated data with a high level of assumptions. If regionally relevant data are not available for natural fibres such as wool where sheep breeds, farming systems and climate are highly variable across production regions, care is needed in interpreting results and making comparisons.
5. Land use, reported simply as the area of land used to produce a product, is estimated in some LCA studies to rank fibres or textiles. For wool from sheep farms, the area is large relative to other fibres. Although some arable land may be used for feed or supporting farm management, most land for wool production is non-arable and not suitable to support non-ruminant livestock or tree planting operations. Occupation of pastoral land in arid regions or on slopes cannot be compared with use of highly fertile cropping land or land in strategically important locations as a metric for environmental impact. Variances occur, for example, a simple land area approach with lower stocking rates produces a worse rating for land use impact. This is inconsistent with established ecological science which accepts that low intensity grazing is less likely to cause environmental damage through degradation and erosion or biodiversity loss. Case studies have shown that light grazing can improve biodiversity values and pastoralists often provide valuable stewardship of areas where extensive grazing is the only practical and economically viable use. Some LCA studies have used approaches in which land is disaggregated according to its productivity. Reporting arable land (cultivated and non-cultivated permanent grassland) and non-arable land occupation separately can lead to consistent and fair comparisons of production impact.
6. Wool fibres lend themselves well for recycling. Recyclability is one of the key factors for environmentally sustainable products, because the environmental impacts created throughout the supply chain become relative: the longer a material remains in use the lower the impact over time. Re-use and renewal of fibres is absent from most LCA scores which are usually based on laboratory tests and rarely include real time applications.
7. Being a natural fibre, wool readily biodegrades in land and in water, whereas currently harmful microplastic pollution is not accounted for in many LCA processes.
8. It is recognised that for wool garments, greasy wool production on sheep farms contributes in the order of 50% of the total greenhouse gas emissions of wool textile production. The natural digestive process which produces methane enables sheep and other ruminant animals to thrive on grasses that are inedible or provide insufficient nutrition for most animals. The potential for novel wool products to replace commonly used oil-based materials is also likely to change the LCA for the industry.

Current areas of variation in LCA for wool include:

When conducting LCAs using scientifically sound methods and robust data, comparisons between functionally similar products can be made e.g., garments made from different fibres. However, where research has been published, it often relates to local or application-specific situations and lack of updates mean that available data are not representative of current practice. Lack of regionally relevant data means current impact assessments have a high level of uncertainty. Collecting comprehensive or representative data for diverse wool production and processing systems is a major challenge due to its scope and commercial sensitivity. Another challenge is in collecting and analysing data for the wide range of human practices relating to purchase, care, and disposal of clothing. In many cases, there has simply not been an incentive to invest time and money in building and managing datasets for environmental performance assessment.

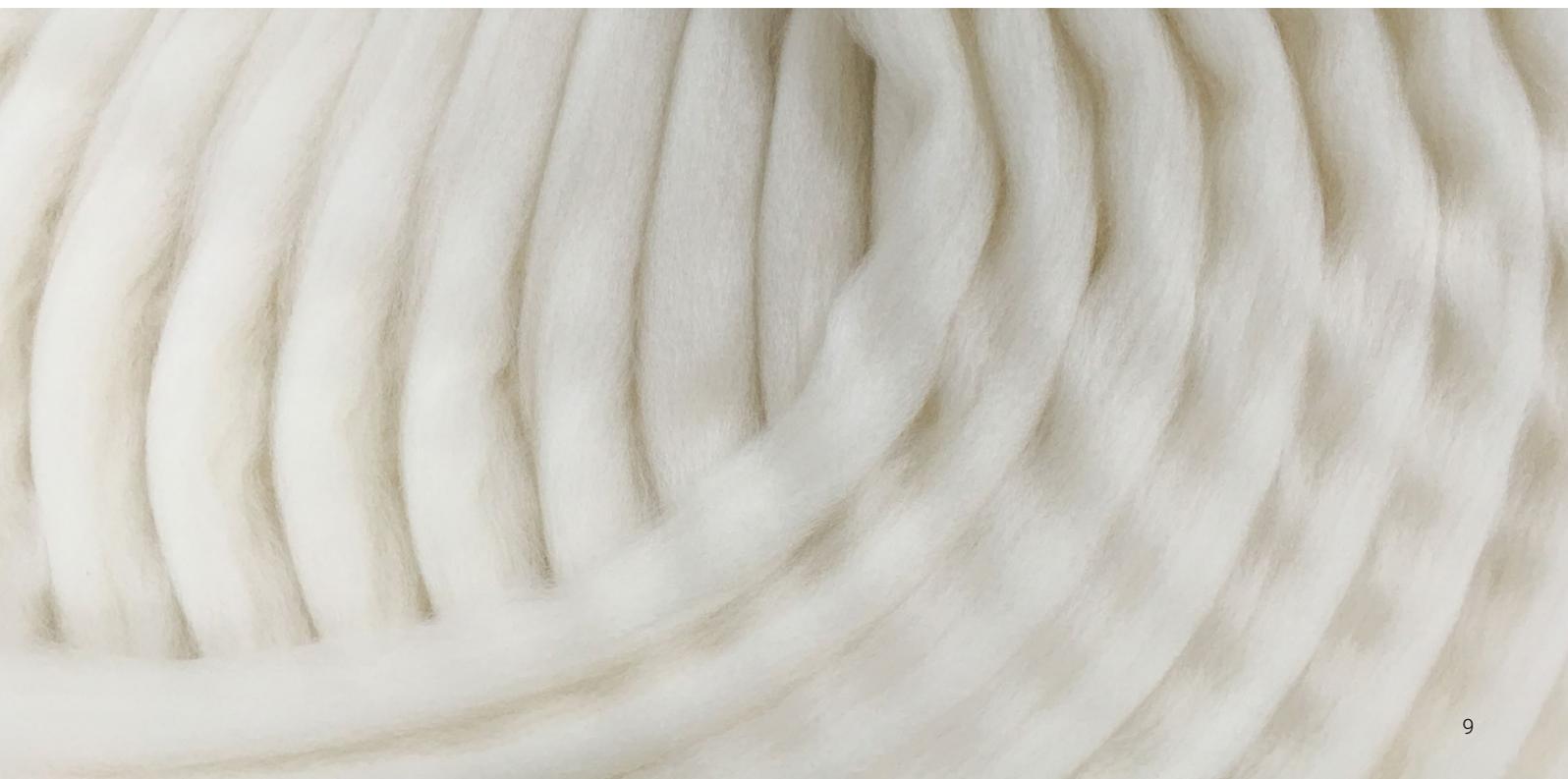
British Wool is working with industry stakeholders and academic partners to deliver an up to date LCA on the British Wool clip and have made significant investments in improvements after 2 years worth of feasibility and pilot projects.



British Wool will be able to offer a national clip with full traceability data back to the farm by 2023.



A robust wool LCA methodology is a priority to help wool growers, processors, spinners, weavers, and all in the value chain, to understand their impacts and make changes which are likely to have positive economic benefits. A trusted LCA will also allow innovative wool products to compete with existing oil-based products in high value markets, informing consumers about their supply chain and the potential for wool to improve environmental performance.



Key Wool Sector Drivers

Social & Economic

Social & Economic

Enabling the wool sector to innovate and be more profitable would deliver social and economic benefits to traditional rural farming communities.

Wool is a by-product of the sheep industry. The sheep sector is a significant employer in the UK and employs 34,000 people on farms and a further 111,405 jobs in allied industries. It is the foundation of rural economies where there are limited alternative employment opportunities. This contributes a huge £291.4m to the UK economy. Historically, many UK towns developed rapidly due to the value of the wool industry. In 2020, there were over 15 million breeding ewes over the winter period in the UK. In 2021, the UK produced just over 32m kg of wool, with net wool exports of 36m kg at a value of \$58m (US dollars), and net imports of 21m kg wool at a cost of \$46m.

There are no major players in the Sheep Farming industry, with no single operator obtaining a market share of above 1%. The industry is comprised of micro-enterprises, small and medium sized farms. Firms within the industry operate on narrow margins, with many farmers relying on Common Agricultural Policy (CAP) subsidies.

Reforms to the CAP, mainly the replacement of Single Farm Payments with the Basic Payment Scheme (BPS), led to lower subsidies for UK sheep farmers at the start of the five years through to 2022-23. Now that the UK has left the EU, the loss of CAP subsidies could substantially increase barriers to entry as direct subsidy payments account for a considerable proportion of a farm's revenue and many farms would operate at a loss without funding. By 2027, the BPS is due to be comprehensively replaced by the Environmental Land Management Scheme (launched 1 January 2023). This new scheme intends to support the



In 2020 UK farmers were receiving just 15-30p per fleece, yet paying more than £1 to have each sheep sheared, meaning farmers lose money on every sheep sheared. ””

rural economy while achieving the goals of the 25-Year Environment Plan and a commitment to Net Zero emissions by 2050, focusing on environmental protection rather than total land size. Hence, larger less sustainable farms will experience the greatest reduction in subsidy payments.

The Covid-19 pandemic has negatively impacted the market and price of wool, in part due to the closure of the global wool markets. Global uncertainty saw wool prices drop around the world by 40-50 % pushing wool prices in UK below viable economic level. To illustrate this, in 2020 UK farmers were receiving just 15-30p per fleece yet paying more than £1 to have the sheep sheared, meaning farmers lose money on every sheep sheared. In more recent years returns for the British wool clip have improved, however, the industry is being pushed to look for innovative ways to increase the resilience of the value chain and encourage a fair price for high quality British wool.

As a valuable industry which is here to stay due to consumer demand for lamb, and the role that sheep play in maintaining rural landscapes, it is necessary to look for opportunities to maximise the profit wool can deliver.

Wool Value Chain & Stakeholder Summary

**Multiple
opportunities for
circular approaches
and innovation
towards Net Zero**

Wool Value Chain & Stakeholder Summary

There are several potential ‘hot spots’ in the wool value-chain at which innovation, including circular approaches, could impact Net Zero goals. These include during production at farm level, at processing and washing (scouring), and innovation around wool-based end products.

The Wool Value and Supply Chain refers to the series of multiple processes and transactions involved in taking wool from the farmer in the greasy state to the supply of products containing wool to consumers.

After shearing, the greasy wool fleece (average weight 2.2kg) is pressed into ‘bales’ (average weight 350kg). Fleeces are either sent to British

Wool (a farmers’ owned cooperative run by elected sheep farmers which handles 75% of the UK wool clip) or it is privately collected by farmers and sold directly to a private buyer. Prior to baling, the British Wool grading system categorises wool based upon both its style and characteristics. In doing so British Wool seek to maximise value for their members by increasing the value of wool to manufacturers with specific requirements. The grade of wool is generally determined by its staple length, crimp, fineness, handle and lustre.

Processing of the greasy wool to get it into a state ready for spinning involves scouring (removing grease and dirt) and topmaking (combing the wool and aligning the fibres). From this point, the stages are similar to other fibres and somewhat dependent on the type of end-use. For wool, these are typically spinning followed by weaving, dyeing and garment making.



“ After shearing, the greasy wool fleece is pressed into ‘bales’, the average weight of a fleece is 2.2kg. ”

Image courtesy of British Wool

Wool Producers/Production



At the producer level there has been a distinct lack of improvement in profitability.

Farmer motivation to drive wool innovation is low given the historic low value of wool, despite shearing being necessary for animal welfare at a net cost to the farmer. Some farmers even utilise 'wool shedding' sheep varieties, which do not need to be sheared – thus reducing wool's competitive position. Farmers will need motivation to take an active interest in selling or seeking to maximise returns, especially for mixed farmers where wool income is only a minor proportion of total farm returns.



Within the majority of flocks in the UK sheep industry, the sale of meat provides the main income stream and wool is a low value by-product. The importance of livestock in providing societies with food, income, employment, and nutrients is widely recognised. However, there is concern about the relationship between livestock and climate change. Innovation within the livestock sector is looking to reduce the environmental emissions from livestock production, for example, grassland management can determine whether extensive livestock systems are a net sink or a source of greenhouse gases. The livestock sector is an industry that will be here to stay for the foreseeable future and, as such, taking opportunities to maximise the value this industry has to offer by increasing resource efficiency and utilising the by-products to combat emissions has significant value.



In Dec 2020/Jan 2021, 70,979 sheep holdings across England, Scotland and Wales were reported by the Animal and Plant Health Agency, a total of ~15,890,276 sheep. The wool from 50% (~35,000) of these holdings is collected through British Wool, which represents 75% of the wool produced in the UK. Collecting wool from many small and medium sized UK businesses poses a significant logistical challenge and is a major source of greenhouse gas (GhG) emissions in the wool industry. Wool is already compressed and compacted as much as possible at British Wool's many intermediate depots across the UK to improve transport efficiency.

Wool Brokers and Private Buyers



British Wool is responsible for collecting, grading, marketing, and selling British fleece wool. Formerly the British Wool Marketing Board, the organisation is owned by approximately 35,000 sheep farmers in the UK. They sell British wool on behalf of UK producers to the international wool textile industry for use in flooring, furnishings, and apparel. Wool that has been through their grading system is quality assured.



Products bearing the Shepherd's Crook and Union Jack logo are British wool rich - a mark consumers can trust. This Licensee's scheme focuses on the traceability of the wool all the way through the supply chain (manufacturers, spinners, top makers, merchants) and provides visibility of the British wool content by product range.



Alternatively, some producers opt to form co-operatives for collecting wool to sell direct to private buyers for quick sale and returns.



A global demand for wool exists. As wool is traded in the global commodity market, producers and British Wool have been significantly challenged in finding customers who specify a demand for wool produced in the UK and are willing to pay a fair price for it. This has impacted margins and the net result is a UK wool supply chain under considerable pressure – not helped by its complexity and high cost compared to other non-natural fibres. The UK's wide range of fleece types across 60 sheep breeds, high welfare standards and British Wool's ability to grade and sort fleeces to specific customer needs is greatly undervalued and underutilised both nationally and internationally.

Wool Auction & Export



Wool auctions are at the British Wool head office, with all wool offered for sale through an online auction platform. British Wool approached various companies who had designed Online Auction Platforms to help them replace an ageing platform for their wool fleece auctions. This 'Online Auction Platform' is a complex technical project the online auction developer team has worked on, providing insight into an auction methodology that is both interesting and exciting. Moving forward, British Wool are using data collected through the platform to continue to innovate.



We need commercial customers that will specify British wool for their products and are prepared to pay for it even if other wool prices globally are cheaper. We want to work with companies and brands that are genuinely committed to 'stand by' British sheep farmers and source wool from them.



Haldi Kranich-Wood – British Wool

Wool Early-Stage Processing/Processors



Early-stage processing refers to the activities that get wool ready for spinning. This involves removal of the dirt, grease, and vegetable matter by either 'scouring' and 'carding' or 'carbonising' and then aligning the fibres into a 'sliver' by 'topmaking'. The sliver of wool top can then be blended with other fibres for spinning.



Scouring involves washing the wool using warm water and detergent to remove the dirt and grease. It is then rinsed and dried and either packed for shipment or moved directly to the carding process.



Carding is a mechanical action that removes vegetable matter (burrs and seeds) and partially aligns the fibres. Wool that is very high in vegetable matter (more than 8% by weight) is carbonised, a process that removes vegetable matter through acid treatment. While this process does not destroy the wool, its performance in manufacture (for example, dyeing) is impacted and value is correspondingly lower.



Wool that is to be used in the manufacture of worsted (woven) fabrics is then combed - removing any remaining vegetable matter and aligning fibres for spinning.



Continuous blending occurs through these processes to ensure an even final product.

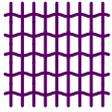


Machinery used for early-stage processing is expensive and specific to wool. Innovation could help to reduce water use, emissions, and chemical use.



There are only 2 major scouring facilities in the UK, both of which do not typically clean small batches due to the economies of scale and size of equipment used.

Wool Late-Stage Processing/Processors



Later stage processing refers to those activities that are not specific to wool and in which wool may well be blended with other fibres. These include spinning, weaving, dyeing and garment making. There are many different companies involved, from those who perform a single operation using only wool to those who are vertically integrated and use many different types of fibres.



Blending wool with other natural fibres or synthetic fibres reduces the ability to separate wool fibres for re-use or recycling at the product end of life.

Wool Use/End-Users



Wool has the potential to replace other more carbon intensive materials. Further work is required to understand its full potential. The diversity of breed and fleece type means British wool can be used in a broad range of applications.



The potential for innovation in the applications of wool is huge and reaches across several different sectors. For example, clothing/textile manufacture, packaging, insulation/building materials, compost, lanolin use in cosmetics, water management for filtration/oil spills, flood defences, peatland restoration and as a growing substrate.



The range of innovative wool uses exemplifies the potential for innovation, but to date we have only 'scratched the surface'. By bringing together the wool industry with new potential end-users from a range of industry sectors, there are multiple opportunities that will enable new circular economy approaches to be implemented.

“

Wool has high potential to replace non-recyclable or non-recoverable plastics in applications such as packaging, construction, horticulture and agriculture, and is itself suitable for reuse and recycling.

”

The Action Plan

Identifying and addressing grand challenges and innovation priorities

The Action Plan

From April to December 2022, this action plan has been developed, validated and prioritised with 30 core sector experts and presented to over 300 stakeholders across the supply chain.

The development of the Wool Action Plan has been overseen by the Circular Economy Innovation Network (CEIN) Steering Committee, which includes representatives from: Business in the Community, Defra, Department of Business Energy & Industrial Strategy,

Economic & Social Research Council, Ellen McArthur Foundation, Engineering and Physical Sciences Research Council, Exeter University NICER Programme, Innovate UK, Invest Northern Ireland, Welsh Government and Zero Waste Scotland.

Three grand challenges have been identified for the network to address in the long term, with medium to long term innovation priorities listed below for each challenge. The suggested actions for the community are outlined in further detail in the later 'Actions to address Grand Challenges' section.

3 Grand Challenges & Innovation Priorities:

Challenge 1	Challenge 2	Challenge 3
<p>Low technological innovation within the supply chain to support circularity.</p> <p>Innovation Priorities:</p> <ul style="list-style-type: none"> • Innovation to recycle or reduce heat, water, and chemical use during processing. • Technologies which enable wider use or increased value of low grade and coarse wool (via processing or breeding). • Novel methods of recycling wool waste resulting from textile/clothing production. 	<p>Identify needs to adapt processing and/or grading to meet standards for wider scale uses of wool in other sectors. Wool innovators unable to access new markets.</p> <p>Innovation Priorities:</p> <ul style="list-style-type: none"> • Development of new markets with high potential to bring economic value to the farmer (construction, packaging, horticulture, agriculture & land management). • Novel uses of wool to replace non-recyclable/non-recoverable materials & plastics. • Verify and demonstrate wool properties for novel uses. • Map the supply chain needs for new markets. 	<p>Need for improved traceability and LCA data to demonstrate the circular economy credentials of wool products to end users.</p> <p>Innovation Priorities:</p> <ul style="list-style-type: none"> • Support needed for knowledge exchange on existing ongoing innovation projects to improve and standardise traceability. • Collaboration needed to agree standardisation of LCA methods for the wool industry and wool product landscape. • Need for fair comparison of wool's sustainability credentials against other products.

Important issues identified:



There is no national strategy for the future of sheep farming, making it difficult to predict wool supply and sheep numbers in the next 5-10 years.



Low consumer awareness of the sustainable properties and uses of wool and a lack of knowledge around country or origin are major challenges and barriers to growth. A step change in consumer understanding and social behaviour and increasing demand for locally sourced wool would greatly impact sector progress.



Funding is needed for mapping and landscaping of the wool supply chain to address the fragmented nature of the UK wool industry and highlight key opportunities for resource efficiency and circularity.



The wool sector and associated industries recognise the need for a standardised, systematic approach to LCA to ensure like for like measurement across material types.



Actions to help address the 3 Grand Challenges

Actions	Suggested Ownership	Timeline for delivery
<p>Support Wool Project Development & Innovation</p> <p>Support members of the Wool Community in using funding products/resources (including those at Innovate UK and Innovate UK KTN) to develop collaborations and innovative projects which address the Wool Grand Challenges 1-3 outlined above.</p>	<p>Innovate UK Cross Sector Teams</p> <p>Wool and Sheep Industry Representatives</p> <p>RTOs/Academia</p>	<p>Medium to Long Term</p> <p>1-5 years +</p>
<p>Develop ‘Learning Journeys’ and Networking Opportunities for the Wool Community</p> <p>Create a series of activities and resources for members of the Wool Community to encourage communication, capacity building and collaboration across the supply chain with increased awareness of expertise and existing projects. These events will help to map out the supply chain, discuss/disseminate what work is being done with regards to LCA and traceability, and what innovation is ongoing in terms of developing wider uses.</p>	<p>Wool and Sheep Industry Representatives</p> <p>Innovate UK KTN</p>	<p>Short Term</p> <p>1-2 years</p>
<p>Showcase Wool as a Smart Technical Fibre</p> <p>An outward facing series of resources and case studies, using shared data to showcase wool as a Smart Technical Fibre. The aim of this activity is to encourage wider cross-sector collaboration and raise a broad cross-sector awareness of the circular potential of wool products, novel wool uses and existing wool innovation.</p>	<p>Government & Regulatory Bodies</p> <p>Wool and Sheep Industry Leaders</p>	<p>Short Term</p> <p>1-2 years</p>



Actions to help address the 3 Grand Challenges

Actions	Suggested Ownership	Timeline for delivery
<p>Support the Development of Circular Wool Fashion</p> <p>Focus on community development and discussion around circular design, circular models and circular recovery of wool fibres within the fashion and apparel industry - a primary high value market for British wool.</p>	<p>Innovate UK KTN Cross-Sector Teams</p> <p>Wool and Fashion Retailers</p>	<p>Long Term</p> <p>1-5 years</p>
<p>Mapping and Landscaping of the Wool Supply Chain</p> <p>This activity involves building on and sharing existing regional supply chain mapping data to address the fragmented nature of the UK wool industry and highlight key opportunities for resource efficiency, co-location and circularity.</p>	<p>Wool Supply Chain Regional Wool Industry</p> <p>Representatives</p> <p>RTOs/Academia</p>	<p>Long Term</p> <p>5 years+</p>
<p>Development of a National Sheep Strategy and Policies to Support Wool Use and Re-use</p> <p>To support wool innovation - there is a need for a National Sheep Strategy to steer the future of sheep farming, and allow stakeholders to predict both wool supply and sheep numbers over the next 5-10 years. A policy and regulatory framework is needed which supports a just Life Cycle Analysis for wool, which recognises the carbon capture and sequestration opportunity of wool products, appropriately reflecting the environmental credentials of wool.</p>	<p>Government</p> <p>Policy Makers</p> <p>Regulators</p>	<p>Long Term</p> <p>5 years+</p>



References

1. FAO (2015) Greenhouse Gas Emissions and Fossil Energy Demand from Small Ruminant Supply Chains: Guidelines for quantification, Version 1. Livestock Environmental Assessment and Performance Partnership. FAO, Rome, Italy.
2. IBISWorld (2022) Sheep Farming in the UK industry trends (2017-2022).
3. International Wool Textile Organisation (2022) Fact Sheets
(Various accessed via website 2022: <https://iwto.org/resources/fact-sheets/>).
4. Laitala K and Klepp IG (2016) "Wool Wash: Technical Performance and Consumer Habits"
Tenside Surfactants Detergents, vol. 53, no. 5, 2016, pp. 458-469. <https://doi.org/10.3139/113.110457>.
5. LEAP (2015) Principles for the Assessment of Livestock Impacts on Biodiversity. Draft for Public Review.
Livestock Environmental Assessment and Performance Partnership. FAO, Rome, Italy.
(Website access: <http://www.fao.org/3/a-i6492e.pdf>).
6. Periolatto, M and Gozzelino, G. (2015) Greasy Raw Wool for Clean-up Process of Marine Oil Spill:
from Laboratory Test to Scaled Prototype. Chemical Engineering Transactions. 43. 2269. 10.3303/CET1543379.
7. Russell SJ, Swan P, Trebowicz M and Ireland A (2015) Review of wool recycling and reuse.
Proceedings of 2nd International Conference on Natural Fibres. Portugal 2015.
8. Statista (2022) Wool industry in the United Kingdom (UK).
9. Wiedemann S, Ledgard S, Henry BK, Yan M, Mao N and Russell SJ (2015)
Application of life cycle assessment to sheep production systems: Investigating co-production of wool
and meat using case studies from major global producers. Int J LCA 20: 463-476.
10. Wiedemann SG, Yan M-J, Henry BK and Murphy CM (2016) Resource use and greenhouse gas emissions
from three wool production regions in Australia. Journal of Cleaner Production 122: 121-132.
11. WRAP (2012) Valuing Our Clothes, the true cost of UK fashion retail.
12. WRAP (2017) Valuing our clothes: The Cost of UK Fashion.

Looking ahead

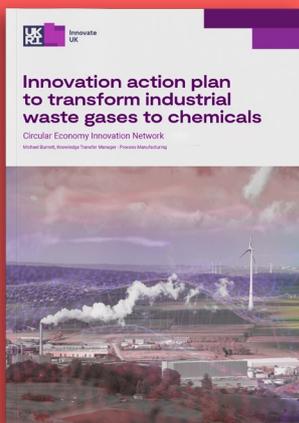
Wool Action Plan: Next Steps

As the population increases, so does our demand on energy systems, raw materials and supply chains. By supporting the development of new wool markets and innovative wool products through strategic cross-sector engagement and knowledge exchange, this action plan offers a pathway to optimise resource use within the British wool industry. Wool is a readily available natural, smart fibre which has the potential to reduce our reliance on non-renewable, non-recyclable and oil-based materials across a number of applications. The Innovate UK KTN Circular Economy Innovation Network will continue to champion the move towards a circular future for the wool sector and the delivery of this action plan by the Wool Community.

Join the Innovate UK KTN Circular Economy Innovation Network

The Circular Economy Innovation Network is open to all organisations across the UK, from large companies, SMEs and start-ups, to academics and researchers. Be part of our collaborative communities working towards: Circular Design, Circular Business Models, and Circular Recovery. Together we can enable more resilient industries, inspire innovative businesses to create value through circular economy principles, and involve talented people to create vibrant and successful ecosystems, for a positive impact on the UK's economy, environment, and society.

[Find out more](#)



You can find all our industry reports, future thinking, events and information at our website.

[Read more](#)

Connecting for
Positive Change.



This is an independent paper reflecting the views of the Circular Economy Innovation Network team at Innovate UK KTN. This programme aims to enable more resilient industries to work together, connect, collaborate, and share experiences to achieve Net Zero through circular innovation.

Authored in February 2023 by:

Dr Jo Gosling, Knowledge Transfer Manager - Aquaculture and Livestock
Debbie Tully, Knowledge Transfer Manager - Food

Contributors:

Lucy Mather, Knowledge Transfer Manager - Livestock & Aquaculture
Jenni McDonnell MBE, Knowledge Transfer Manager - Thermal Energy Systems
Dr Stephen Morris, Knowledge Transfer Manager - Smart Materials and Technical Textiles
Rachel Beach, Knowledge Transfer Manager - Digital Economy & Creative Industries
Mike Moseley, Knowledge Transfer Manager - Construction
Elle Runtou, Knowledge Transfer Manager - Net Zero

Head Office

KTN
Suite 218 Business Design Centre
52 Upper Street
Islington
London N1 0QH

Telephone: 03333 403251
Email: enquiries@iuk.ktn-uk.org
Website: iuk.ktn-uk.org