

Wool: a sustainable solution



The Woolmark Company

The Woolmark Company is the global authority on wool. Through its extensive network of relationships spanning the international textile and fashion industries, the company highlights Australian wool's position as the world's premium, sustainable fibre that is optimal for circular, traceable products.

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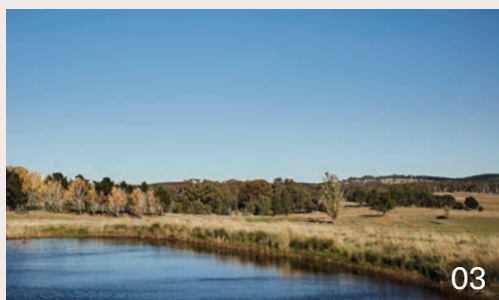
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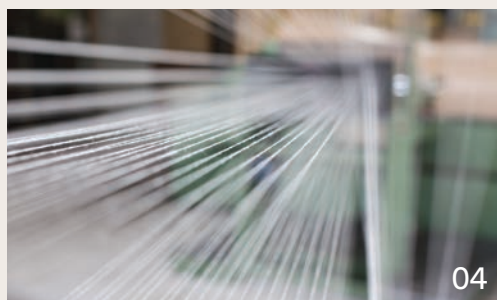
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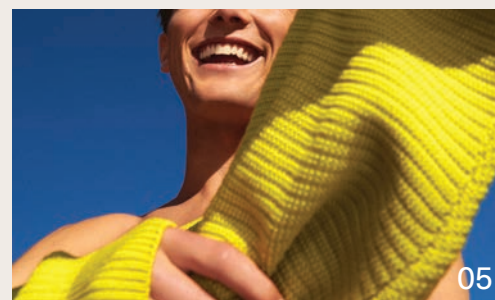
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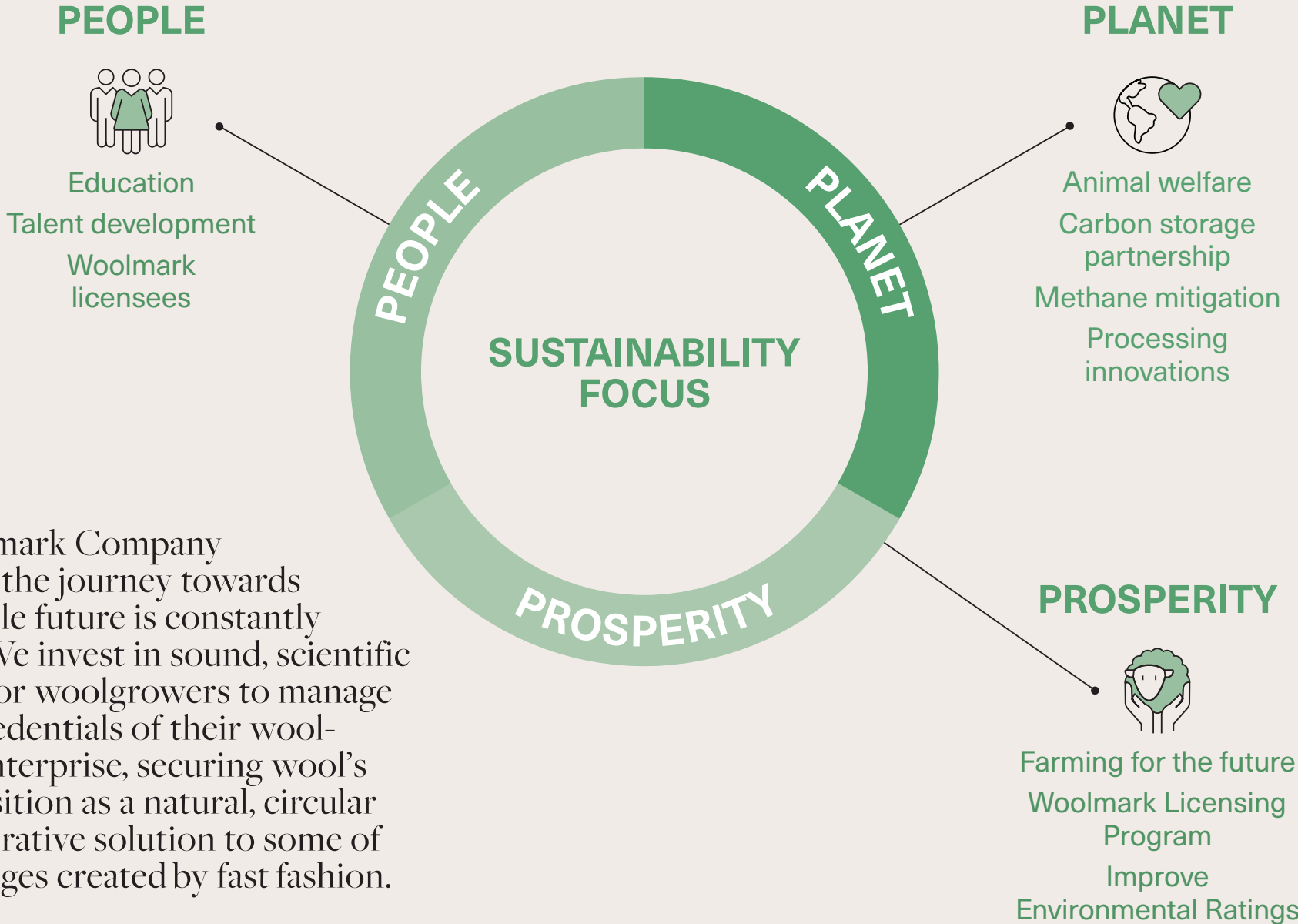


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Introduction



The Woolmark Company recognises the journey towards a sustainable future is constantly evolving. We invest in sound, scientific solutions for woolgrowers to manage the eco-credentials of their wool-growing enterprise, securing wool's market position as a natural, circular and regenerative solution to some of the challenges created by fast fashion.

Sustainable development and the textiles industry



Sustainable development and the textiles industry

“Sustainability can be defined as the goal of living within our natural, social and economic means, and sustainable development is how we get there.”

– UNESCO

While the term ‘sustainability’ generally relates to a long-term goal, ‘sustainable development’ refers to the route and behaviours required to achieve that goal. The concept of ‘sustainability’ is the common space between planet, people and prosperity. People cannot thrive without a healthy planet, and with prosperity lies the ability to invest in developing a more sustainable future.

For designers, brands and manufacturers looking for sustainable material solutions, wool is a natural, technical and circular fibre that can be easily integrated into sustainable material strategies.



FAST FACTS

Europe leads sustainable development

Europe is the global leader in sustainable development and around 30% of Australian wool is estimated as being consumed in the EU and UK.

Global shift to sustainable development

There are numerous pressures for the textile and fashion industry to shift to a more sustainable system.

These pressures are demanding that brands and manufacturers rethink their materials strategies and choose fibres that are less impactful on the environment. Australian wool is inherently circular and provides a solution for sustainable textile development.



Consumer purchase intent

Consumer demand

Consumers are becoming educated on the detrimental impacts of fast fashion. 9 in 10 Gen Z¹ consumers believe companies have a responsibility to address environmental and social issues, building on Millennials' demand for greener products.

Wool's solution

Australian wool has a strong environmental story to tell. Not only is the fibre natural, renewable and biodegradable, Australian woolgrowers are proving that growing wool can sequester carbon, increase biodiversity and strengthen climate resilience. These initiatives meet the demands of the conscious consumer.



Environmental impact

Pollution

The fashion industry is the second largest industrial polluter accounting for up to 10% of global pollution including over 92 million tonnes of waste produced per year and 1.5 trillion litres of water consumed, alongside chemical pollution and high levels of CO₂ emissions.²

Over consumption

The world now consumes about 80 billion new pieces of clothing every year. This is 400% more than the amount we consumed just two decades ago.³

Wool's solution

Wool is 100% biodegradable so does not contribute to microplastic pollution in terrestrial or marine environments. This has been proven by scientific research.

Wool is 100% renewable, grown on farms with a small pollution footprint.

Wool is a quality natural fibre, valued for its longevity, natural and performance benefits and durability. This means that wool commands a higher price which reduces its contribution to the fast fashion industry.



Legislation and regulation

Legislation and regulation

The European Union (EU) has targeted the textiles industry as one of several priority sectors to enable Europe to achieve a climate neutral, circular economy by 2050. The EU has developed several strategies in this regard, including the European Green Deal, Circular Economy Action Plan, the Sustainable Product Policy framework, and the Industrial Strategy, and is currently working on the EU Strategy for Sustainable Textiles.

Wool's solution

The wool industry is unique amongst other fibre types in having a commercially profitable closed-loop recycling industry in operation for more than 200 years. As a renewable, reusable, recyclable and biodegradable fibre, it is an excellent fit with the EU's strategies for circular products including the Circular Economy Action Plan and the Extended Producer Responsibility initiative.

1. The State of Fashion 2019, BOF, McKinsey & Company

2. Niinimäki, K., Peters, G., Dahlbo, H. et al. The environmental price of fast fashion. *Nat Rev Earth Environ* 1, 189–200 (2020).

3. Bick, R., Halsey, E. & Ekenga, C.C. The global environmental injustice of fast fashion. *Environ Health* 17, 92 (2018).

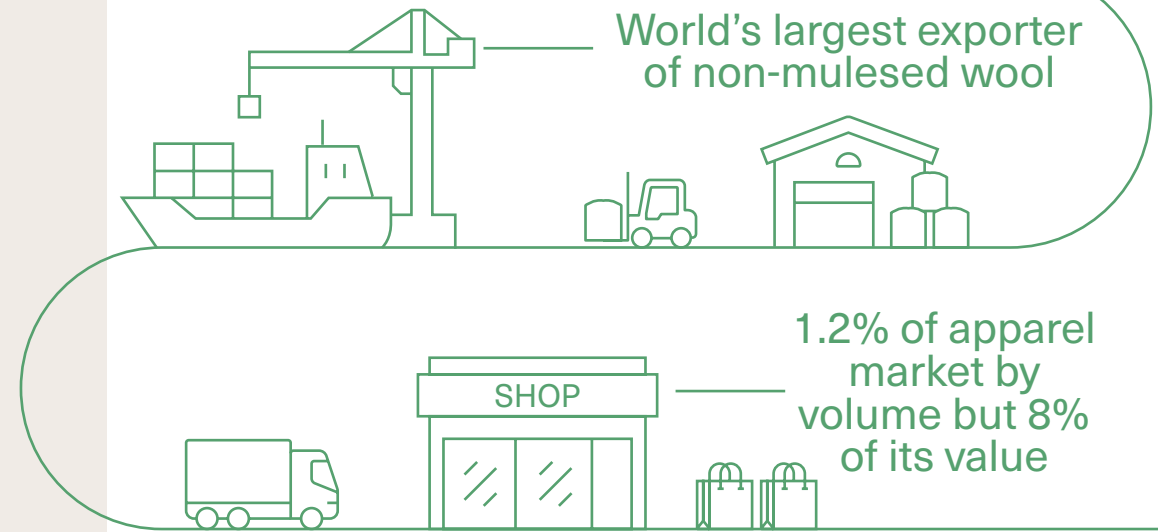
Wool's unique attributes



A unique fibre

Wool is a 100% natural, renewable and biodegradable fibre and commonly refers to those fibres produced by sheep. However, not all wool is the same. There are more than 1,000 breeds of sheep across the world which produce different types of wool, used for various purposes.

Australian Merino wool is much more complex than any of the synthetic fibres and most other natural fibres. It is this complexity that provides wool with the unique set of benefits which cannot be matched by any other fibre – natural or man-made. A relatively new type of wool known for its superior softness, Australian Merino wool is eagerly sought by the world's textile trade.



World's most reused and recycled fibre of the major apparel fibres

Properties of Merino wool

A natural fibre



100% natural and renewable

Wool is a natural protein fibre that is grown by domesticated sheep that produce a new fleece every year.



100% biodegradable

When a wool product reaches its end-of-life and is disposed of, the wool fibre readily decomposes in soil, slowly releasing valuable nutrients and carbon back into the earth, acting like a fertiliser. Wool does not contribute to microplastic pollution in our oceans or land.



Breathable and non-allergenic

An active fibre, Merino wool is thermoregulatory, keeping you cool when it's hot and warm when it's cool.



Super soft

Merino wool is finer than human hair, can be softer than cashmere and gentle on even the most sensitive skin.



Naturally circular

Wool, by nature a circular fibre, can help brands enter more easily into the development of circular products.



The most reused and recycled fibre

The wool industry has had a long, successful and commercially profitable recycling system for the past 200 years. Wool is the most reused and recyclable apparel fibre of the world's major apparel fibres and is valued for its many closed and open loop recycling applications. Although wool only makes up 1.2% of the virgin fibre supply, surveys have shown it represents about 5% of clothing donated to charity.⁴

vs

Synthetic fibres



Petroleum based

Petroleum-based fibres are a type of synthetic fibre that is made from petroleum extracted from the earth through mining. Petroleum fibres include polyester, acrylic, nylon, spandex and acetate.



Microplastic pollution

35% of all primary source microplastics in the marine environment are fibres from use of synthetic clothing.³



Require more washing

Garments made from man-made fibres require more water and energy use per wear, mainly due to the increased laundering frequency needed to address body odour retention.⁶



Non-biodegradable

A non-biodegradable materia, such as synthetic fibres, cannot decompose or degrade through biological processes and becomes a source of pollution.



Landfill and incineration

The majority of man-made fibre waste is either put into landfill or incinerated, emitting new carbon to the atmosphere that had been safely stored under the earth for millions of years.








Non-renewable

Man-made fibres are made from finite resources extracted through mining that cannot be renewed.

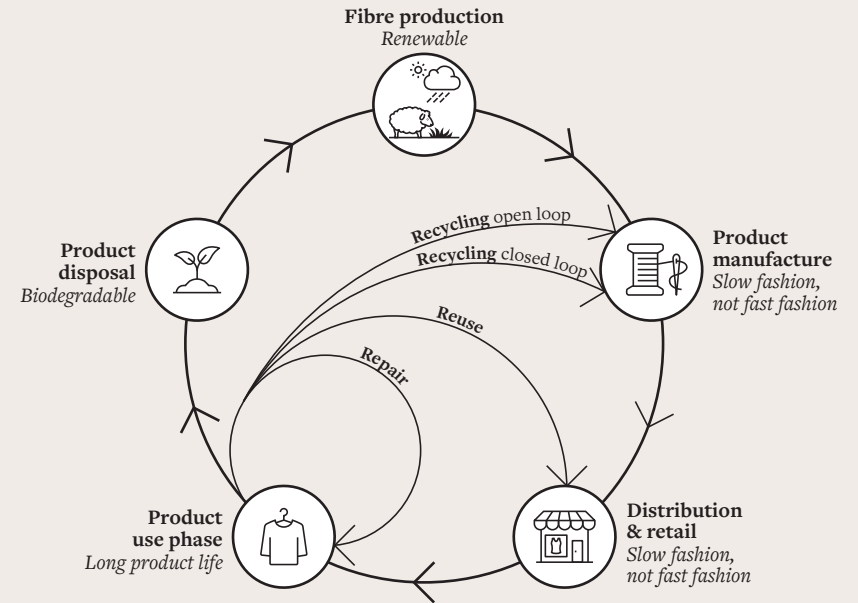
4. Y. Chang, H. I. Chen, and S. Francis, Market Applications for Recycled Postconsumer Fibres Family and Consumer Science 1999, 27(3); p. 220. 16. G. D. Ward, A. D. Hewitt, and S. J. Russell, Proceedings of the ICE, Waste and Resource Management 2013, 166(1); p. 29-37. PCI Wood Mackenzie, Red Book 2016 – Long term global study / Demand uptake.

Wool and circularity

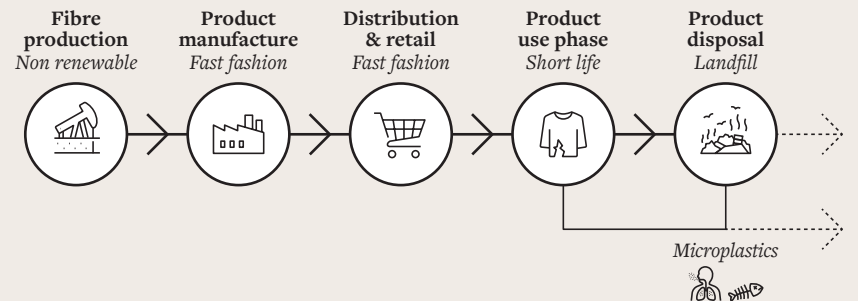
Circular and sustainable design integrates transparency from the beginning; where a garment has a meaningful positive impact throughout its entire lifecycle. Here's why wool is, by nature, a circular fibre.

Aim	Wool properties	Facts
 Use renewable resources	Wool is a renewable fibre with annual regrowth cycles.	Wool is a protein fibre <u>and made of 50% carbon.</u>
 Regenerate natural systems	Growing wool can regenerate natural systems and help build soil carbon. Sheep typically live on land not used for growing food crops, and woolgrowers maintain biodiversity.	89% of Australian woolgrowers use practices to encourage soil health. ⁶
 Remove pollution	Wool does not contribute to microplastic pollution. Garment construction, dyeing and finishing innovations reduce pollution.	A single polyester fleece garment can produce more than 1900 fibres per wash. ⁷
 Keep materials and products in use for a long time	Of the major apparel fibres, wool is the most reusable and recyclable fibre on the planet with high heritage and secondhand value. Less laundering is needed.	<u>The average lifetime of wool garments is more than 50% longer than cotton garments.</u> Wool's donation rate is 5%, which far exceeds wool's 1.2% share of virgin fibre supply.
 Make fit for technical &/or biological cycles	Wool is highly valued in closed and open-loop recycling systems.	Wool is 100% <u>biodegradable, releasing valuable nutrients back into soil.</u>

Wool fits into a **sustainable circular model** of textile production that minimises waste and pollution



Synthetic fibres are more aligned with an **unsustainable linear model** of textile production with waste and pollution



6. Wool Industry Profile, May 2020, Intuitive Solutions prepared for AWL.
 7. Browne, M.A., Crump, P., Niven, S.J., Teuten, E., Tonkin, A., Galloway, T., Thompson, R., 2011. Accumulation of microplastic on shorelines worldwide: sources and sinks. Environ. Sci. Technol. 45, 9175-9179

The social, animal and environmental impact of wool-growing



Wool grown across the world can vary from small to large free-range farms in different environments, leading to differences in production. Regardless of location and size, adopting sustainable management practices helps woolgrowers achieve key Sustainable Development Goals relating to their animals, their natural resources (e.g., soil, water and plants), their businesses and their communities. The following key areas detail the environmental and social impacts of wool-growing, on animals, people and planet.

Social impacts and rural livelihoods

1 Supporting rural livelihoods

Many remote, rural and regional communities continue to be supported by Australian wool-growing, with more than 60,000 Australian woolgrowers and many tens of thousands more working in the industry. No other country has such an efficient, transparent and highly developed wool marketing system; a trained and registered workforce of more than 16,000 wool classers who prepare wool for the world's processors; and objective laboratory test results attached to almost every bale of Merino wool exported.

2 Education

Research and education have been fundamental to the Australian wool industry since the 1930s. The industry provides numerous training, education and scholarship opportunities for Australian woolgrowers. These programs include environmental management, business management and practical animal husbandry courses, leadership scholarships as well as secondary and tertiary education programs for rural and remote students. The industry also provides free training for novice, improver and advanced shearers and wool handlers through regional coaching programs across Australia. Since 2015, we have facilitated more than 11,000 shearer and wool handler training days, delivered through The Woolmark Company-funded programs.



Animal health and welfare



1 Nutrition

Sheep need a balanced diet containing energy (fat and carbohydrates), protein, vitamins, minerals and water and gain these nutrients predominantly by grazing pastures. Woolgrowers supplement their sheep's diet – depending on life stage or season – when necessary to ensure optimal nutrition.

2 Chemical use

Veterinary-registered medication may be administered to sheep for the treatment of external and internal parasites as either a spray or oral application. Minimum withholding periods are specified for wool to avoid coming into contact with these chemicals. In Australia, the Australian Wool Testing Authority independently tests wool for chemical residue.

3 Flystrike

Flystrike is a potentially fatal welfare condition where blowflies lay eggs in soiled or wet wool, most commonly around the breech (the area around the tail). After hatching, the blowfly maggots bury themselves in and under the sheep's wool and skin, feeding off their flesh and causing blood poisoning. This is excruciatingly painful for the sheep and can be fatal if left untreated. Flystrike can be controlled by a range of animal husbandry practices, including regular shearing of wool around the breech (known as crutching), mulesing, breeding sheep to be less susceptible to flystrike and best-practice management of grazing and insecticides.

4 Mulesing

Australia is now the largest exporter of non-mulesed Merino (<24.5 micron) wool. However, the mulesing procedure is still necessary for some Merino sheep. Mulesing is a one-off surgical procedure to protect sheep from breech flystrike, removing excess skin from the breech of the sheep. More than 85% of woolgrowers who mules report they use anaesthesia and/or analgesia.

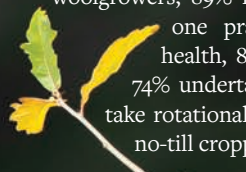
5 Shearing

A key responsibility in caring for healthy and happy sheep involves harvesting their fleece. Shearing is necessary for the health of sheep and if it's not done, the fleece can become overgrown and impact the animals. Shearing is the process of removing the fleece, which is just like getting a haircut as the wool grows right back. It's for this reason that wool is truly renewable and is one of the fibre's many natural benefits.

Environmental health

Regenerative agriculture

Regenerative agriculture is a holistic land management approach that works with the natural systems to foster the health of the soil as the basis of the whole farm ecosystem. The term is relatively new to the fashion industry, however, woolgrowers in Australia have been practicing regenerative agriculture for decades. In a 2020⁶ survey of Australian woolgrowers, 89% reported using more than one practice to encourage soil health, 83% preserve groundcover, 74% undertake soil tests, 72% undertake rotational grazing and 65% practice no-till cropping.



Biodiversity

Australia has some of the world's most unique flora and fauna, which is highly vulnerable to introduced species, and all agricultural industries have a part to play in remedying biodiversity loss. For wool-growing businesses, supporting and protecting biodiversity is essential to maintain a functioning ecosystem and animal health. This can involve protecting their sheep along with vulnerable and endangered native species from non-native predators and grazers, through to regenerating the land. Many woolgrowers in Australia are involved in landscape scale conservation and regeneration efforts with community organisations such as Landcare and Greening Australia.

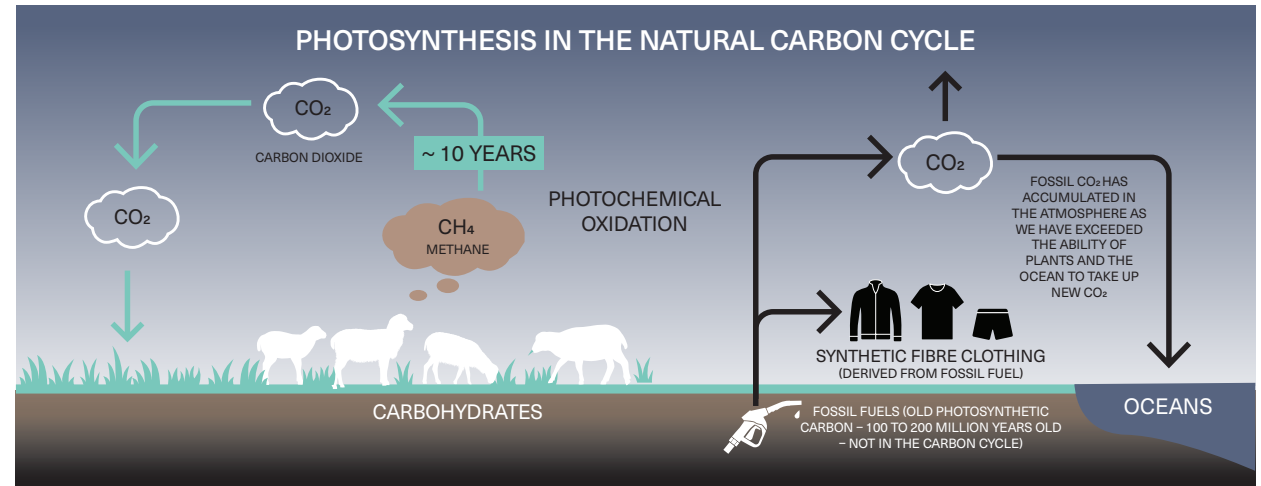
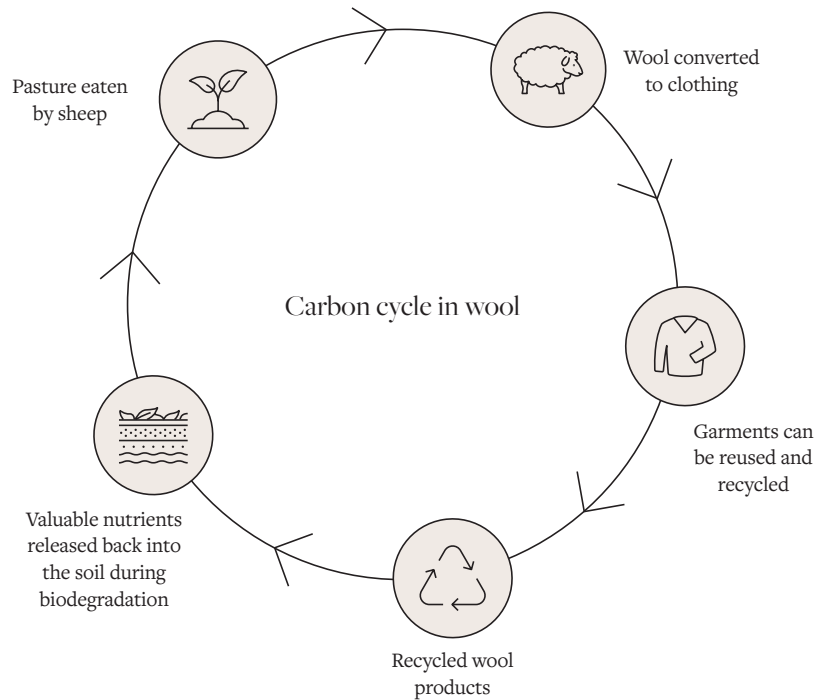
Carbon sequestration

Carbon is sequestered (stored) on wool-growing properties in the pasture, trees and soil. When woolgrowers manage their land sustainably, support healthy soils and encourage biodiversity, they can sequester large amounts of carbon. A recent pilot study involving 11 wool-growing farms, estimated that on average these businesses were sequestering more greenhouse gas equivalents into the landscape than they were emitting to the atmosphere.

Grazing

Sheep raised for wool are commonly grazed on rangelands that are most suited for livestock. Grazing animals are important species in grassland ecosystems, supporting nutrient cycles and vegetation regeneration. Woolgrowers actively employ grazing management techniques to ensure sheep do not overgraze the land. Many woolgrowers implement regenerative agricultural farming practices, such as rotational grazing, to holistically manage their land and support healthy ecosystem functioning.

Wool and the carbon cycle

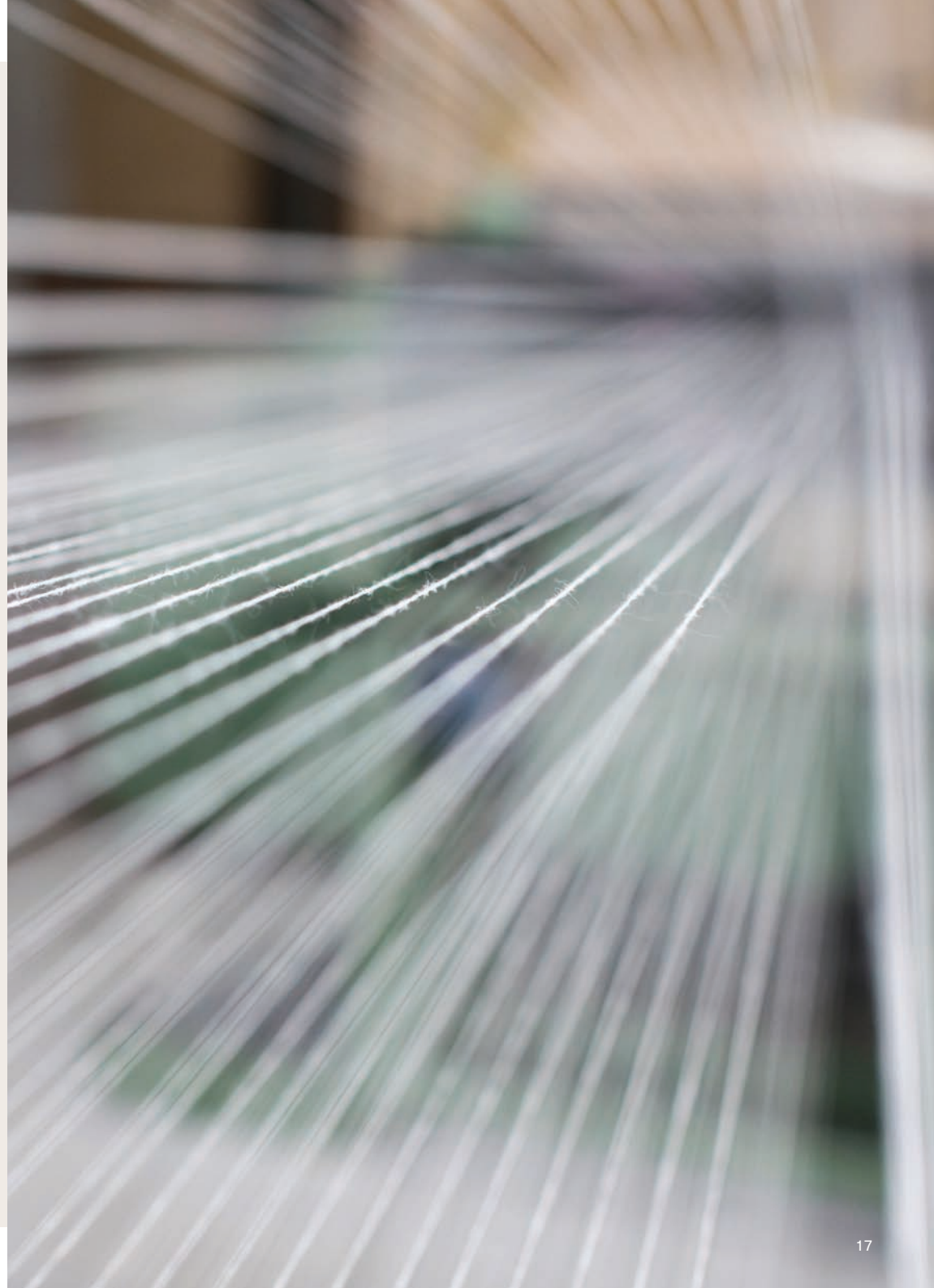


Wool forms a part of the natural carbon cycle. By storing the carbon from the greenhouse gas carbon dioxide (CO₂), wool prevents the gas from contributing to climate change for the time the garment is in use. All this CO₂ is removed from the atmosphere for the fibre's life – from when it is used by the grass during growth, to when it is converted into wool on the sheep, through the wool product's use phase – until it is disposed of and biodegrades. For many wool garments, this period is greatly extended because wool is used or recycled in a variety of textiles. In contrast, CO₂ from the burning of coal, oil and gas is an extra burden on the atmosphere as it is derived from carbon securely held underground for millions of years.

[Learn more about wool and the carbon cycle.](#)

04

Wool manufacturing



The wool manufacturing process

Australia is the largest producer of Merino wool in the world with 80% of all wool for superfine apparel produced in Australia.

Globalisation has increased the specialisation of wool manufacture across numerous regions around the world and Australia exports around 98% of all the wool it produces.

There are many different processes involved in the textile and fashion supply chain. These industries are often categorised into four tiers.

- Tier 1* The facility that directly supplies to the brand/company, e.g. garment manufacturing
- Tier 2* The facility that supplies the materials to the Tier 1 supplier, e.g. fabric production and dyeing
- Tier 3* The facility that supplies Tier 2 with materials, e.g. mills that spin the yarn
- Tier 4* Tier 4 supplies Tier 3 with the raw materials, e.g. woolgrowers

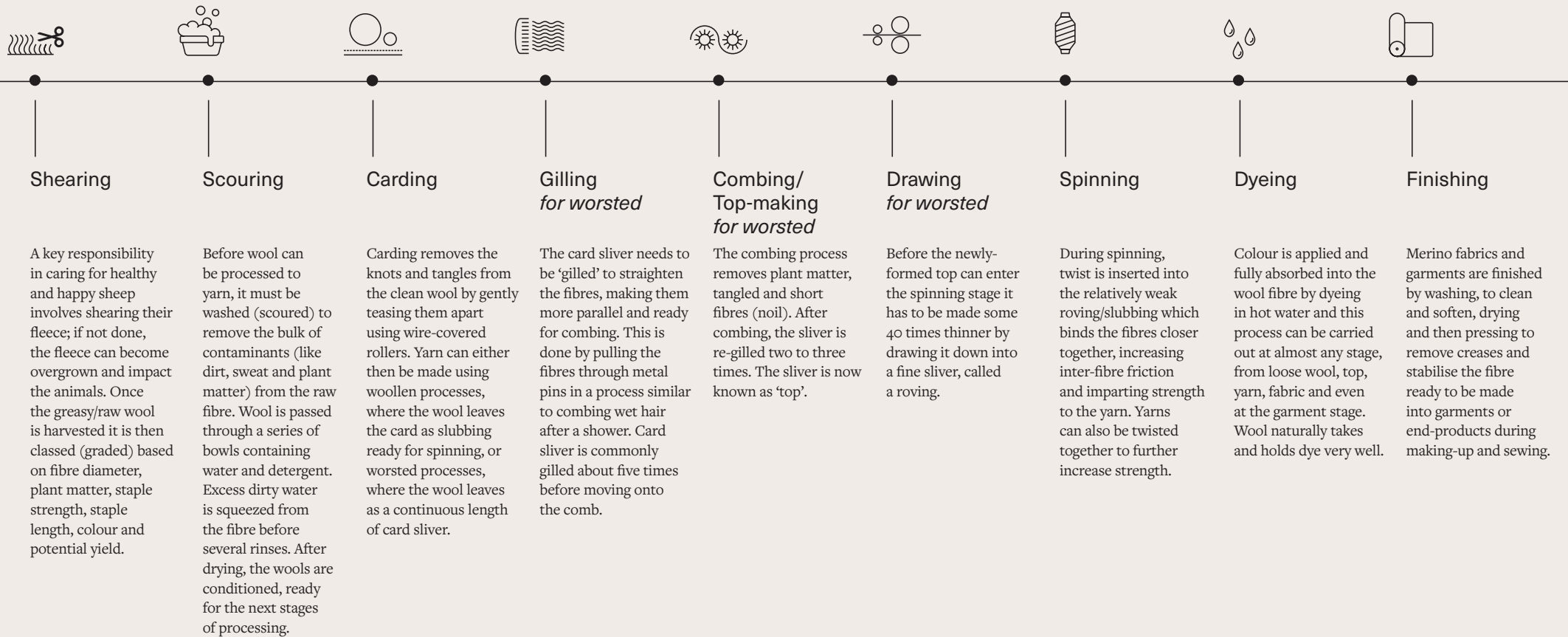


FAST
FACT

Export destinations

- The **primary export destinations** for Australian wool are China, India, Italy, Czech Republic and South Korea.
- **China imports 85%** of Australia's greasy wool.

The wool manufacturing process



Innovations reducing environmental impacts in wool manufacturing

1 Early-stage processing

There has been more than 100 years of research into improvements for the scouring of raw wool and subsequent effluent management systems. These improvements rely on capturing and making potential use of all the natural contaminants of wool before the effluent is released into the environment. For example, Sirolan SWIMS technology and its variants, developed by the CSIRO in Australia, is a newly developed approach. However, there are additional alternatives developed in New Zealand which may be equally effective.

Upcycling production waste: Sirolan SWIMS technology

To demonstrate, Sirolan SWIMS is a three-stage process that turns waste by-products of wool scouring into valuable products. The products created from the waste materials are:

- Lanolin – which has been an important by-product and a key income generator for scouring companies for many years.
- Suint – which is captured in the more recently developed 3-stage scouring systems and can be used as fertiliser.
- Sludge – which contains dirt, salts, some wool wax and was traditionally dumped in landfill, but which can be mixed with green waste to form compost suitable for use as fertilisers or burnt for use as a fuel.



Reducing production waste

2 Performance treatments

Top treatments

The control of environmental issues associated with felt-resistant treatments for tops has been the subject of more than 50 years of research and millions of dollars in investment. Most effort has gone into the development of chlorine-free processes to replace chlorine with an alternative form of oxidation of the fibre surface. There are several chlorine-free felt-resistant treatments for tops that are offered commercially, which include:

- Plasma – eg Naturtexx (Südwolle)
- Chemical Oxidation – several oxidants used
 - EXP process (Scholler)
 - 3E process
 - Ecowash (Kurabo) – combines ozone and permonsulphate
 - E-TEC (Devan PPT)

CHLORINE-FREE FELT RESISTANCE:

NATURETEXX® PLASMA WOOL TREATMENT

As an example, the Naturetexx® plasma wool treatment process developed by the Südwolle Group uses no chlorine to make wool felt resistant. The process involves carefully prepared wool passing through a plasma field, where electrons and ions in the plasma interact with the wool fibre. This process alters the friction profile of the fibre surface, reducing the normal felting effect of untreated wool and makes it machine washable. The Naturetexx® Plasma wool treatment won the Sustainable Innovators' Award at the Outdoor show in Germany in 2015 and has since been both Bluesign® and OEKO-TEX® certified.



Reducing chemical use



Reducing wastewater



Innovations reducing environmental impacts in wool manufacturing (continued)

Garment process

Chlorine-free felt-resist treatments have been used for many years. For knitwear, the SimplX process is commercially available through Floreal and is used most commonly for lambswool. However, there are others based on the use of a non-chlorine oxidant (permonosulphate or peroxide) and a polymer. Enzymes have also been used to impart felt-resistance to wool knitwear, but this process results in weight and strength loss in the fabric and so is mostly confined to next-to-skin wear, as it is claimed to also enhance skin comfort. For woven fabric, polymer-only processes are available (e.g., Synthappret BAP) and are the most commonly used.

For garment processing, the latest commercially available process developed by Jeanologia replaces chlorine with ozone. Similarly, polymer-only processes are available for garment treatments. The use of chlorine in garment or fabric felt-resistant treatment, such as Basolan with hercosett or a silicone, is not widely used.

OZONE TREATMENT FOR MACHINE WASHABLE WOOL: JEANOLOGIA WOOLUP

To illustrate, Jeanologia's WoolUp treatment is a relatively simple dry process that treats product in garment state using an ozone treatment that modifies the surface of the wool fibres. It degrades the tips of the scales and smooths the fibres, allowing them to slide against each other without interlocking, thereby preventing felting and the resultant shrinking. The WoolUp process can be used for the treatment of worsted and woollen apparel (100% wool and wool blend).

However, the technology is promising to be a breakthrough particularly for companies wishing to enter the lambswool knitwear market, in which machine washable claims have previously been difficult to achieve due to the nature of the finishing required and its complexity. This evolution of existing science is less complex and costly than traditional shrink proofing processes whilst also reducing water, chemical and energy consumption.

-  Energy efficient
-  Less complex
-  More accessible



Water-repellence: Optim™ technology

Due to concerns about fluoro-chemicals, the use of such products in water-resist treatments is declining rapidly. Membranes and new coatings, along with innovative fibre stretching technology such as Optim™, are rapidly displacing the use of fluoro-chemicals in all sectors of the textile industry (Goretex, Silicones such as Dowsil IE-8749).

The shift from fluoro-chemicals in oil-repellent finishes is slower, but manufacturers are definitively moving away from perfluorooctanoic compounds. This issue is not exclusive to wool, but an issue encompassing oil-repellent textile products. As such, the issues for wool will remain entwined with those of the general protective-wear market.

Optim™ fibre stretching technology has been developed by a collaboration between The Nanshan Group and The Woolmark Company. The technology works by pre-stretching and spinning Merino wool fibre yarn before weaving at very high levels of thread density in warp and weft. The fabric is then wet-finished, which releases the stretch, causing the yarns to contract and leading to an extreme tightening of the fabric structure and the creation of the immensely dense fabric.



Reducing chemical use

ECO-FRIENDLY DWR TREATMENTS

The Rudolf Group has released two eco-friendly and durable water repellent (DWR) agents onto the market. The Ruco-dry Bio CGR and the Ruco-dry Bio NPE are claimed to be 'breakthroughs in the industry', with the former the first DWR agent entirely based on plant-derived processing wastes. Made of natural waste that accumulates as by-product during the processing of cereal grains in the food industry, the CGR product creates a powerful water and stain repellent textile finish.



Innovations reducing environmental impacts in wool manufacturing (continued)

3 Dyeing and Printing

Natural dyes are not chrome-based and have a number of benefits including renewability and reduced wastewater effluent. Protein fibres, such as wool, generally have the best affinity for natural dyes and as such The Woolmark Company is further investigating this area.



Natural dye: Tintoria di Quarenga natural dyes

Woolmark licensee Tintoria di Quarenga has created an all-natural dyeing process called NATURALE® that uses more than 200 natural ingredients to create a wide range of colours and shades suitable for dyeing wool. No chemicals, additives, dye powders or extracts are used in dyeing. The Italian dyehouse was the first natural dyer to gain Woolmark certification for this innovative process, which continues to gain industry support as designers, retailers and consumers look to more sustainable options.



Reducing chemical use



Reducing wastewater

BIODYE

BioDye focuses on sustainable dye processes with minimal impact, seeding scientific breakthroughs using the best of nature to create 100% natural dyes and biodegradable ingredients through eco-friendly processes.

BioDye colours wool yarn and fabrics with natural dyes using non-toxic mordants, or dye-fixatives, to give the full spectrum of colours that do not fade or bleed when machine washed, while also enhancing UV-absorption. Strengthening the eco-credentials of BioDye's natural colouration technology is the holistic process that the dyehouse employs. Its dye-yielding plants can be used to revegetate degraded forests and provide income to rural women collecting chromogenic leaves in a sustainable manner. The solid waste is then used as fertiliser and the treated wastewater meets parameters for irrigation.



Digital printing

Digital printing is quick and personalised, using direct-to-fabric machines minimising the investment in screens, print tables and additional washing equipment. Chemicals and water usage are significantly reduced when choosing digital printing, and inks can be recycled to minimise environmental impact.



Reducing chemical use

Innovations reducing environmental impacts in wool manufacturing (continued)

4 Textile production

Wholegarment® knitting: Shima Seiki

Technology, such as the Wholegarment® knitting machine from Shima Seiki, can both manufacture knitted garments without waste and produce tailored garments to order. This equipment knits a garment in a single piece: no further cutting and sewing is necessary, meaning the final product can be picked up from the machine and, with minimal finishing, be ready to wear. This process consumes only the yarn that makes up the final garment and allows the fashion label to produce only the garments that they need, with each piece a one-off.



Reducing production waste

Knit and wear®: STOLL

STOLL knit and wear® technology allows you to knit, shape and connect pieces with only one machine within a single process. The result: a first-class seamless knitted garment with a high degree of comfort almost ready-to-wear. Complex further processing steps are omitted completely.



Reducing production waste

Seamless knitwear: Santoni

Santoni's circular knitting machine enables knit structures that cannot be emulated in any other non-seamless garment. It enables the ability for knitting structures to form compression areas within a garment which opens up endless possibilities for patterns, jacquards, ribbing and detailing suitable for both the fashion and active-wear markets.

Benefits include minimal yarn consumption and zero waste in garment construction.



Reducing waste water



Energy efficient

Upcycling: Manteco Recype® process

Merino wool is a high-quality fibre that is readily recycled. Manteco recycles the finest pre- and post-consumer luxury garments and high-quality worsted wool scraps to create new wool fabrics that are of high quality for the apparel industry. The recycling process uses no new dye or chemicals and diverts pre- and post-consumer waste from landfill whilst keeping quality wool materials in use.



Reducing waste water



Energy efficient

Seamless knitwear: Santoni

Wholegarment® knitting: Shima Seiki

Innovations reducing environmental impacts in wool manufacturing (continued)



5 *Wool alternatives*

Wool fur

Merino wool is a natural alternative to fur made from animal hide or synthetics. The fur fibre can be 100% Merino wool, knitted onto a synthetic base. Wool faux fur fabrics are cropped and brushed to replicate a traditional fur or shearling look and feel. Wool fibre, being 100% natural and biodegradable, does not shed microplastics like synthetic faux fur fabrics and, being a keratin fibre with superior warm, odour resistance and breathability, is an ideal substitute for traditional fur.

Wool fill

Wool is a natural alternative to synthetic filling and wadding. Wool fill and wadding is lightweight - wool fill offers the same warmth as polyester fill, is odour resistant and 100% biodegradable. The natural crimp of wool creates insulating air pockets to offer superior protection from the cold and because of the fibre's breathability, it also creates a drier, more comfortable microclimate within garments.

Wool velvet

Manufacturing both traditional velour and velvet includes a shaving or thread cutting process which results in fibre shredding, causing significant synthetic fibre waste at the production stage. Wool is 100% biodegradable which means wool velvet and velour avoid the non-biodegradable (and potential microplastic) waste generation associated with synthetic fibres.



Wool footwear

The average pair of shoes take more than 50 years to decompose. By incorporating wool into the upper, inner or lining of wool footwear, designers can create footwear that has a lighter environmental footprint. Being 100% natural, renewable, biodegradable and recyclable fibre, makes wool inherently circular and the ultimate choice when designing for longevity and preventing waste going to landfill.

How consumer garment use impacts the environment



Increasing garment wear lowers environmental impact

How often clothes are worn is the most influential factor in determining environmental impacts from clothing.

This indicates consumers who are aware of wool's attributes have the largest power to influence the sustainability of their wool garments by maximising the active garment lifespan and therefore reducing overall impacts. Indeed, brand and retailers can also play a vital role in educating consumers about best practice care methods to extend a product's lifetime.

By producing garments using high-quality materials, such as wool, and designing for longevity rather than seasonal trends, brands can influence consumer behaviour and encourage them to cherish their garments for longer. Wearing wool clothes to maximum potential and practicing optimal garment care can reduce their environmental impact by 75% compared to current practices, according to a [2021 study](#)⁹.

The world's first peer-reviewed [textile fibre cradle-to-grave LCA](#)¹⁰ study found the number of times a garment is worn is the most influential factor in determining garment impacts.

The survey completed for this study showed woollen sweaters in consumer wardrobes had been purchased between <1 year and up to >30 years ago, and some survey respondents reported garments had been used for >200 times. However, if this garment was disposed of after only one season, or 15 uses, this would result in a 5.8- to 6.8-fold increase in environmental impacts and resource use.

A [2020 Wardrobe Study](#)¹¹ found that wool garments are amongst the longest kept in the wardrobe. The study revealed the average lifetime of wool garments was more than 50% longer than cotton garments, with wool products given multiple lives through re-sale or change of ownership.



1 in every 10 items in female wardrobes comprise wool, with sweaters, jackets, coats and scarves the most likely to be made from wool or wool blends. 5% of these wool garments were purchased more than 10 years ago, double that of cotton and polyester.



9% of wool garments in male wardrobes were purchased more than 10 years ago, compared to just 3% of cotton and polyester clothing.



10% of wool and wool blend garments compared to 25% of cotton and cotton blends, or 33% of denim garments, were purchased by males in the past 6 months.

It was found in the same [Global Wardrobe Study](#) that wool garments are less frequently washed than most other fabrics, with denim, cotton and synthetics washed most often. Further, woollens were only present in 8% of tumble dry loads. Optimal garment care is outlined in more detail in the following pages.

9. Wiedemann, S.G., Biggs, L., Nguyen, Q.V. et al. Reducing environmental impacts from garments through best practice garment use and care, using the example of a Merino wool sweater. *Int J Life Cycle Assess* 26, 1188–1197 (2021)
10. Wiedemann, S.G. et al. 'Environmental impacts associated with the production, use, and end-of-life of a woollen garment' (2020) 25(8) *The International Journal of Life Cycle Assessment* 1486–1499
11. The Nielsen Company: Global Wardrobe Audit: All Countries, 2020. Prepared for Australian Wool Innovation)

Best-practice garment care reduces environmental impact

Best-practice garment care is another highly influential factor in reducing a garment's environmental impact. Because wool is resistant to odour, stains and wrinkles it requires less laundering over its lifetime. Brands can positively influence the environmental impacts of garment care by communicating to their consumers best-practice care for their clothing.

The results of a [2021 study](#)⁹, outlined below, show that consumers can greatly reduce the impact their wool clothes have on the environment. This is achieved by choosing and wearing quality garments that have a lengthy life and need minimum laundering, such as those made from Merino wool.

14 wears

The optimal numbers of wears per wool sweater is 14 before it requires laundering. Wool products are best air dried, saving energy from using a tumble dryer.

68%

Increasing the number of wears from current practice (109 wears) to 400 wears per wool sweater over its lifespan can reduce the environmental impact of that garment by up to 68%.



<30°

Wool clothes are best washed with cold or 30° water, which saves energy compared to washing with hot water.

75%

Wearing wool clothes to maximum potential and practicing optimal garment care can reduce their environmental impact by 75% compared to current practices.

28%

Reusing a wool garment by multiple users can increase its life span and reduce environmental impacts by up to 28%.

Multiple lives & end of life

Repair

Wool garments have a long history of being mended. Most wool products can be easily repaired, extending the already long use phase of these quality products, without placing added strain on the environment if a new garment was to be purchased. Depending on the type of repair, it will usually be less expensive to repair a wool garment than purchase a new one. The Woolmark Company's [guide to repairing wool products](#) is helping keep them in circulation longer.

Reuse

Wool is one of the most reused fibres on the planet of the major apparel fibres, with wool garments often preferentially donated or sold for extended life. According to a [Nielsen wardrobe study](#)²¹, 50% of wool and wool blend garments owned by survey participants were donated to charity, family, friends or sold.



Recycling

The wool industry is unique in having had an established recycling pathway for more than 200 years, turning old, exhausted wool into new products.

'Closed loop' recycling: This involves high-value wool garments deconstructed to enable new yarns to be spun and new high-value garments fabricated. Wool is the most recyclable fibre on the planet of the major apparel fibres.

'Open loop' recycling: This is essentially 'down cycling', in which wool products are pulled apart and fabricated into cheaper non-woven products for insulation, padding, interiors etc. Wool is highly valued for these purposes because of its inherent flame resistance and acoustic insulation properties.

Product Disposal

If a wool product reaches its end of life and needs to be disposed, science has found that wool fibres are 100% biodegradable in both land and marine environments.

Wool fibres will naturally decompose in soil in a matter of months or years, slowly releasing valuable nutrients such as nitrogen, sulphur and carbon back to the soil. Synthetic fibres, on the other hand, can be extremely slow to degrade and significantly contribute to the world's overflowing landfills.

Wool also biodegrades in a marine environment and does not contribute to microplastic pollution. In contrast, microplastics from synthetic textiles accumulate in marine environments, as well as terrestrial environments, where they damage ecosystems.



Wool and the UN SDGs



Wool and the UN SDGs

The Sustainable Development Goals, launched by the United Nations in 2015, are a collection of 17 interconnected goals and act as a blueprint to address the most pressing problems of the world.



Natural

Wool is a natural protein fibre that is grown organically by sheep. This means the fibre is created through natural processes which do not emit pollutants and the fibre readily biodegrades at end-of-life.

Renewability

Wool is a 100% renewable resource, grown by the simple blend of sunshine, fresh air, grass and water.

Biodegradability

Wool fibres are 100% biodegradable in both land and marine environments as proven by numerous peer-reviewed scientific studies. This means that wool does not contribute to microplastic pollution.

Soil health

Australian woolgrowers work with national initiatives such as Landcare and Greening Australia to implement regenerative initiatives on their farms that support soil health. These practices include planting trees, rotational grazing, sequestering carbon in dry matter compost and soil, nurturing pasture diversity and soil biota through pasture cropping, improving water retention in farm soil through 'leaky weir' techniques, repairing erosion and using revegetation to remove pollutants from waterways.

Water quality

Management practices undertaken by Australian woolgrowers that effectively protect and regenerate waterways and riparian areas include:

- Fencing off waterways to control erosion, grazing pressure and to allow native species to regenerate
- Planting of native species along waterways to revegetate the area and encourage soil stability and health, shelter and improve water quality
- Manage water allocations to prevent over usage of the natural resource and improve land management.

Animal Welfare

Since 2001, Australian woolgrowers have invested AU\$77 million into research and development that focuses on the health and welfare of their sheep.

Five Welfare Domains: Australian woolgrowers work to ensure their sheep are cared for in a way that meets these Five Welfare Domains and constantly look for improvements to be included in their management practices. The Five Domains are defined as Nutrition, Environment, Health, Behaviour and Mental state.

Flystrike: Australian woolgrowers have been proactive in collaborating with researchers and industry to protect Australian sheep against this condition. To date, Australian woolgrowers, have invested AU\$41.6 million to combat flystrike.

Shearing: Through Australian woolgrower funding, shearers and wool handlers are provided free training for novice, improver and advanced shearers and wool handlers through regional coaching programs. Since 2015, there have been close to 11,000 shearer and wool handler training days to 43,000 people.

Wool and the UN SDGs



Processing

The Woolmark Company works with industry partners – from early-stage processors through to end garment makers – to adopt innovative processes and technologies to ensure best practice across the supply chain and reduce water waste and pollution.

Innovations in processing includes waterless dyeing, natural dyes, new digital print technologies and alternatives to finishing processes.

Circularity

Wool is inherently circular and aligns with the circular economy. Wool is the most reused and recyclable apparel fibre of the world's major apparel fibres that is valued for its many closed and open loop recycling qualities and applications. Although wool only makes up 1.2% of the virgin fibre supply, surveys have shown it represents about 5% of clothing donated to charity.

Longevity

The average lifetime of wool garments is more than 50% longer than cotton garments and are washed less often. The fact that wool clothes need less frequent washing not only reduces energy and water consumption, it also preserves the as-new look of the garment, enabling consumers to continue wearing it for longer.

Garment care

Laundering frequency is the most influential factor for differences in the environmental impacts per wear between garment types. The wool fibre is naturally resistant to stains, odours and creases, which means wool clothing does not need to be washed as often as clothes made from other fibres. Woollen garments have the lowest water and energy use per wear, as well as related greenhouse gas emissions compared to other common apparel fibres, mainly due to the reduced laundering frequency.

Renewability

Wool is a 100% renewable resource, grown by the simple blend of sunshine, fresh air, grass and water.



Research & development

The Woolmark Company invests in research and development along the entire wool supply chain to create innovations in wool production, processing and product development that reduces the impact on the environment. Innovations in processes include seamless garment construction, flat-knit and whole-garment knitting that reduce yarn and fabric waste.

Education & leadership

The Woolmark Company delivers a suite of education and leadership opportunities along the entire wool supply chain. The Australian wool industry funds numerous education and leadership opportunities for woolgrowers as well as free training for novice, improver and advanced shearers and wool handlers through our regional coaching program.

- Since 2015, close to 11,000 shearer and wool handler training days have been run, educating 43,000 people.
- The Woolmark Company's parent company runs numerous best-practice animal health and welfare face-to-face courses that focus on a wide range of sheep health and welfare considerations.
- All Woolmark licensees and partners are responsible for abiding by the ethical labour practices set by the International Labour Organization and United Nations.
- More than 72,000 primary, secondary and tertiary students from across the world have been educated through The Woolmark Company's annually-run programs and online courses since 2019.

Employment

200,000 people are employed within the Australian wool industry across production, farm services and research and many more people are employed throughout the global wool supply chain. By supporting the livelihoods of rural and remote families, the Australian wool industry provides economic stability and supports community and diversity.

Collaboration

By working directly with Australia's 60,000+ woolgrowers, The Woolmark Company is able to promote responsible and sustainable farming practices and build consumer trust by connecting woolgrower responsibility to a quality end product.

From 2020-2022, The Woolmark Company co-developed 29 new product and processing innovations.

The Woolmark quality assurance symbol



The Woolmark quality assurance symbol

For more than 50 years, we've certified more than 5 billion wool apparel and wool care products, guaranteeing durability, performance and quality. The Woolmark logo is the world's best-known textile quality fibre brand, representing a long-term commitment between woolgrowers, mills, brands and consumers.

What are the Woolmark certifications?



OUR STANDARDS

Wool Content: We assess the wool's purity, to verify the product is 100% what it claims to be.

Colourfastness to Light: We expose the wool product to the harshest light – for up to 10 hours – to assure its colours are lasting.

Durability: We subject the wool product to extreme pressures – we push, pull and stretch it to its physical limits – to measure its strength.

Wash Testing: We wash the wool product in hard, unforgiving machines to ensure no shrinkage and no loss of shape.

Colourfastness to Liquid: Finally, we take the wool product, intensely, against the very liquids it would normally meet throughout its lifetime.



Natural fibre authentication

Woolmark certification verifies that the wool in each certified product meets our exacting quality standards and is what it claims to be.



Independent quality assurance

We guarantee the fibre composition of wool garments and wool products with testing at independent laboratories.



Building a traceable supply chain

Every certified Woolmark product has a unique batch number that can be traced back to the garment maker, providing the first step in supply chain traceability.



Technical support

Utilise the Woolmark Technical Team for on-demand technical support and product development.



Staff development and training

Tailor-made training days, webinar participation and free educational resources on the Woolmark Learning Centre.



Customer satisfaction

85% of consumers agree the Woolmark symbol ensures quality. Leverage the reputation and authority of the iconic Woolmark symbol to build consumer confidence.

Opportunities for wool



Opportunities with wool

Brands and designers can utilise the circular benefits of Australian wool to align their businesses with sustainable development.



1 Technical design

Wool is a natural, biological fibre – with technical properties – that meets the demands for numerous product categories including activewear, lounge-wear, insulation and bedding, intimates, automotive, workwear and more. Enhanced through product and process innovations, wool provides a natural design and material solution to meet the demands of today's consumers.

2 Traceability

The demand for traceability in the fashion industry is growing. For Australian wool, traceability is a pathway to showcase the industry and provides wool-growers with opportunities for premiums, contracts and higher demand. The Woolmark Company has a number of current traceability trials and projects to assess the feasibility of tracing wool through the supply chain.

3 Circularity

Wool has a unique set of circular features – such as being a renewable and biodegradable fibre, and suitable for reuse and recycling. These attributes recommend wool as the circular solution to the material strategies of companies along the supply chain including designers, brands and retailers.

4 Extended Producer Responsibility

The Woolmark Company is currently undertaking an Extended Producer Responsibility project, so that the EPR benefits of wool can help brands prepare and position themselves in line with the circular economy, with a high recycling rate and low end-of-life clothing costs. The evidence being gathered will arm those brands seeking to reduce these costs and capitalise on the long-established mechanical wool recycling industry. Our research will consider the economic viability and of end-of-life pathways for wool relative to other fibre types, including price trends for used and recycled synthetic clothing and used wool clothing.



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