



AMBIENTA

Environmental Investments



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Sustainable innovation in the textile industry: the answer to an ever growing polluting value chain

The evidence of weaving activities dates back to around 5000 BC. For thousands of years the textile industry has developed around natural fibres being transformed into clothes to protect from cold weather or strong sun exposure. Today, the textile industry creates more plastic waste than Germany's urban waste and consumes more oil than the whole of France. This can be attributed to the massive changes of the last 150 years. The industrial revolution, the invention of synthetic fibres and ultimately fast-fashion trends have amplified the impact of the textile industry much beyond the boundaries of our wardrobes. An impact which has even expanded to include industrial applications as airplanes, cars, machinery and construction goods. There is a long journey from agricultural

fields and oil fields through to processing, dyeing, weaving, finishing and distribution. Because of this, people often do not appreciate the complexity of the value chain behind a coat, a swimsuit or a parachute, to name only a few modern textile products. When we buy a pair of jeans we rarely reflect on how they have been made and we certainly neglect the environmental footprint when we throw them into the trash bin.

In this newsletter we unpack the textile industry's value chain and its drawbacks. The extent to which this industry is growing into a global environmental priority will astonish much of our audience. From our perspective it is not a surprise, but another great opportunity to reconcile economic and sustainable development.

People scour a mountain of used clothes that are being sold at low prices in Cordova, Cebu, Philippines
@ViewsByDrones - 2015

Textile industry: a deep-rooted and outgrown companion of mankind

The textile industry has played a central role in the history of mankind: from the wool industry during medieval England to the Silk Road in Asia and the cotton plantations in southern US. These examples remind us of major historical events or periods of history.

For millennia raw materials were completely natural; wool, silk, and cotton all come from either animals or plants. The same was true for major production consumables such as dyes. Materials often express preciousness in their own nature. Silk, for example is the epitome of preciousness among textile materials: its rarity and price is derived from its long journey through Asia to reach western markets. In ancient Rome, the Tyrian purple was the colour of the Senators' robes, the tremendous cost of which was related to crushing thousands of sea snails to extract a few grams of dye. Until recent decades, Royal Purple referred to a colour that could only be afforded by Kings and Bishops. Availability of materials and complexity in processing defined the price of the final product. Nonetheless, even then, most people did not

understand the origin or the production process behind a certain product. When cotton was introduced to Europe in the medieval age from India, it was so deeply associated with wool that in some text it was described as a plant used to feed lambs that would then produce cotton instead of wool. The German term for cotton, Baumwolle, literally means "tree wool".

Between the industrial revolution and the economic boom after the Second World War, the industry was completely reshaped. Three main changes impacted the industry: ① productivity enhancements from technological innovation in machinery and the introduction of new synthetic materials for ② dyes and for ③ fibres.

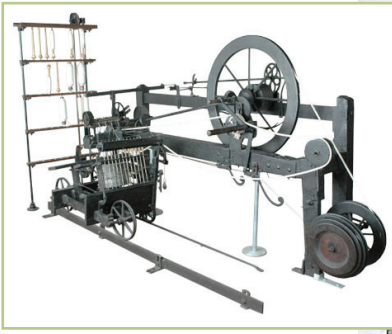
① From the mid-18th century, the flying shuttle, the spinning jenny and the Crompton's mule drove the cost of cotton yarn down by 90% and reduced the number of workers required to turn wool into yarn by 80% in the decades leading up to 1830. This paved the way for the development of a large textile industry in Britain and the growth of global trade to feed the growing upper-class fashion demand. Raw cotton imports from the Americas increased eight times and refined cotton became half of Britain's exports at the time.

② In the late 19th century, the issue of the availability and cost of dyes was solved when the first synthetic dye for mauveine was accidentally discovered by William Perkin in 1856 and the first synthetic indigo was created by BASF in 1897. Until then all colours relied on expensive and unstable natural materials such as plants (for indigo) or animal (such as for Tyrian purple). These inventions were so impactful that they reshaped whole value chains in fifteen years: the production of plant-based indigo dropped from 19,000 tons in 1897 to 1,000 tons in 1914.

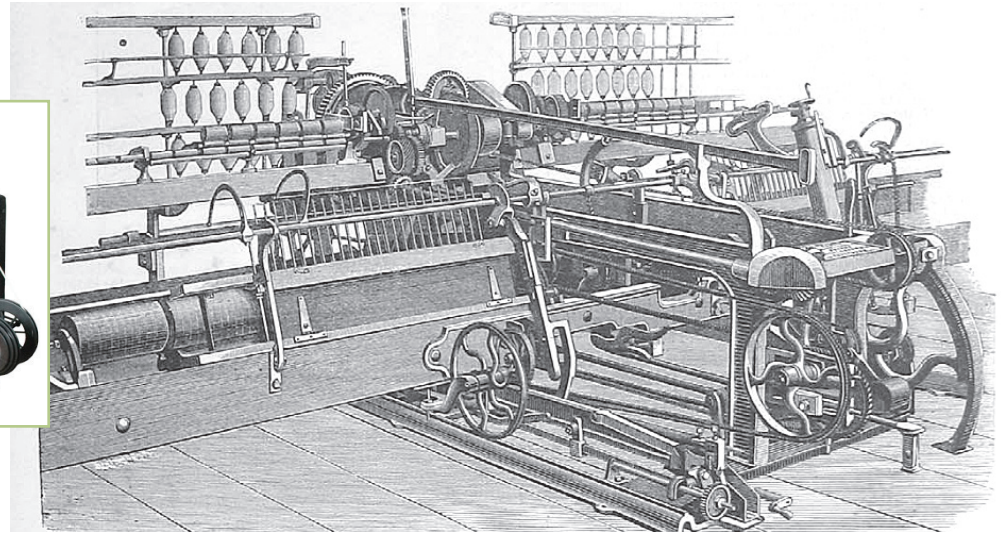
③ In addition to this, the introduction of man-made fibres provided the ultimate shake-up to the industry value chain. Experiments with semi-synthetic artificial silks, viscose rayon and acetates in the late 19th century led to the development of the first fully synthetic fibre, nylon, by Wallace Carothers, a researcher at DuPont in the 1930s. Polyester, the most used synthetic fibre today in the clothing sector, came to life in 1941. After 70 years, man-made fibres have come to dominate the market because of their cost, the availability of raw materials (mainly oil) and specific properties such as higher durability, workability with dyes or consumer-friendly functions such as stretching, waterproofing and stain resistance. Today, man-made fibres represent more than 70% of global production, weighing 70 million tons per year



The Tyrian purple dye and the sea snails of the Muricidae family it comes from. ©Renars Pranevskis; Sergio Delle Vedove



The only surviving example of a spinning mule built by the inventor Samuel Crompton, Bolton Museum (Greater Manchester) and a cotton mill around 1900

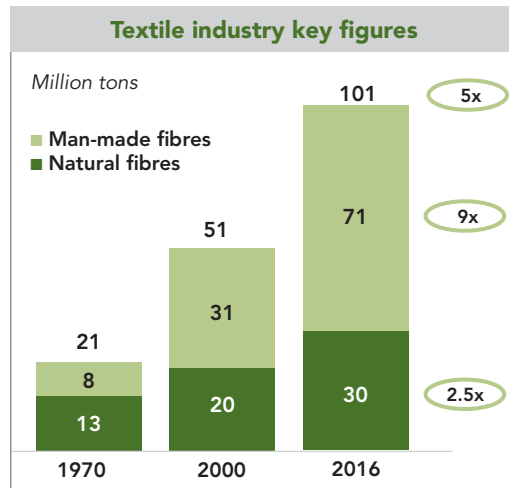


(equivalent to the weight of about 30 million cars, one third of global car production per year). More modern fibres, like carbon fibres or aramid fibres, have in turn defined the segment of “technical textile”, which is today the fastest growing segment and represents 20% of global fibres production. These materials have become critical materials for space and aeronautical

applications, dentistry or orthopaedic surgery, wind turbines, optical cables and flame-resistant clothing, just to name some areas of application.

The three innovations mentioned above are at the core of the technical evolution that has supported industry growth for over a century. In the last fifteen years two new factors have come into the picture on the consumer side: the booming middle class in developing economies and the fast fashion consumer model. They have doubled annual clothing unit sales from 2000 to 2015. This additional demand has been almost completely satisfied through an increase in man-made fibre production, since the potential yield of natural fibre production is capped by available land for agriculture and livestock. This growth represents additional resource demand and industrial activities and it comes at a cost for the environment. This cost is mostly invisible to consumers searching for a new pair of jeans, but it is there!

The tremendous growth of man-made fibres over the last 50 years



Behind the scenes: a linear, wasteful and polluting value chain which is still expanding its footprint

In 2015 global clothing sales reached 100 billion units, double the figure of 50 billion units in the year 2000. This represents an annual increase of almost 5%, even during the 2008-2009 global financial crisis. Global growth of consumer standards has certainly played a decisive role, as it has done in many other industries since 2000.

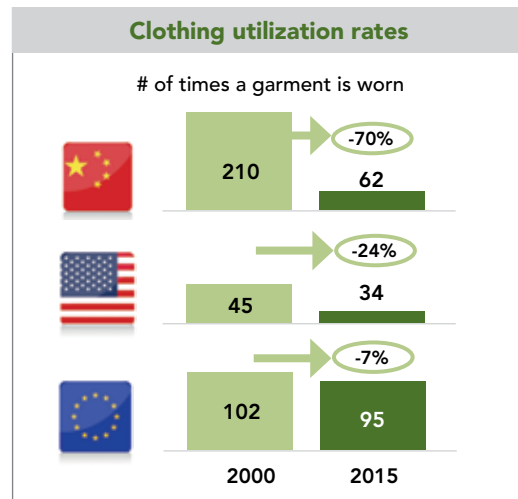
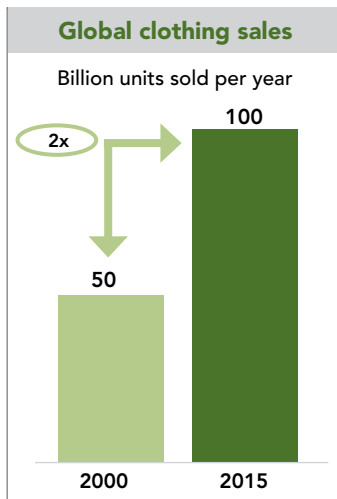
For instance, global car and light commercial vehicles sales moved from around 60 million to roughly 100 million over the same period. This exemplifies a similar, yet not as drastic, increase, especially when considering the fact that clothes are necessary goods and, in many parts of the world, cars are luxury items and ownership is not always common. The growth

in clothing sales has become iconic of growing consumer standards and consumerism. Since global population grew far less in the same fifteen years (roughly 1% per year, from 6.1 billion to 7.3 billion) it means that each person bought many more clothes than they used to. Even more when considering that half of this population growth occurred in Africa and India, who have not yet extensively participated in this consumer standards improvement. This is strongly reflected in the clothing utilisation rate, which expresses the number of times a garment is used before being disposed of. It shows a widespread decrease of utilisation

the availability of cheap raw materials, such as plastics, coupled with demand side fast fashion trends, have created a perfect storm in the clothing industry. Clothing has become extremely affordable and this has pushed people to own more items, sometimes just to wear them a couple of times.

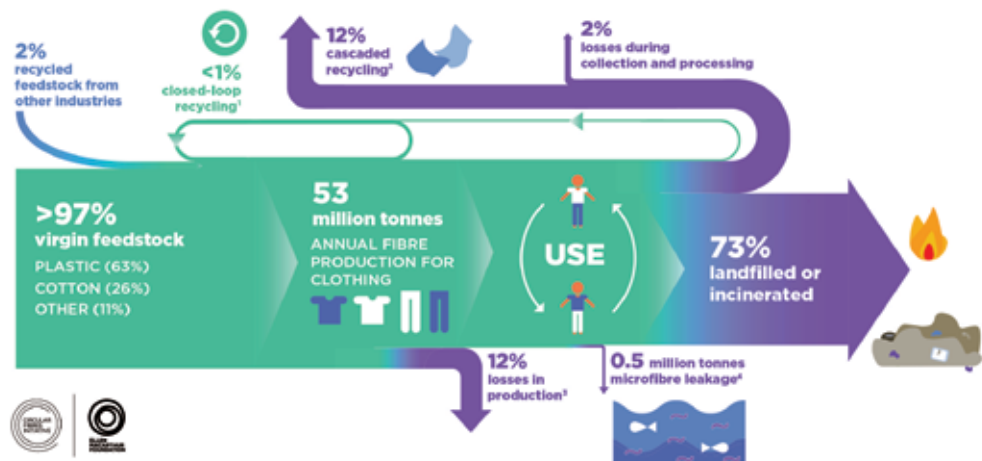
The change in utilisation rate is a pretty common trend among modern consumers, but is particularly pertinent from an environmental perspective to the clothing industry. This is because the clothing industry is an extremely linear industry, typical of low value items whose opportunity cost for collection and recycling outweighs the production of a brand-new item. The clothing industry uses more than 97% virgin feedstock, from both natural and man-made origin (primarily plastic), and only 12% of output is recirculated into a new product after disposal. Clothing waste is significantly mixed and often each piece is made up of different materials, making recycling into new clothes almost impossible. More commonly, garments are recycled into lower value applications such as insulation materials or mattress stuffing. Even the production and distribution steps of the value chain are not particularly sensitive to wastage. These stages can accommodate around 12% of production losses between factory offcuts and overstock liquidation, a figure that in some industries represents the whole value chain economic margin. This behaviour probably reflects the textile industry's involvement in relatively rich end markets like the fashion goods area.

Clothing industry shows a declining utilization rate across all geographies



rates across all major geographies. The figures are dramatic, particularly in the case of China, whose utilisation rate of garments has dropped by a factor of three in just fifteen years, far below European figures.

Supply side technological innovation and



The clothing industry global material flow (Source: Ellen McArthur foundation)



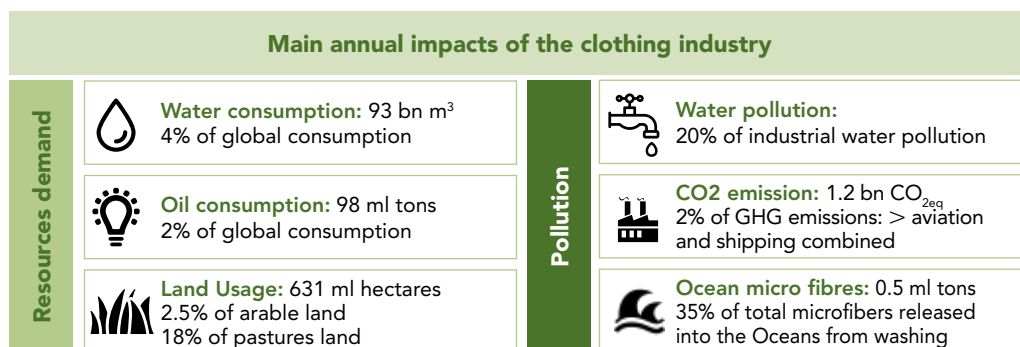
Bales of used clothes, mainly jeans, waiting to be incinerated. Guangzhou, Cina.

The astonishing outcome of this phenomenon is reflected in a single figure: 73% of global clothing sales are landfilled or incinerated. This represents roughly 40 million tonnes of resources wasted every year, equivalent to the annual waste produced by German cities. If we add up all resources used in the value chain, the picture gets even worse. The water involved in the growing of cotton, the spinning and dyeing of a garment, and the domestic washing of a garment can easily be more than 10,000 litres per item. The cumulated water demand of the clothing industry comprises about 4% of global consumption, equivalent to 40% of global domestic consumption which includes water for drinking and cooking. Clothing represents 2% of global oil demand and thus a significant share of the 300 million tons of plastic produced globally every year which is equivalent to the annual oil consumption of about 50 million vehicles every year.

can excrete or metabolise it), disruptive to hormones or carcinogenic. Nevertheless, they are still used where the site of production is located in a region with more relaxed environmental regulations. In terms of greenhouse gas emissions, the lifecycle impact of these products is higher than aviation and shipping combined. Last but not least, clothing represents the source of 35% of global plastic microfibres in the ocean, the single largest source. In fact, the washing of polyester fabrics in both factories and domestic washing machines sheds microfibres that pass through wastewater plants (when present), reach waterways and ultimately the ocean.

All of these aspects emphasise the fundamentally flawed attitude we have toward clothes and textile products. Innovations have made these products so affordable that we treat them as low value goods without considering the associated resource demand and pollution

Clothing industry's footprint in terms of resources demand and pollution



The pollution produced by the clothing industry is just as environmentally detrimental as the resources it consumes. The production of fibres, their dyeing and washing to get the desired effect, and the chemicals used to obtain specific properties, all contribute to the remarkable 20% of global industrial water pollution attributed to the sector. In terms of type of pollutants, the range is wide. Tests of a number of brands' products confirmed the presence of hazardous chemicals. Many of these are banned or strictly regulated in various countries because they are toxic, bio-accumulative (meaning the substance builds up in an organism faster than the organism

spill over of the whole value chain. The case for sustainability driven transformations throughout the textile industry is strengthened when compared to other global industries which have made major changes in their consumption of materials and their production of waste. From CO₂ emissions in the energy sector, to water consumption in the agricultural sector, to urban waste production, industries worldwide have identified environmental solutions that are growing in scope and scale and are working towards a sustainable development goal. In this industry, the most has yet to be done, particularly to push it towards a circular economy model.

Women walk past tannery wastewater that is being pumped from a factory straight into the street in Cairo's Ain el-Sirra district



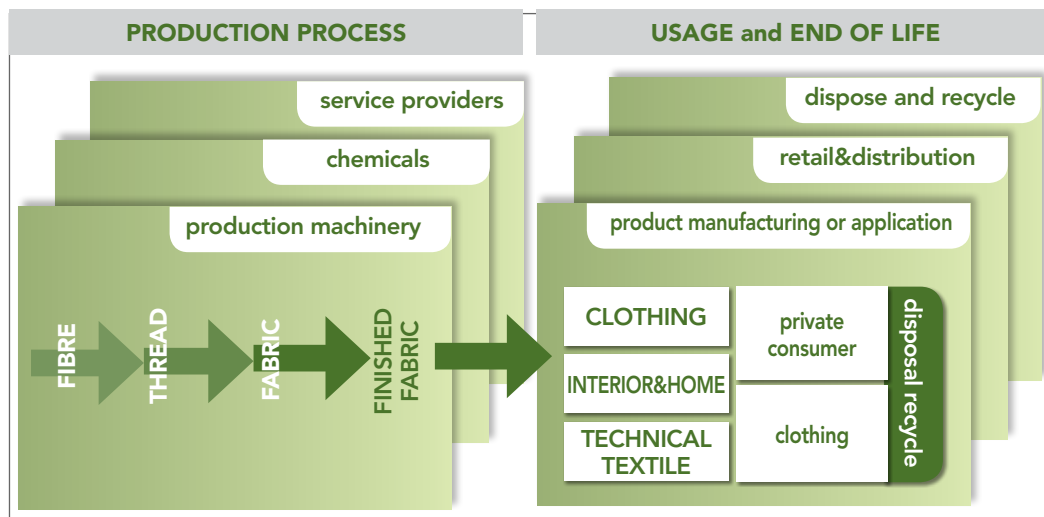
Sustainable textile industry: a long way to go, but an already viable investment opportunity

The simple fact that there are limited and scattered ideas on how to tackle sustainability issues in the textile industry on a global scale does not mean that there are not investment opportunities for an investor such as Ambienta. On the contrary. The textile value chain is a complex one where material sciences and chemistry meet consumers and business requirements in terms of functionality or product appearance. In keeping with Ambienta's strategic approach, each of its building blocks has to be analysed in the light of the environmental issues that it poses. The environmental impact of the production process is related to a multitude of issues such as the amount of water used, the energy used, the amount and type of chemical used etc. In the usage phase of traditional textiles for clothing or interiors, the environmental impact primarily comes from washing and cleaning. Resources such as energy and water are consumed and pollution is created from chemicals used in the cleaning process. Chlorine based chemicals, which are persistent pollutants of waterways, are still relevant consumables for the dry-cleaning

sector. Similarly, in the disposal and recycle phase, the major opportunity to achieve a strong environmental impact would be in the area of resources reclaim. Even the upward part of the value chain, fibres production, holds several opportunities, but for the sake of brevity we will neglect these in this newsletter. It would encompass considerations on land utilisation and livestock breeding for natural fibres and an assessment of the impact of oil and mining activities for man-made fibres.

We have already engaged in the discussion of several business models and types of activity that contribute to shape the industry. In fact, all value chain participants have to contribute if a large impact reduction is to be achieved. No new low-pollution chemical can enter the market if it does not find a machinery manufacturer that enables its utilisation in the production process. No sustainability driven material innovation will be adopted at incremental cost if consumers are not willing to pay for it. Luckily consumer awareness is growing. The more the environmental impact of the industry is visible, the more new

Simplified textile value chain with business model examples



sustainable solutions will be adopted. In 2016 Adidas started to produce shoes from plastic recovered from oceans. In 2017 it developed a full collection, and in March this year Adidas announced that they had sold one million pair of shoes at roughly \$200 per pair. It is a fairly small number when compared to the 23 billion shoes produced every year, but it demonstrates that there is a demand for these products.

Similarly, on the supply side, machinery technology is now reacting to the growing resource concerns. For decades the air jet loom (a type of loom that uses compressed air) emerged as the winning technology, replacing the rapier loom (an older technical solution which does not require compressors but it is usually less productive), due to its lower total cost of ownership. Its higher productivity rate compensated for the shorter life expectancy of the equipment and for the increased energy consumption due to its need of compressors. Today the increase of energy prices has pushed research and development to innovate the rapier loom in order to reduce the productivity gap and thus provide both an economically competitive and less energy consuming production machinery. Since there are no standards for sustainability performance level of machinery in the textile industry, it is interesting to note initiatives like the ACIMIT Green Label, the initiative of Italian textile machines manufacturers to assess the carbon footprint of machines during its operation and

label them accordingly. There are many other examples of sustainability driven products and services that highlight this growing trend. Summarised below are some examples that we consider mature and economically viable for private equity investors.

- Sustainability driven final products:** clothing and interior textile manufacturers will increasingly leverage sustainability driven equity stories (i.e. products from recycled materials, usage of cleaner chemicals products) to position products towards an ever more sensitive customer base (we have already analysed a few). This is particularly relevant for young consumers, millennials and generation X, who show a much stronger interest in sustainability when compared to their parents. In this case it is important for Ambienta, as a sustainability driven investor, to distinguish between clear sustainability leaders and “green washing” marketing stories with little content behind the commercial surface.

The UltraBoost sneaker from Adidas made of plastic waste recovered from the sea





The ACIMIT (Association of Italian Textile Machinery Manufacturers) green label initiative that leads to machines environmental performances certification

- **Energy, water or generally resource efficient solutions in production machinery:** as highlighted by the loom example above, energy efficiency is a growing concern in the textile industry as in many other manufacturing industries. There are already several solutions and components specifically engineered to reduce the energy consumption of the workshop through, for example, the removal of compressors in the case of the rapier looms, or the removal of air-conditioning or refrigeration equipment needed to maintain effectiveness of the winders. Similarly machinery and processes that reduce water consumption or resource consumption, as defects or scrap, represent a growing opportunity.

- **Digitalisation of production processes and value chain:** the clothing industry faces 12% losses because of production offcuts, scraps or overstock liquidation. The digitalisation of production process through software (i.e. digitalisation of prototyping) and sensor led solutions (i.e. yarn break sensors) has a great potential to reduce scraps. The machine vision solutions provided by Lakesight Technologies, one of Ambienta's portfolio companies, for textile inspection or digital textile printing can significantly reduce production offcuts through early detection of defects in the fabric. Outside of the production process, the digitalisation of distribution chain has the potential to optimise stocks across channels, thus improving the overall industry's resource footprint.

- **Enhancement of life extension and materials recovery:** the sustainable

management of the disposal of a garment represents a challenging issue from a materials reutilisation point of view. Thus, traditional recycling activities, like some that have developed in Germany, struggle to achieve sustainable margins. Conversely, second hand business models, often enabled through peer-to-peer e-commerce platforms, seem better positioned to provide both an economically viable and sustainable solution. Interesting cases already exist in the luxury goods segments in the US. Even rental of clothes is an emerging business model with credible use cases and unit economics. Clothing rental finds its killer application where consumers have short ownership period requirements, for instance, in the case of baby clothes.

These examples highlight that large scale impact in this industry relies primarily on pressure from end users, particularly consumers, on textile product manufacturers. The extent and the speed with which clothing or interior textile manufacturers will embrace sustainability requirements into their missions will drive the scale of the impact and, in turn, the number of opportunities for Ambienta as an investor. The Green Carpet Awards, established by the Italian Chambers of Fashion, or the Detox campaign from Greenpeace to clean up value chain which was embraced by firm as Inditex and Benetton, are example of initiatives that reinforce our optimism. We look forward to seeing these innovations ramping up as quickly as possible for the benefit of the planet, humanity as a whole and our investors, which we aim to continue provide with outstanding financial returns.



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