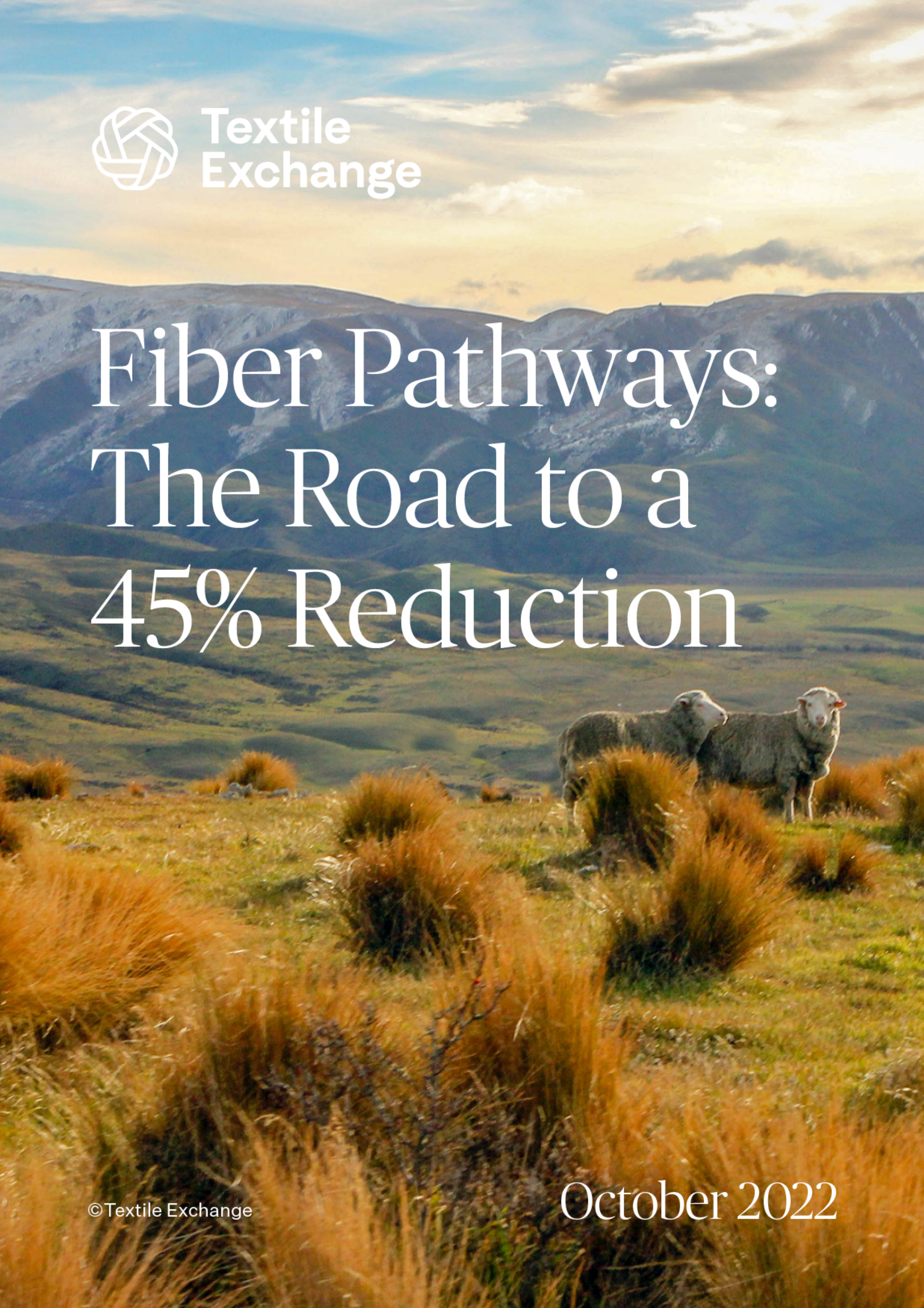


Textile Exchange

Fiber Pathways: The Road to a 45% Reduction

October 2022

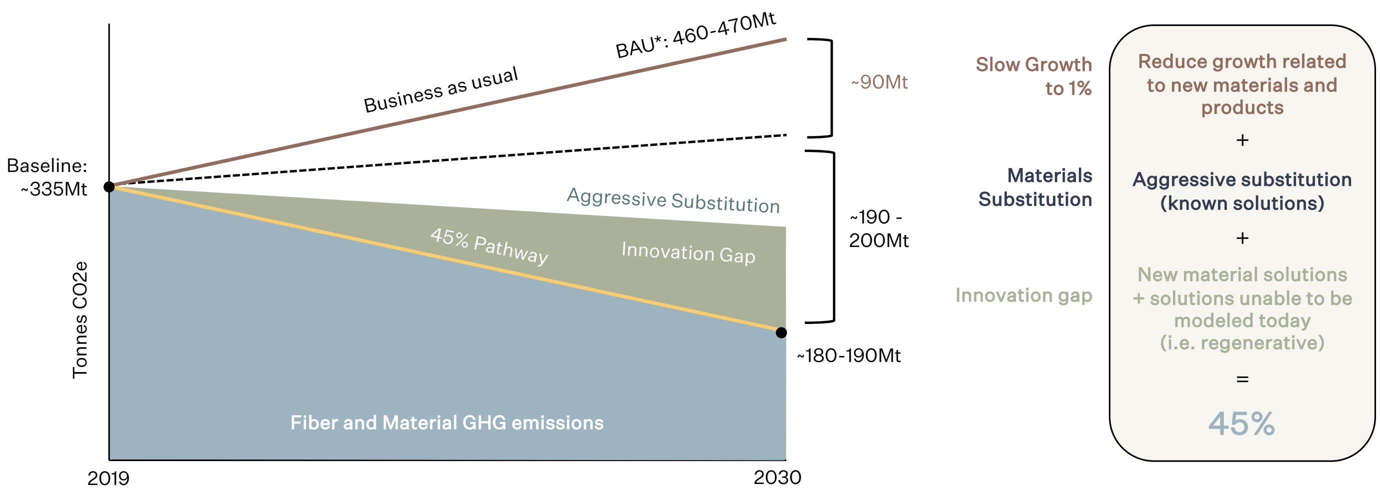
Fiber Pathways: The Road to a 45% Reduction

A holistic approach to achieving a 45% reduction in greenhouse gas emissions, while protecting biodiversity and water, and improving soil health across all fiber categories and strategic fiber types.

Introduction

The clock is ticking. If fiber production and consumption continues at its current rate, the fashion and textile industry will not meet our shared Climate+ goal. We will fall short of the 45% drop in greenhouse gas (GHG) emissions we aim to reach by 2030, and we will not have played our part in climate action to the level we’re capable of.

Decisive action is necessary. But the reality of the present situation is that there are gaps across all fiber categories. Simply put, there are things we don’t know. But there are things we *do* know, and we have defined a direction of travel which, if followed, will start the transformation of the industry, the successful achievement of our Climate+ goals, and a brighter, greener future for everyone.



* BAU scenario assumes a 3% growth per year from 2019 to 2030

Based on our modeling, even if current and existing, proven solutions available in the market reach 50% of total fiber and raw materials production, the savings in GHG emissions will only account for a third of the total reduction targets set. That’s why material substitution is just the first of three necessary levers to pull to reach our targets on time. Beyond substituting for preferred, proven raw materials, the scaling of innovation, and the slowing down of continued growth in the annual production and consumption of new raw materials, are needed.

The industry must focus on strategic fibers, too: those that represent the majority of the total global fiber volume and greenhouse gas impact. These include polyester, cotton, wool, bovine leather, nylon (polyamide), and man-made cellulosic fibers (MMCFs), such as viscose. Figure 1 represents the GHG impact and production volumes for fiber and material categories against the 2019 baseline.

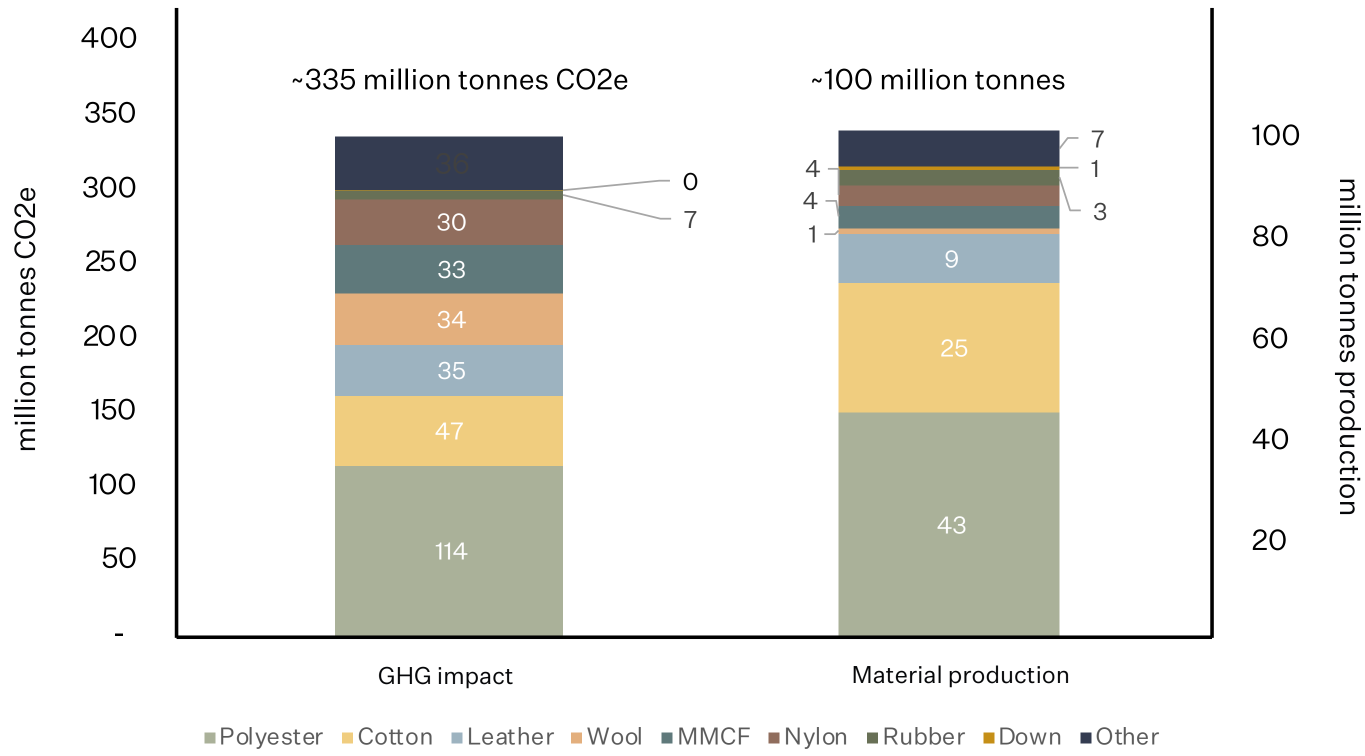


Figure 1: GHG impact and production volumes for fiber and material categories for the 2019 baseline.[1] This chart considers the following sectors only: fashion and apparel, home textiles and footwear and does not consider total global production (as published in the Preferred Fiber and Material Market Report. Sources: Production data – Textile Exchange's Preferred Fiber and Material Market Report, 2022; Sector split data – Textile Exchange Data and Technology Team research, 2021; Results were calculated using Higg MSI 3.3 data at Higg.org. Retrieved by Textile Exchange in March 2022

Improving the data that guides sourcing decisions

Right now, data widely used to draw comparisons between the impacts of these fibers and guide sourcing decisions needs improvement. As written in the Fashion Charter for Climate Action's "Identifying Low Carbon Sources of Cotton and Polyester Fibers" report, "The mapping of current life cycle assessment (LCA) landscape for cotton and polyester (PET) revealed key data gaps, inconsistent modeling approaches and lack of a standardized methodology, which makes it inappropriate to compare the environmental performance of one fiber to another.

Overall, datasets lack geographic variability and transparency, and in general, existing LCAs are not comparable due to the following overarching issues:[2]

- Inconsistent time period of data collection
- Credits applied for biogenic carbon stored in the product
- Implication of choice of LCA software and use of different LCA databases
- Use of different LCA methodology

[1] Note that all charts in this report consider the impact and production of fibers and materials related to the following sectors only: fashion and apparel, home textiles and footwear. This impact is calculated using sector split data applied to global production data sourced from Textile Exchange's Preferred Fiber and Materials Market Report, 2022. Global average GHG emission factors are then applied to production volumes. The GHG impacts calculated represent an estimated impact for fiber and materials only and should be interpreted with caution.
[2] UNCCC Fashion Industry Charter for Climate Action, 2021. Identifying Low Carbon Sources of Cotton and Polyester Fibers.

LCA methodology, when applied to raw materials used by the apparel, textile, and footwear industry, has some key limitations as it stands today. It does not capture all impact areas such as soil health, biodiversity, animal welfare and social impacts; can be cost prohibitive and resource intensive; there can be significant variability in the scope of what is covered as well as in other assumptions that are made; system boundaries defined for LCA studies can vary within and across fiber types, and results from LCA studies can be present in multiples ways (e.g., "global averages" or regional impacts).

Most of the LCA data collected is at the global level and thus, not a full representation of country or regional production. So, we must recognize data quality and what the data covers. That's why we're developing an LCA+ approach to give the industry a more holistic way to fill key gaps in LCA data and methodologies, while also investing in identification of additional impact data approaches to address other important impact areas not covered by LCA methodology today, such as biodiversity and soil health.

Slowing down growth in the production and extraction of new raw materials

It's also key to recognize that right now, the sheer amount of new raw materials being grown, produced, or extracted is a barrier to achieving the level of reduction needed. This volume is increasing year on year, but to reach a 45% by 2030, it needs to slow down significantly. If this area is neglected, any progress in the remaining areas will count for little.

Action here varies from fiber to fiber, but in every case, increasing the volume of feedstocks—the raw material used for the process and manufacture of fibers—made from waste will dramatically limit the need to produce new raw materials. Additionally, to start creating value outside of producing and extracting new raw materials, we must support systems that extend the usable life of garments such as resale and repair.

At the design level, creating clothing with durability, longevity, recycling potential, and other circular end-of-life qualities in mind is key. Designing with a purpose is the first step towards responsible creation, and that can have a ripple effect across an entire supply network.

Sharing the responsibility across the supply chain

Government engagement can support and enforce waste reduction and collection to help scale recycling efforts and technologies. Informed policy and regulation allow for the rapid development of systems and mechanisms to level the playing field, and create true systemic change.

But no one organization can do this alone. The responsibility for gathering data, improving data quality, designing for longevity and circularity, and investing wisely falls on all of us, across the fashion, apparel, and textile industry. We face a global challenge which by definition involves everyone, and tackling it must therefore involve everyone as well.

There are no silver bullet solutions for systems change, and this transition comes with both risks and rewards. All too often, this financial burden falls on those furthest away from the final product. Putting the pressure on farmers, growers, and producers won't lead us to sustainable change–instead, it's about ensuring that those at the beginning of the supply chain are rewarded and valued for positive change that impacts the entire industry.

We need to make the most of our existing efforts, across all programs and schemes, and look to opportunities to strengthen them, maximizing the potential for beneficial outcomes. We need to secure supply and consider climate adaptation and resilience measures. And we need to incentivize scalable solutions that reward our partners on the ground, at the farm level, who are at the forefront of the movement.

For all this to happen, we must form new kinds of partnerships and new ways of working: closer collaboration, greater innovation, and a firm shared commitment to standing side by side in playing our parts. The time for working in isolation, for treating problems as standalone and abstracted from the whole is over.

Now, we have to view our absolutely critical work in its proper context, setting exploitative, competitive business models aside, and approach climate action with the whole system—including the communities affected—in mind.

Key takeaways

Throughout this report, we've provided clear guidance on actions to take and areas to focus on by strategic fiber type: polyester, cotton, viscose, and wool. We uncover what we know as an industry, what we need to solve for, and which specific solutions we need to pilot, advance, and commercialize. Leather and nylon will be included in the next phase as we continue to build upon this work.

Each year, we will expand on our guidance as we learn and make progress, solve for gaps, and identify new opportunities to move forward. This is just the start of an evolving roadmap, but *now* is the time to start aligning and acting on what we *know* can move the needle.

An overview of each fiber

Polyester: From performance to price, there are many reasons that make polyester the most significant fiber on the market in terms of volume. Here, the priority lies in moving away from fossil-based feedstocks to recyclable or renewable ones, and closing the loop that would allow old polyester textiles to be recycled into new ones. To facilitate this journey, we'll need to close the data gaps that currently exist in measuring the impacts of different recycling technologies, and potential biosynthetic material alternatives. Plus, we'll need input from everyone–not least the collecting and sorting industry that deals with synthetic textile waste.

Cotton: There's no better indicator of cotton's environmental impact than the quality of the land where it is grown. That's why we're advocating for a holistic approach that moves beyond reducing GHG emissions to exploring the positive environmental outcomes that cotton production can deliver through the upscaling of regenerative agriculture. Progress in this sector also requires increasing traceability and assurance to ensure stakeholders can feel confident that the sourcing decisions they make are directly resulting in beneficial impacts. Most importantly, it will require that those at the end of the supply chain must have direct, long-term relationships and commitment to those at the start.

Wool: The most important fiber in the animal fiber category, wool brings with it not only environmental considerations, but animal welfare ones too. Increasing the use of certified Responsible Wool will help ensure both are taken into consideration by producers, while allowing us to collect more data and close the current gaps in impact data available. When it comes to actions to take today, it's about learning from the land, and going back to the positive biodiversity or soil health outcomes observed on the ground by producers–even if they're yet to be translated into hard numbers.

Viscose: The forest-based feedstocks that feed global viscose production have huge potential, both positive and negative. They have the power to bring beneficial social and environmental outcomes through a stewardship approach, or to contribute to the degradation of ancient ecosystems that are fundamental to the health of the planet. The choice is ours. To become a leader in sustainable forestry and industry transformation, the MMCF sector must scale innovative solutions and put a stop to the extractive forest management practices that lead to the destruction of forest ecosystems such as deforestation, or ecologically harmful harvest of trees and timber. Realizing this vision will mean engaging the whole supply chain like never before, as well as expanding the focus onto developing next-generation materials and circular business models.

Cross-cutting solutions

Across all fibers and materials there are common important themes and action items that offer multiple pathways to achieve our shared, collective goals.

Substituting conventional materials with preferred fibers and raw materials

- Evolving impact data comparison and collection to an LCA+ approach.
- Tracing material sourcing back to the regional, farm or site level.
- Eliminating virgin-fossil-based (oil-derived) fibers and raw materials.
- Incorporating regenerative principles across agricultural, forestry and livestock programs.
- Decarbonizing raw material production by shifting to renewable energy.
- Committing to conservation and preservation efforts such as deforestation.

Scaling innovative and emerging preferred fibers and raw materials

- Investing in proven solutions and systems to accelerate and facilitate transformation such as textile-to-textile recycling.
- Aligning on a methodology to assess new and emerging materials.
- Identifying, researching, and aligning on new solutions.

Creating value outside of new raw material production

- Increase waste feedstocks through closed loop production systems.
- Extend product longevity through resale, repair, rental services, and new circular models.
- Design for circularity by focusing on durability, recyclability, and biodegradability.

Every one of these actions will require collective, connected action, with input from stakeholders at every stage of the supply chain. Truly sustainable solutions will be the ones that share risks and rewards fairly among everyone involved, allowing for a collaborative solidarity that facilitates real progress. If there’s one key takeaway from this report, it’s that we’ve got to work together.

Synthetics: Polyester

What we know: The urgency to act

Synthetic fibers are made through chemical processes. As it stands today, the vast majority of compounds and chemicals used to make these fibers come from feedstocks that are fossil fuel-derived. As reported in our 2022 Preferred Fiber and Materials Market Report, this fiber category accounted for about 64% of global fiber production in 2021 (or roughly 55% of total fiber and raw material production related to the fashion and apparel, home textile and footwear sectors).[3]

Despite the known sustainability challenges with fossil-based synthetic fibers, as an industry, we cannot simply remove them from use today. That's because synthetic fibers provide us with materials which have attributes that are not found in any other fiber available at significant scale. The markets and applications for synthetic fibers reach far beyond fashion and textiles too, on account of their high durability and performance properties.

The critical need in this category is to shift production urgently away from conventional, virgin fossil fuel-based inputs and towards more responsible raw material inputs. This creates a huge opportunity for the industry to innovate and develop new fibers and materials which can provide equivalent performance from alternative feedstock sources. Collaboration across the industry and a consistent industry-wide strategy to support the transition will be key to mitigating the risks and impacts whilst enabling innovation to provide alternative solutions.

As it stands, the industry is missing the mark when it comes to making the changes required. To achieve the Climate+ goals within the synthetics fiber category, fast and meaningful action is critically needed to develop accelerated and ambitious strategies that take us from recycling plastics into textiles to recycling *textiles* into textiles at scale. The approaches required must be multi-faceted; and one solution alone will not get the industry where it needs to be in respect of reducing GHG emissions by 45%, in line with the Climate+ strategy goal.

At present, our efforts should be focused on closing the loop for synthetic textile waste by scaling all feasible recycling technologies and systems. In the long-term, bio-based solutions could play a role in providing additional alternatives, but further research is needed to inform how best to scale and adopt these new emerging materials. This research will ensure production is not causing additional, unnecessary harm to our environment. New partnerships will be needed to overcome some of these challenges and assure those working with new technologies that feedstocks will be used to ensure economic as well as environmental sustainability and security across the value chain.

Consideration must also be given to the traditional, linear business models according to which the production and consumption of synthetic fibers operates. This must change: the industry has to implement new business models and ways of working which do not rely on buying fibers and materials at the lowest possible price. The implementation of business models which support retaining the value of products through rental and subscription services is a great way for organizations to begin valuing their products in new ways and create new business opportunities.

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[3] Global fiber production considers fiber production only across all sectors, it does not include leather or rubber, this data is sourced from the Preferred Fiber and Material Market Report 2022. Synthetic fibers account for approximately 64% of global fiber production only (excluding leather and rubber). When focusing on fiber and material production for fashion and apparel, home textiles and footwear synthetic fibers account for 55% of fiber and material production. This includes: synthetics fibers, animal based fibers and materials (including leather), plant based fibers, manmade cellulosic fibers and rubber.

Conventional polyester is our biggest challenge

The production and consumption of polyester is responsible for most of the environmental impacts caused by synthetics. Polyester is the largest fiber type by volume used, accounting for approximately 54% of global fiber production (or roughly 55% of fiber and material production related to the fashion and apparel, home textile and footwear sectors).

The second-largest fiber in this category is polyamide, also known as nylon, which accounted for approximately 5% of global fiber production in 2021, (or around 4% of fiber and material production related to the fashion and apparel, home textile and footwear sectors). The difference in these production figures once again highlights that polyester is the top priority for this category.

The GHG impact of Polyester - 2019 baseline

The baseline year from which the industry-wide 45% reduction target is calculated is 2019. The 2019 GHG impact of the synthetic fiber category is estimated to be ~165 million tonnes CO2e.[4] Polyester accounts for around 70% of this. Figure 2 presents the 2019 baseline impacts across the synthetic fiber category.

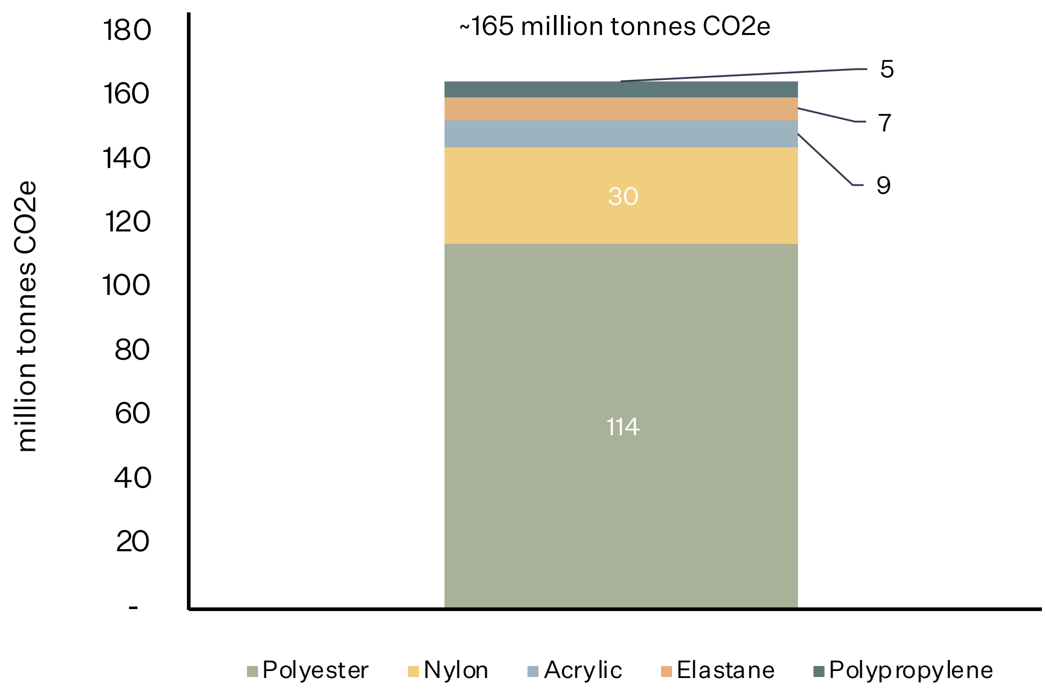

Figure 2:GHG impact across the synthetic fiber category for the 2019 baseline. This impact considers the following sectors only: fashion and apparel, home textiles and footwear. Sources: Production data–Textile Exchange's Preferred Fiber and Material Market Report, 2022; Sector split data–Textile Exchange Data and Technology Team research, 2021; Results were calculated using Higg MSI 3.3 data at Higg.org. Retrieved by Textile Exchange in March 2022.

[4] The synthetic fiber category includes the following materials: polyester (virgin, recycled & biobased), nylon (virgin, recycled and biobased), Polypropylene (virgin & recycled), Acrylic (virgin & recycled) and Elastane (virgin & recycled)

Figure 3 below shows the GHG impacts for the synthetic fiber category alongside the GHG impact by sector for polyester only.

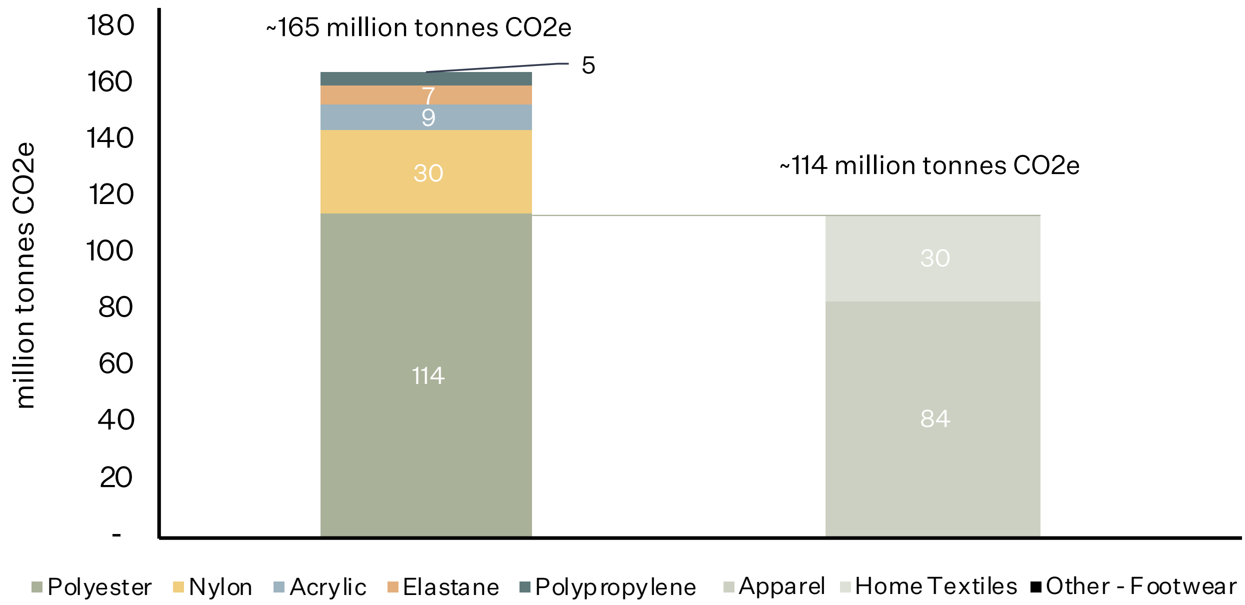

Figure 3: GHG impact across the synthetic fiber category for the 2019 baseline alongside the share of impact for polyester across sectors (apparel, home textiles and footwear only) Sources: Production data–Textile Exchange's Preferred Fiber and Material Market Report, 2022; Sector split data–Textile Exchange Data and Technology Team research, 2021; Results were calculated using Higg MSI 3.3 data at Higg.org. Retrieved by Textile Exchange in March 2022.

Without accelerated and collective action, and assuming a 'business as usual' (BAU) scenario, by 2025 it is estimated that the production of synthetics will have a **196 million** t/CO2e impact.[5] Following BAU for another five years, this would equal an impact of **228 million** t/CO2e by 2030.

[5] The Business As Usual scenario assumes a 3% year on year growth rate across all fibers and materials from the 2019 baseline to 2030

What we don't know: The gaps to solve for

Impact data on recycling processes and recycled feedstocks

Many recycling technologies for synthetic fibers have been developed, but it is important to be able to assess these based on their impact so that we can make informed decisions. We know that all recycling technologies will have different impacts, but today, a limited amount of data exists on the GHG impacts of the variety of technologies that exist today and/or are under development. Because of this, we are unable to accurately report the extent to which the GHG impact is being reduced with the uptake of different technologies, or the potential implications (harmful or beneficial) to ecosystems.

Regardless of the current Technology Readiness Level (TRL) at which recycling technologies are operating, the industry needs to find solutions to measure the impacts of different processes. This is necessary so it can optimize and select the most appropriate technology (e.g., mechanical or chemical) for each specific need. This also involves understanding the different chemical recycling technologies which can be employed to recycle synthetic fibers, such as glycolysis and methanolysis, and whether full or partial depolymerization is occurring. The type of feedstock being recycled–for instance, textiles, bottles, or packaging—is also relevant here, as different feedstocks could lead to different GHG impacts.

To learn more about polyester data gaps, please visit the UNCCC Fashion Industry Charter for Climate Action's report "Identifying Low Carbon Sources of Cotton and Polyester Fibers". This report provides further information on the landscape of current LCA data and data gaps for polyester. It also provides an overview and commentary on the inconsistent approach to modelling petrochemical products used in virgin polyester production as well as recycled polyester.

Impact data on biosynthetic fibers

The category of biosynthetic materials is a complex one and is evolving rapidly. Textile Exchange's working definition of biosynthetic fibers includes those which are being produced wholly or partly from biobased or regenerative sources and create a fiber which has equivalent properties to a conventional synthetic and is therefore suitable to be used as an alternative. This can include fibers produced from plant-based sources such as sugar cane or castor oil, as well as feedstocks which are biobased and produced using synthetic technologies. Further information can be found in Textile Exchange's "The Sustainability of Biosynthetics" guide, published in 2022.

There are a variety of biosynthetic fibers on the market and in development, made from biomass feedstocks derived from agricultural crops and waste residues. The potential of carbon capture and utilization is also being explored.

We are working under the assumption that there will be biosynthetic fibers which will have a reduced GHG impact when compared with a fossil-based synthetic fiber, but we don't know which of these biosynthetic options will provide the highest reductions in GHG impacts, or the impact they will have on land use and food security. More data on the different feedstock types for biosynthetic fibers is needed to support optimal choices, and this will enable the industry to make better decisions about where to focus its efforts in this sub-category of synthetics.

We also encourage the industry to think beyond partially biobased solutions, and innovate to come up with new solutions for 100% biosynthetic fibers that consider regenerative methods, land management, and the optimization of fiber and food crop global needs.

Scaled solutions for textile-to-textile recycling

To increase the scale of textile-to-textile recycling solutions, the industry needs to work together on setting up the infrastructure to support this. Gaps still exist between the collection/sorting sector and those operating textile recycling technologies.

This is in part because, for many years, the collection and sorting industry has built significant business around selling clothing for direct reuse without having to recycle, repurpose, or remanufacture garments. The infrastructure around this industry has been set up to operate this way, and making changes will have an impact on the business models on which these organizations are working.

Closer collaboration between collector/sorters and recyclers is necessary to ensure that business can be maintained, but that the right thing is being done for the environment. Diverting textiles to appropriate recycling technologies where the materials can be recycled to their highest value (e.g.,100% polyester items to a polyester-specific technology and blended fabrics to a technology capable of extracting more than one material from a blend into a useable recycled product) will begin to close the loop on these materials for the future. With the right infrastructure in place, materials can go back into the system again and again, and therefore create continued business for all parties involved.

Fiber fragmentation and biodegradability

There has been much discussion across the industry around the hot topics of fiber fragmentation and biodegradability, and continued research in both of these areas is needed. Scientific research on fiber fragmentation pollution has begun to gain momentum in the last five years or so, as study after study has revealed the growing prevalence of all fiber types in marine, freshwater, and terrestrial environments. In the context of synthetic fibers, a common term used for this pollution is "microplastics," which refers to fibers that are unintentionally shed from synthetic-based materials. Textile Exchange is working with The Microfiber Consortium (TMC) in this area and will be supporting the TMC's 2030 Roadmap. Further details on that roadmap can be found here.

Within our scope at Textile Exchange, we are focusing on a "recycling first" approach, there is a need to acknowledge and expand learning around biodegradability so that this can be brought in longer term. The industry must align on a methodology and approach to assessing fibers and materials for their biodegradability potential, whilst being open and transparent about the specific conditions under which biodegradation occurs. However, this can't be seen as a priority over – nor can it compete with - recycling solutions, as we can't lose sight of the scale and impact such technologies can yield in creating closed loop production systems.

Our direction of travel: The vision for a new path

The volume of synthetic fibers being produced and consumed throws the importance of taking bold action in this category into sharp relief. The vision for synthetic fibers at Textile Exchange is that we support and promote a transition towards a fiber category where there are no new virgin fossil-based materials entering the supply chain.

We envision that all the materials used in this category are sourced from a recycled or regenerative bio-based source. The vision for synthetic fibers is supported by the long-term goal that Textile Exchange has for this category of materials by 2030, which is that we will have accelerated the uptake of preferred synthetic fibers within the fashion, apparel, and textile industry, and that beneficial impact is maximized.

Proposed solutions: A call to action

Substituting conventional materials with preferred fibers and raw materials

Across the industry, it’s essential that we eliminate the use of virgin fossil-fuel-based synthetic fibers. Broadly, the approach that Textile Exchange is working towards regarding material substitution for synthetic fibers is as follows:

- Substitute virgin PET with recycled textile-to-textile feedstocks to lessen the industry’s reliance on plastic bottles and create a more balanced portfolio of feedstock solutions.
- Support innovations in biosynthetic materials, including polyester and polyamide. Ensure regenerative practices are integrated into the production of biosynthetic feedstocks–the fact that these materials are produced from natural sources does not automatically mean that their impacts are lower.

This approach will reduce GHG emissions and drive additional beneficial impacts for nature and people. To reduce GHG impacts even further, we need to work on decarbonizing polyester fiber production across the value chain by moving to renewable energy.

Scaling innovation and advancing existing solutions

Simultaneously, we must work on the development, expansion, and growth of existing solutions that help us retain the value of synthetic fibers over time and move towards a circular system.

This means increasing the efficiency of the existing machinery used in synthetic fiber recycling, as well as developing new recycling technologies. It might also involve scaling fully biobased synthetics or partially biobased synthetics blended with preferred feedstocks (e.g., recycled) whose production satisfies the goals set out in our Climate+ vision, providing it does not impede the recyclability of the material.

But innovation will also be crucial in a broader sense: it's only through innovation that we can come up with entirely new solutions for synthetics.

Creating value outside of new raw material production

In the short term, our priority must be to significantly reduce the total production of virgin fossil-based synthetics. At the design level, we must ensure that any synthetics-based clothing is created with circular end-of-life qualities—such as durability and the potential for recycling—in mind.

Designers must also have a rigorous understanding of the technologies being developed for textile-to-textile recycling. This will help to ensure compatibility with these processes when items inevitably re-enter the waste stream to be transformed into new materials.

Synthetic fibers are an excellent candidate for multiple-cycle recycling, and the scaling-up of innovations and technologies that support this are vital if we are to reduce the need for virgin materials to be produced.

Plant Fibers: Cotton

What we know: The urgency to act

Cotton is one of the most frequently used materials in the fashion and textiles industry, accounting for almost a quarter (22%) of global fiber production in 2021.[6] Supply chains worldwide depend on this natural, land-based raw material, and the healthy, functioning ecosystems needed to produce it. But we are already seeing cotton farmers having to adapt to the effects of climate change more rapidly than ever expected, putting livelihoods at risk. This growing season, we've seen the cotton industry suffer through floods, droughts, pest plagues, and fires across the globe, affecting farmers, ginners, traders, suppliers and many others involved in the textile industry.

Conventional cotton contributes to significant GHG emissions associated with cotton cultivation and is often chemically intensive. According to the UNFCCC Fashion Industry Charter for Climate Action's report "Identifying Low Carbon Sources of Cotton and Polyester Fibers," fertilizer production accounts for 29% of the GHG impact for conventional cotton. Field emissions account for 27%, and use of farm machinery for 13%.

Pesticides and fertilizers are applied to cotton with the aim of protecting the crop from natural interference from pests and/or increasing cotton yields. But the use of synthetic chemicals in cotton production raises many concerns related to human health, water contamination, and the degradation of soil systems. Beyond that, our soil has been depleted of its critical nutrients and so proves to be less able to adapt to the implications of climate change.

Moving to regenerative and organic farming systems has the potential to sustain and promote the health of soils, ecosystems, and people by relying on ecological processes, biodiversity, and cycles that are adapted to local conditions, rather than using external inputs that could have adverse effects. However, according to our 2022 Organic Cotton Market Report, only 1.4% of cotton was currently grown organically in 2022.

There are no silver bullet solutions to systems change, and the transition from conventional cotton production to regenerative and organic practices won't happen overnight. Breaking down the challenges farmers face in this transition requires ongoing dialogue with stakeholders from all stages of the supply chain. It's about moving away from seeing organic cotton simply as a commodity and recognizing that it's the result of ongoing collaboration, collective action, and commitment. This will in return, build stronger and more resilient ecosystems and establish new, healthier foundations for those generations to follow us.

[6] Textile Exchange, 2022. Preferred Fiber and Materials Market Report.

The GHG impact of cotton - 2019 baseline

The baseline year from which the 45% reduction is calculated is 2019. The 2019 GHG impact for cotton[7] is estimated to be ~47 million tonnes CO2e. Conventional cotton accounts for around 98% of the GHG impact across cotton.[8] It should also be noted that where LCA data is not available for a particular cotton program, the impact is modeled off conventional cotton. Figure 4 presents the 2019 baseline impacts for cotton.

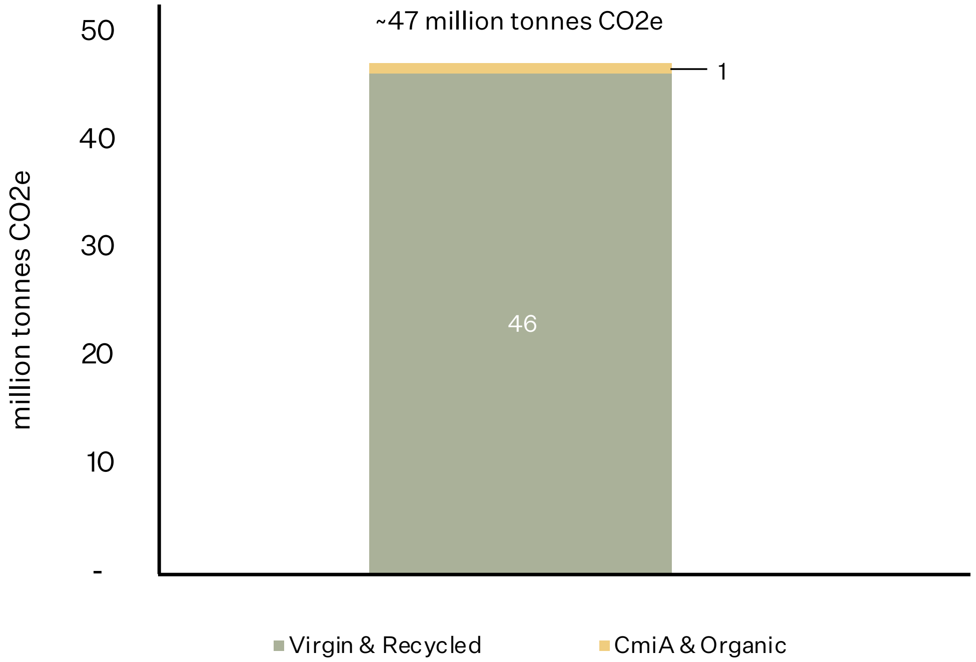

Figure 4: GHG impact of cotton for the 2019 baseline. This impact considers the following sectors only: fashion and apparel, home textiles and footwear. Virgin and recycled cotton includes conventional cotton impacts and cotton program impacts where data is not available (excluding organic cotton and CmiA). CmiA and Organic impacts includes these two options only. Sources: Production data–Textile Exchange's Preferred Fiber and Material Market Report, 2022; Sector split data–Textile Exchange Data and Technology Team research, 2021; Results were calculated using HIGG MSI 3.3 data at Higg.org. Retrieved by Textile Exchange in March 2022'.

[7] The cotton impacts include conventional, organic, recycled and Cotton Made in Africa (CmiA). All other cotton programs, where impact data is not available, are modelled off conventional cotton.
8 It is estimated that 29% of the GHG impact of conventional cotton production results from the use of fertilizers, 27% from field emissions, 19% from irrigation and 13% from machinery used. This information has been taken from the Fashion Industry Charter for Climate Action Report, Identifying Low Carbon Sources of Cotton and Polyester Fibers, figure 2.2.1.1

What we don't know: The gaps to solve for

Two important streams of work need to happen simultaneously for us to unlock new ways to reduce impact in cotton sourcing: generating and improving access to reliable data, and improving traceability in cotton supply chains so companies can confidently measure the positive impacts that their decisions are having on the ground.

Right now, there are a number of data gaps that exist across the cotton category. Impact data from LCAs is only available for organic, conventional, recycled, and Cotton Made in Africa (CmiA) cotton. No other cotton programs have specific impact data that can be used within impact modeling. Where LCA data is not available, we take a conservative approach by modelling cotton programs using conventional cotton data.

We are currently working on LCA studies to refresh the impact data used for conventional and organic cotton, using an LCA+ approach to go beyond the impact areas typically covered in LCA methodology, such as biodiversity, soil health, and social responsibility. We will have some more details in the next year to 18 months—but we can't wait for that information before we start to take action.

Tracking soil health, alongside water quality and biodiversity, can give us a much more holistic picture of cotton's impact than focusing on commonly used indicators like greenhouse gas emissions alone. The more data we can collect on these interdependent impact areas, the better we can help companies understand the implications of their sourcing decisions all the way back to farm level.

With data and increased information, growers and producers are better able to protect their farms, businesses and livelihoods; and we are better able to prove the need for new business models and incentives that lead to meaningful action. However, it's vital to recognize that although our industry will constantly be evolving its impact data and methodologies, there will always be gaps in knowledge. If there are actions, we can take today that will make a meaningful difference—and there are—it's vital that we do them.

To learn more about cotton data gaps, please visit the UNCCC Fashion Industry Charter for Climate Action's report "Identifying Low Carbon Sources of Cotton and Polyester Fibers".

Our direction of travel: The vision for a new path

We aim to drive the transition to a resilient global cotton industry that works with nature, not against it, ensuring a sustainable future for everyone involved in its production.

For us, the relationship between cotton, ecosystems, and communities starts in the soil. That's because its environmental impact varies greatly depending on farms' operational systems and regions, and there's no better indicator of this impact than the quality of the land where it is grown. Tracking soil health, alongside water quality and biodiversity, can give us a much more holistic picture of cotton's impact than focusing on indicators like greenhouse gas emissions as a standalone.

Our direction of travel for cotton is made up of four impact levers that move us along our journey from reducing negative impacts to accelerating the adoption of practices that have measurable positive ones.

- Educate the industry about the external inputs cotton uses, and which ones are associated with negative impacts.
- Move away from using global averages to determine the impacts associated with cotton, and look at the local context.
- Raise our ambitions from reducing harm to maximizing beneficial impacts.
- Rapidly scale in-conversion programs to accelerate the adoption of organic and regenerative approaches that complement one another and are grounded in shared principles.

All of this won't be possible unless we improve traceability in the cotton supply chain, as well as generate and improve access to reliable data.

Proposed solutions: A call to action

Substituting conventional materials with preferred fibers and raw materials

Best practice for cotton means taking a holistic, place-based, outcomes-focused approach. While we must continue to collect data, measure impact and study outcomes, we can implement on-the-ground changes that will start to support soils, ecosystems, and farmers already. These are the first steps towards meaningful change.

Reducing negative impacts across interdependent areas including soil health, water, and biodiversity starts by immediately addressing inputs like pesticides and synthetic fertilizers. This includes incentivizing the adoption of alternative practices and sharing financial risks and opportunities.

Beyond this, cotton farmers, mills, and brands can harness the potential of cotton farming to create positive co-benefits to the lands and hands that help it to grow. This includes sourcing from, committing to, and supporting programs that require farmers to move towards more sustainable agricultural practices, like in conversion cotton.

We're calling on companies to invest in initiatives that are developed in full financial partnership with farmers, Indigenous communities, and researchers, to generate data on the beneficial impacts of these agricultural systems. Ultimately, we want to accelerate the development of landscape-level solutions that break down silos and build lasting commitments along the supply chain, from seed to stitch.

Scaling innovation and advancing existing solutions

Regenerative agriculture: Today, we have clear examples that regenerative practices are working and result in beneficial impacts and outcomes across many pilots and programs implemented across the globe, as detailed in our Regenerative Agriculture Landscape Analysis published in 2022. Exciting new advancements are already being made in regenerative farming methods and approaches. New technology and machinery is under development and being trialed for farmers to plant seeds mechanically without the need for tilling. Cover crops with new variations and rotations are being tested to evidence the best results for soil heath and yields. Synthetic fertilizers and defoliants are being replaced with organic inputs that are local and native to the growing region, which can result in a significant GHG reduction when growing cotton. These new approaches are deemed innovative as we are pairing best practices and activities to yield the best results, in addition to monitoring soil health, water consumption, and farm productivity.

The urgency to scale and replicate these methods at a global level is evident. In order to make this a reality we need strong collaborations across the value chain with engagement at national and regional levels, with the private sector and governments working together to unlock and maximize true potential.

Cotton recycling: We also need to advance innovation aimed at using cotton waste as feedstocks for future fiber production. Textile-to-textile recycling is a pathway to reduce our dependency on virgin cotton and diversify feedstocks. All of this requires new partnerships across the value chain and investment in mechanical and chemical recycling processes and technologies that maintain fiber quality, consume less energy and/or use clean energy and avoid the use of hazardous or toxic chemicals in production. Innovation also requires data collection mechanisms and methodologies to prove that these new recycling technologies result in improved or beneficial outcomes. Once we have the data to assess and evaluate such innovative fibers and raw materials, we can then classify these new fibers as proven, "preferred" options.

Traceability: None of this will be possible unless we are able to advance and scale solutions for tracing cotton back to the farm level and for ease of future recyclability. Such traceability mechanisms and technologies are critical for identifying the origin and material composition, for data collection, and for creating more meaningful relationships from farm to final product. Stakeholders can strengthen their commitment to cotton sourcing by getting to know the farmers that grow it and better understanding their needs. This level of understanding is critical, and the scaling of solutions is nearly impossible without it.

Creating value outside of new raw material production

Given the rate at which we produce and discard clothing and textiles, garment and textile waste, including cotton, is an abundant feedstock for new material production. But while there are multiple closed-loop textile-to-textile technologies engaged in a race to the top, many of the dilemmas we face are concentrated at the bottom, and stem from collecting and sorting textile waste at scale.

Another avenue to explore is that of creating value for farmers outside of the increased production of new virgin cotton. As the effects of climate change, land degradation, and food scarcity will likely put increasing pressure on cotton farmers, making resilience and adaptation essential to improving farmer livelihoods and that of their communities.

The textile industry can play a significant role here through cross-sector collaboration and farm level support as farmers transition to more varied production systems and income sources. Exploring the production of cross commodities across the textile and food sectors is one approach to promote healthy ecosystems whilst maintaining farmers' incomes and protecting the livelihood of the communities. Increasing the diversity of the crops produced also plays into adopting regenerative practices that bring multiple benefits for climate and nature.

Animal fibers: Wool

What we know: The urgency to act

In volume terms, sheep wool is the most common animal fiber used in the fashion and textile industry, accounting for 1% of the global fiber market in 2021. It's natural, breathable, and resilient, and has good insulation and thermo-regulating properties. It reacts to changes in body temperature to keep the wearer warmer when it is cold and cooler when it is warm.

The key challenges associated with sourcing animal fibers are animal welfare and environmental impact. In terms of animal welfare, sheep, for instance, can be subject to painful procedures such as mulesing—the removal or destruction of wool-bearing skin. Mismanagement and mishandling are also a risk—for instance, when animals are sheared or combed to remove their fiber. In terms of environmental impact, fiber-producing animals are ruminants and so produce GHG methane through enteric emissions. Poor land management and overstocking can also damage soil and reduce habitats for wildlife.

We believe that through regenerative land management systems, the climate impact of animal fibers can be reduced, and these farming systems can improve biodiversity, water and soil health while respecting the rights of people and animals. While we know that the extensive grazing practices commonly used in animal fiber production can deliver animal welfare and land and biodiversity benefits already, we also know that improvement is needed.

Some of those improvements include getting better production from each animal in terms of lambs and wool–while still respecting animal welfare–as well as looking at types of feed and feed additives that reduce GHG emissions, and how much fuel and other energy is used to run farm machinery and other equipment.

The GHG impact of wool - 2019 baseline

The baseline year from which the Climate+ 45% reduction target is calculated is 2019. The 2019 GHG impact of the animal fiber category is estimated to be around 35 million tonnes CO2e.[9] The biggest impact in the animal fibers category is driven by sheep wool, which accounts for roughly 98% of the GHG impact for the animal fibers category. Figure 5 presents the 2019 baseline impacts across the animal fiber category:

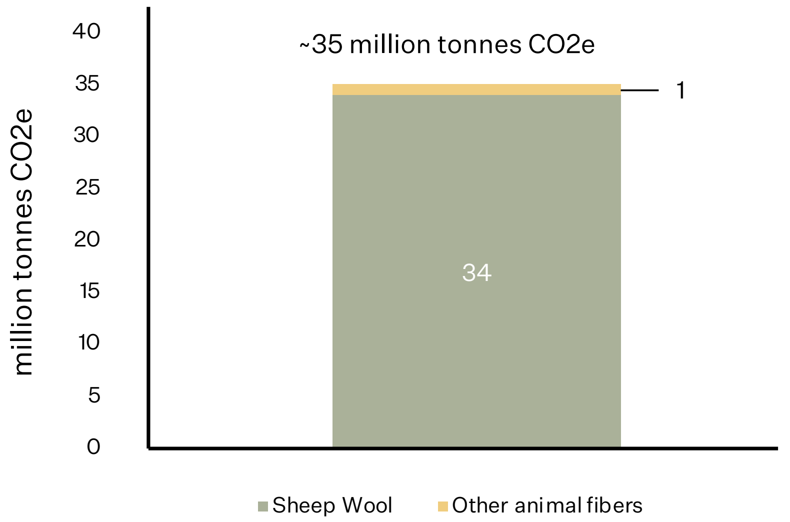

Figure 5: GHG impact for animal fibers for the 2019 baseline. This impact considers the following sectors only: fashion and apparel, home textiles and footwear. Sources: Production data–Textile Exchange's Preferred Fiber and Material Market Report, 2022; Sector split data–Textile Exchange Data and Technology Team research, 2021; Results were calculated using Higg MSI 3.3 data at Higg.org. Retrieved by Textile Exchange in March 2022.

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[9] The animal fibers category includes wool (virgin and recycled), alpaca and down. Other animal fibers are not included in the GHG impact calculation due to the lack of impact data/LCA data available.

What we don't know: The gaps to solve for

Impact data for animal fibers

While we support certification to make sure animal welfare is upheld, and regenerative land management systems in order to protect and potentially improve the health of the environment, we can't yet quantify the scale of difference this makes to the climate cost of wool and other animal fibers. But, there are "no regrets" actions that we can take now to move us in the right direction. For example, protecting or restoring natural habitats on farms is going to give a positive outcome for biodiversity, and the benefits can be observed in person, on the ground.

We are working on an LCA for animal fibers, including cashmere as well as wool and mohair certified to the Responsible Wool Standard (RWS) and Responsible Mohair Standard (RMS). We're using an LCA+ approach to go beyond the conventional LCA approach and to account for other key factors, like biodiversity, animal welfare and social responsibility. We will have some more details in the next year to eighteen months—but we can't wait for that information before we start taking action.

Our direction of travel: The vision for a new path

For animal fibers like wool, it's about learning from the land. Many of the actions we can start to take might not yet be quantified through exact data, but they result in holistic impacts that can be observed by the farmers and ranchers that produce them. The piece that's missing is translating this evidence into numbers, and that can be done later. The important thing is that we start to act.

At the farm level, we need to markedly increase the number of farms that are certified to ensure good animal welfare and good land management. Certifying farms and farm groups connects us with farm-level activity. We can collect data, support training, communicate industry expectations as well as providing financial support for infrastructure and resources needed to transition towards regenerative practices.

We need to continue to use technology to map the location of farm groups and compare this with biodiversity hotspots, watersheds and other key environmental factors in order to target the most important actions for different countries and regions. In addition, we need to work collaboratively with stakeholders in their jurisdictions, including communities, Indigenous Peoples and conversation experts with localized knowledge.

We need processors and brands to ramp up demands for certified fibers, and beyond that, to support key regional actions—for instance, introducing regenerative land management techniques, or supporting biodiversity restoration.

Proposed solutions: A call to action

Substituting conventional materials with preferred fibers and raw materials

Material substitution: In the short term, we need to focus on "preferred" forms of wool. This includes several different certifications for virgin wool. As part of our current standard review work, we are strengthening the requirements within our Responsible Animal Fiber (RAF) standards to better align with our Climate+ aims and introduce additional outcome measurement possibilities.

We'll continue to engage with other animal fiber certifications as our definition of "preferred" evolves, with the goal that, as a sector, we all move the needle in the right direction, and greatly increase the volume of certified wool. Globally since the RWS–the first standard specifically for wool–was first introduced in 2016, the volume of certified wool, defined as preferred by Textile Exchange, has grown to over 58,000 tonnes of greasy wool. This is an amazing result but only accounts for 3% of all wool production. We need to urgently accelerate the uptake of certification.

Other options for preferred wool include recycled wool, the use of which markedly reduces environmental impact–though it is not usually possible to verify animal welfare from the sheep that originally produced the wool. Organic wool is another option, although in animal fibers the benefit of organic versus non-organic is not as clear cut as in other materials such as cotton where non-organic production is more reliant on synthetic inputs. In addition, some organic certification is short on detail concerning animal welfare requirements.

Incentivizing best practices: These are shorter-term solutions. In the longer term, we need to shift towards certified wool production with measurement and verification of regenerative outcomes. This could involve greater cooperation between the animal fiber and food sectors, engaging with different livestock production types and systems, and wider fiber ecosystems.

And as we move in this direction, we can also explore and develop new and more sophisticated funding models that improve the livelihoods of those involved in the production of animal fibers. This includes making use of Impact Incentives to drive change in those regions where additional support to gain certified status, adopting regenerative practices, and measure the outcomes is needed, and to reward those farms that have embedded climate action into their work.

If we can give farmers more clarity around what we as an industry expect, as well as signposting the technical and financial support that can help them transition, we can encourage and incentivize best practices and climate- and nature-friendly forms of production. This will require commitments, goal setting and financial investment from all players up the value chain.

Scaling innovation and advancing existing solutions

Regenerative agriculture: As noted above, in the long term we need to shift towards wool production with regenerative outcomes. While the term regenerative has become a buzzword in recent years, there is still sometimes confusion about what regenerative agriculture entails. While there is different, and sometimes conflicting, advice on a variety of different practices that could be used for regenerative production, there is agreement on the outcome of beneficial ecosystems services that should be delivered. Another key aspect of regenerative production is continual improvement: unlike traditional certification where the goal is to achieve a set level of management.

So, although regenerative is much talked about, it is still an innovative solution for wool and other animal fibers. While the principles are understood, individual farmers must adapt them to their specific landscape and climate. What works in one context may not work in another, so best practices should be adapted to regions and support local peer-to-peer learning. Changes to regenerative management also often require new infrastructure. One example is the need for new fencing to facilitate changes in grazing management: regenerative management tends to focus on rotating animals through smaller areas of pasture rather than leaving animals for longer periods of time in larger pasture areas. To achieve this, existing pastures need to be subdivided with new fencing, and new water troughs and additional handling facilities will be required.

Creating value outside of new raw material production

Right now, global fiber production is increasing year on year. If the industry is to meet its climate goals on time, this growth needs to slow.

But wool shows us just how interconnected different fiber categories are. Reducing production in one category, but increasing it in another, doesn't move us any further towards where we need to go.

As synthetic materials have come to the fore in recent decades, the value of wool dropped, and sheep numbers declined. For example, New Zealand now has around 26 million sheep compared with a peak of around 70 million in 1982. However, this does not mean that today's imperative to reduce overall production does not apply to wool. If, for example, sourcing strategies reduce the use of virgin synthetic fibers, it should not be taken as a signal to simply move growth to, or *back* to, a different fiber type. In the context of wool, it's important to remember that switching the demand rather than starting to reduce it could result in increased land pressure, leading to issues such as overgrazing.

In this category, we should support the resale and repair of animal fiber-based materials. We should also throw our weight behind increased recycling, as wool and other animal fibers lend themselves to this and the infrastructure is already in place. Designers, equally, need to be on board with the broader climate action from the organizations they represent. By creating garments from animal fibers produced in systems that deliver regenerative outcomes that are durable, enduring, recyclable, and have other end-of-life qualities, the need to produce will automatically decrease. Ultimately, the vision is to reach the balance needed for well-managed sheep support positive climate outcomes from healthy grassland ecosystems.

Manmade Cellulosics: Viscose

What we know: The urgency to act

MMCFs are one of the fastest-growing fiber categories in the textile market. This growth can be attributed to many different factors, such as their renewable provenance, performance, and potential for systematic circularity. Today, the vast majority of MMCFs are produced using forest biomass. Trees, from both plantations and natural forests, are grown, harvested, and chipped to produce the pulp that feeds the industry.

When responsibly managed, forests can provide the wood and other resources we rely on in daily life while simultaneously capturing and storing carbon, producing oxygen, and directly mitigating climate change. The role forests play in the latter is extremely important. Conversely, when forests are not responsibly managed, or are altogether cleared to produce crops or for other purposes, the impacts are detrimental. When a forest is cleared and the land converted, it can't simply be regrown or left to regenerate. In other words, when it's gone, the role it played in mitigating climate change and protecting biodiversity, habitats and ecosystems is gone with it.

Many of the issues the MMCF industry is facing today stem from the management of the forests and tree plantations that feed the industry. It can be assumed that chips and pulp from deforestation activities still enter the supply chain, even if unintentionally. As reported in our 2022 Preferred Fiber and Materials Market Report, approximately 40% of the feedstock for the MMCF industry came from "conventional/unknown" sources in 2021.

The 60% of known or "certified" feedstocks were supplied by companies tracking their feedstock supply chain through certification schemes such as the Forest Stewardship Council (FSC®) or the Programme for the Endorsement of Forest Certification (PEFC). Although the percentage of feedstock certified by any one of the various certification schemes continues to increase, we must collaborate as an industry and commit to 100% sustainably sourced feedstock, and ensure that complete chain of custody is embedded, tracking from fiber to final garment.

The GHG impact of viscose - 2019 baseline

The baseline year from which the 45% reduction is calculated is 2019. The 2019 GHG impact of MMCFs[10] is estimated to be around 33 million tonnes CO2e. Viscose accounts for approximately 88% of the MMCFs GHG impacts. Figure 6 presents the 2019 baseline impacts across the MMCFs category:

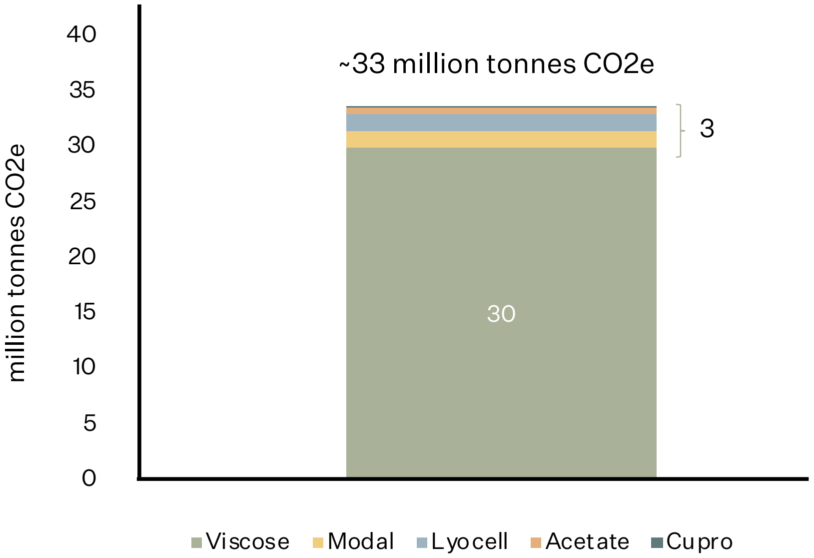

Figure 6: *GHG impact for MMCFs for the 2019 baseline. This impact considers the following sectors only: fashion and apparel, home textiles and footwear'. Sources: Production data - Textile Exchange's Preferred Fiber and Material Market Report, 2022; Sector split data - Textile Exchange Data and Technology Team research, 2021; Results were calculated using Higg MSI 3.3 data at Higg.org. Retrieved by Textile Exchange in March 2022*

[10] MMCFs impacts include viscose, lyocell, modal, acetate and cupro. The impacts of conventional MMCFs are modeled only due to the limited production data available across MMCFs programs.

What we don't know: The gaps to solve for

When looking at the MMCF industry as a whole, it's clear that there are many opportunities to collect more data and information that can inform adaptive management and the kind of decision-making that will help us reach the goals of Climate+ and our GHG emission reduction targets.

As noted above, feedstock traceability is widely a data gap; but there are other gaps that extend beyond the scope of raw material procurement, or simply are not aggregated or widely available at a supply chain level, such as fossil-fuel-generated electricity use in manufacturing operations, chemical and air emission data, and other information related to the state of the industry and its environmental impact. Data gaps also exist when it comes to topics such as viability of alternative feedstocks and their impact when compared with traditional woody biomass feedstock.

As the industry pushes to identify alternative feedstock sources to wood, we must be making these decisions through a critical and objective lens that allows for a direct comparison. This can be done by utilizing LCA and LCA+ approach that goes beyond the scope of a traditional LCA to look at ecosystem impacts on soil, water, and biodiversity. The LCA+ approach also incorporates and assesses the impacts on the communities and people affected by the industry. Historically, these communities, in this and other industries, have been overlooked. Placing these "environmental justice" communities and Indigenous Peoples front and center, and engaging them to participate in the decision-making process, must be a priority for the industry.

Our direction of travel: The vision for a new path

Our vision is for the MMCF sector to become a leader in sustainable forestry and industry transformation by scaling innovative solutions and putting a stop to the extractive forest management practices that lead to the destruction of forest ecosystems, such as deforestation or ecologically harmful harvest of trees and timber. To realize this vision, the MMCF supply chain must engage like never before and focus on developing next-generation materials, circular business models and committing to restorative action.

MMCFs offer the opportunity to drive environmental benefits at a global scale. For this to happen, the sector must realign by moving away from the extractive practices as mentioned above that have traditionally driven the industry and embrace a stewardship economy approach. An approach that doesn't force an "either/or" choice between profit, environment, or social benefit but instead challenges us to make "and" decisions: decisions that generate profit *and* restore ecosystems *and* improve the quality of life of those involved in, and impacted by, the industry.

Proposed solutions: A call to action

Transforming the MMCF industry from an extractive-based economy into a stewardship economy will require collective action and commitment. Waiting for another to solve the problem is no longer acceptable or responsible. Below, we have compiled a list of proposed solutions for the MMCF industry to act upon.

Substituting conventional materials with preferred fibers and raw materials

Material substitution is a major opportunity for improvement within the industry. This term can be misleading: it includes not only substitution, but also the activities related to sustainable feedstock procurement.

Forest restoration and stewardship: The forests that provide feedstock for the industry must be cared for and responsibly stewarded. Doing so will not only ensure these ecosystems have the capacity to continue providing for the industry in the future, but also leverage their ability to mitigate climate change; protect biodiversity, communities and livelihoods; and sequester carbon at a globally effective level. Historically, forests have been exploited for their resources, which has led to the loss of entire forests and environmental issues that extend beyond the obvious impacts. Investing in forest restoration and using the residuals from restoration activities is the foundation of a sustainable and environmentally responsible MMCF industry.

Material tracing: Eliminating unknown biomass sources from the supply chain is vital to ensuring no material from deforestation activities makes it into the supply chain. Deforestation is a major issue throughout the world and committing to sourcing *only* sustainably procured feedstock is critical. Beyond this, striving to source sustainably harvested feedstock on a more localized scale reduces reliance on imported/exported material and the associated impacts of transportation.

Alternative feedstocks As the technology for MMCF production continues to develop, the ability to incorporate alternative feedstocks, such as agricultural wastes or other cellulosic biomass, increases. Identifying alternatives, assessing their viability, and incorporating them into production processes will decrease the demand for forest biomass and offer new opportunities for the industry.

Eliminating fossil fuel electricity: Coal, natural gas, and other fossil fuels are still commonly used to produce electricity across the globe. These fuels not only produce harmful emissions but also have negative impacts for the communities where they are mined or drilled. Technological advancements have driven the cost of renewable energy generation systems down significantly in the last decade and are now more accessible and affordable than ever. Controlling the overhead costs associated with energy use through renewable energy development often offers a cost advantage as well. “Cleaning up” electricity sources and eliminating reliance on fossil-fuel-generated energy is low-hanging fruit for the industry, and is an easy way to reduce emissions and environmental impact.

Scaling innovation and advancing existing solutions

The MMCF industry has an outstanding record of innovating and driving technological advancement when it comes to manufacturing and the development of new products and processes. These innovations are responsible for where the MMCF industry is today. Continuing to focus on and invest in innovation will ensure the industry reaches its potential to be a leader in sustainability and circularity.

Textile-to-textile recycling: Both pre-and post-consumer textile wastes present an opportunity to apply the innovative spirit the MMCF industry is known for. There are numerous complexities associated with textile-to-textile recycling, but if those complexities can be addressed, there are many opportunities. Developing and implementing strategies to bolster fiber recycling activities will take communication and collaboration across the supply chain from manufacturers to retailers.

Manufacturing advancements: The complexity of manufacturing MMCFs often means that the feedstocks required by a system must be uniform and consistent. This leads to specific requirements about what can be used in a fiber manufacturing operation. Investing in technological innovations that expand what a system can take offers the opportunity to allow more diverse feedstocks to be used to produce MMCFs.

Creating value outside of new raw material production

Closing the loop: Next-generation MMCFs derived from textile and agricultural waste can play a huge role in creating closed loop production systems and solutions to lessen our dependency on virgin, wood-derived feedstocks – made from trees.

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