南豐作坊
the mills
fabrica

The Mills Fabrica 2022 Impact Report

Introduction

Left: Fires Blaze Through South-Central Chile. Images by Lauren Dauphin and Allison Nussbaum. Source: NASA Earth Observatory.
Middle: The drying up of the Aral Sea. Source: Patrick Schneider / Unsplash
Right: Cloud streets over the Great Lakes. Source: NOAA, NOAA Environmental Visualization Laboratory

Accelerating innovations for social-ecological resilience in an age of extremes

The world is fast approaching the precipice of a climate tipping point. On the back of COP27, it is evident that the goal of staying within 1.5°C by 2030 is slipping away from the grasp of humanity.[1]

Not only have the top ten warmest years occurred since 2010, but it's becoming more evident that other aspects of the planet are also under increasing pressure. The recently concluded COP15 gave humanity a stark warning; “without nature, we are nothing,”[2] highlighting the urgency of preserving our biodiversity, including reducing land use, chemical pollution, and over-extraction of our natural resources.

The production of fibers, food, and other associated inputs requires natural capital. This has undoubtedly contributed to the precarious state of our social-ecological system, becoming ever more unbalanced and seemingly verging toward the tipping point.

1 Schlosser, Peter. “After COP27, all signs point to world blowing past the 1.5 degrees global warming limit – here’s what we can still do about it”, *The Conversation*, 22 Nov, 2022.
2 UN (2022) “‘Without nature, we have nothing’: UN chief sounds alarm at key UN biodiversity event”, *UN News*, 6 Dec, 2022.

The Mills Fabrica is continuing to build an ecosystem of techstyle and agrifood innovators to drive planet-positive impact

Since 2018, The Mills Fabrica has been actively working to foster an ecosystem of innovators within the techstyle (the intersection of technology and lifestyle) and agrifood industries who are committed to driving positive change for the planet.

To achieve this goal, The Mills Fabrica believes in fostering innovation from ideation to commercialization. Only with a comprehensive approach can we target the fundamental principles of impact generation. Our first step is to invest in and incubate high-impact techstyle and agrifood innovations throughout their entire value chain.

In addition, The Mills Fabrica recognizes the importance of nurturing the next generation of innovative thinkers and doers. To this end, we collaborate with educational institutions to support the prototyping of cutting-edge ideas, encouraging young talent to think boldly and take action towards creating a more sustainable future.

- Since 2018 the Mills Fabrica has partnered with industry experts and leaders in the textile and apparel, and agrifood industry to host our international student competition, Techstyle For Social Good, and The Central Saint Martins x The Mills Fabrica Prizes.
- To date, both events have attracted 400+ submissions, supported over 20 winners, gave out the equivalent of more than HKD1.5 million in prize, including the use of our Lab space. Past winning innovations include flavors derived from microalgae, fabric made from bioplastics and mycelium, to granola made from beer brewing by-products.

our international student competition:

attracted **400+** submissions from universities globally

supported **20** winners

more than **HKD 1.5 Million** in prize handed out

Left: Colony growth of microflora showing the diversity of microorganisms. Source: Unsplash
Right: Central Saint Martins x The Mills Fabrica Prizes 2021 winner YongFan Lu (SOIL·BIORI·ASHION)

At The Mills Fabrica, we place equal importance on raising awareness, building knowledge, and fostering collaboration. We believe that these three elements are essential to contributing to the development of a thriving ecosystem.

- Our interactive space allows us to host thought leadership events that bring together innovators, industry players, and investors under one roof to exchange knowledge, generate ideas, and explore collaborative opportunities. Since our inception we have hosted numerous ecosystem buildings events including Denim Futures, StartmeupHK Festival, London Craft Week and Future Fabric Expo.
- Our Impact Retail Space, Fabrica X, provides a platform for the public to understand different environmental and social issues related to the textile and apparel, as well as the agrifood industries. For example, it recently addressed the issue of ocean plastic pollution and emphasized the importance of biomaterials in the fashion industry. The space also showcases sustainable brands and our own portfolio companies that are providing solutions to these problems. In addition, Fabrica X is supported by and partners with stakeholders from various industries, including banking, automotive, textile, and apparel.
- Overall, since our inception, both of our impact initiatives have collaborated with hundreds of brands and partners, and have welcomed over 25,000 visitors.

The key to driving innovation and impact is collaboration. With The Mills Fabrica's innovation platform, we welcome all stakeholders to collaborate and become part of the driving force that catalyzes the fundamental change needed to increase our social-ecological resilience, and maintain a just and sustainable earth system to ensure humanity thrives in the future.

Clockwise: Denim Futures, Impact Retail Fabrica X, London Craft Week and Techstyle For Social Good


unspun
FabricaX

Part 1 Impact Strategy

Planet-positive impact informed by planetary thinking

Delving into our approach to generating positive impact for the planet, grounded on a deep understanding of ecological issues in techstyle and agrifood industries, and informed by the planetary boundaries framework.

The Planetary Boundaries

The Stockholm Resilience Center determined that nine planetary boundaries maintain the current stable living condition that allows civilization to thrive. These boundaries are climate change, biosphere integrity, land-system change, freshwater use, biochemical flows, ocean acidification, atmospheric aerosol loading, novel entities, and stratospheric ozone depletion. Crossing over the safe operating space increases the risk of destabilizing the current stable Earth System.

Source: Azote for Stockholm Resilience Centre, based on analysis in Wang-Erlandsson et al 2022

The Planetary Boundaries Framework is a scientific approach that defines the safe operating space for humanity within the Earth's natural systems. It identifies nine planetary boundaries that must not be crossed to avoid irreversible environmental changes. By staying within these boundaries, we can work towards a more sustainable and equitable future.

Sadly, it is the case that six of the nine planetary boundaries have already crossed[3] the safe operation space – including freshwater use, climate change, biosphere integrity, land-system change, novel entities, and biogeochemical flows. This means our planet is increasingly being destabilized from the relative balance state of the Holocene period — representing approximately the last 12,000 years — that allowed humanity to grow, develop and thrive.

Undoubtedly, our planet is increasingly under more pressure from anthropological modifications.[4 & 5] With both the textile and apparel, and agrifood industries combined emit up to 44% of global greenhouse gas emissions — where the techstyle industry is estimated to emit up to 10%,[6] and the agrifood industry emits between 26%[7] to 34%[8] of total global emissions — it makes these two industries one of the most significant contributors to climate change.

up to **44%**

global emission comes
from textile and apparel, and agrifood industries

up to **10%**

global emisison comes
from textile and apparel industry

up to **34%**

global emission comes from
agrifood industry

3 Wang-Erlandsson, Lan, et al. "A planetary boundary for green water." *Nature Reviews Earth & Environment* 3.6 (2022): 380-392.
4 Steffen, Will, et al. "Planetary boundaries: Guiding human development on a changing planet." Science 347.6223 (2015): 1259855.
5 Anthropological modifications refer to changes made to the natural environment by human activity including the atmosphere, oceans, and land.
6 Cornell, Sarah., et al. *A sustainable and resilient circular textiles and fashion industry: towards a circular economy that respects and responds to planetary priorities*. Stockholm University's Stockholm Resilience Centre, 2021.
7 Poore, Joseph, and Thomas Nemecek. "Reducing food's environmental impacts through producers and consumers." *Science* 360.6392 (2018): 987-992.
8 Clark, Michael A., et al. "Global food system emissions could preclude achieving the 1.5 and 2 C climate change targets." *Science* 370.6517 (2020): 705-708.

Top left: Blooms of the harmful algae Karenia brevis occur regularly along the west coast of Florida. Source: NASA Earth Observatory. / Top right: The Aral Sea was once the world's 4th largest inland water body but now has dried up due to Soviet-era inefficient water management policies, leaving fishing ships rust on the former seabed outside the fishing town of Moynaq in northwestern Uzbekistan. Source: Keval Singh via Canva.com. / Bottom left: Cotton and oil field in Texas, U.S. Source: NASA Earth Observatory, images by Lauren Dauphin. Bottom right: Sea water contaminated by microplastics and microfiber. Source: Tunatura via Canva.com

Not only do the textile and apparel, and agrifood industries significantly impact climate change, but they also generate a host of other environmental issues that push planetary priorities beyond their safe operating space. These are:

- BIOGEOCHEMICAL FLOWS AND NOVEL ENTITIES
  The textile and apparel, and agrifood industries have long been synonymous with chemical pollution and the excessive use of fertilizers (phosphorus and nitrogen)[9] for cash crops like cotton and food crops. With less than half of the nutrients applied taken up by crops, this has led to pollution in aquatic and terrestrial ecosystems, such as hypoxic dead zone and algae blooms.[10]

- FRESHWATER CHANGE (GREEN AND BLUE WATER)
  Freshwater use in food, and cotton irrigation uses a large amount of water. The treating, dyeing, and finishing of all types of fibers and fabrics also uses a large quantity of water — on average, 100 to 180 liters of water per 1 kg of fiber.[11]

- LAND-SYSTEM CHANGE AND BIOSPHERE INTEGRITY
  Both the textile and apparel and agrifood industries contribute to land system change by converting forests, wetlands, grasslands, and other vegetation types into agricultural uses, destroying habitats and reducing biodiversity.[12]

- NOVEL ENTITIES
  The textile and apparel, and agrifood industries are releasing significant amounts of human-made substances into our ecosystem. For example, the widespread use of pesticides in crop production, antibiotics in livestock production, and the release of micro and nano plastics can all lead to irreversible social-environmental damages.[13]

9 Tian, Hanqin, et al. "A comprehensive quantification of global nitrous oxide sources and sinks." *Nature* 586.7828 (2020): 248–256.

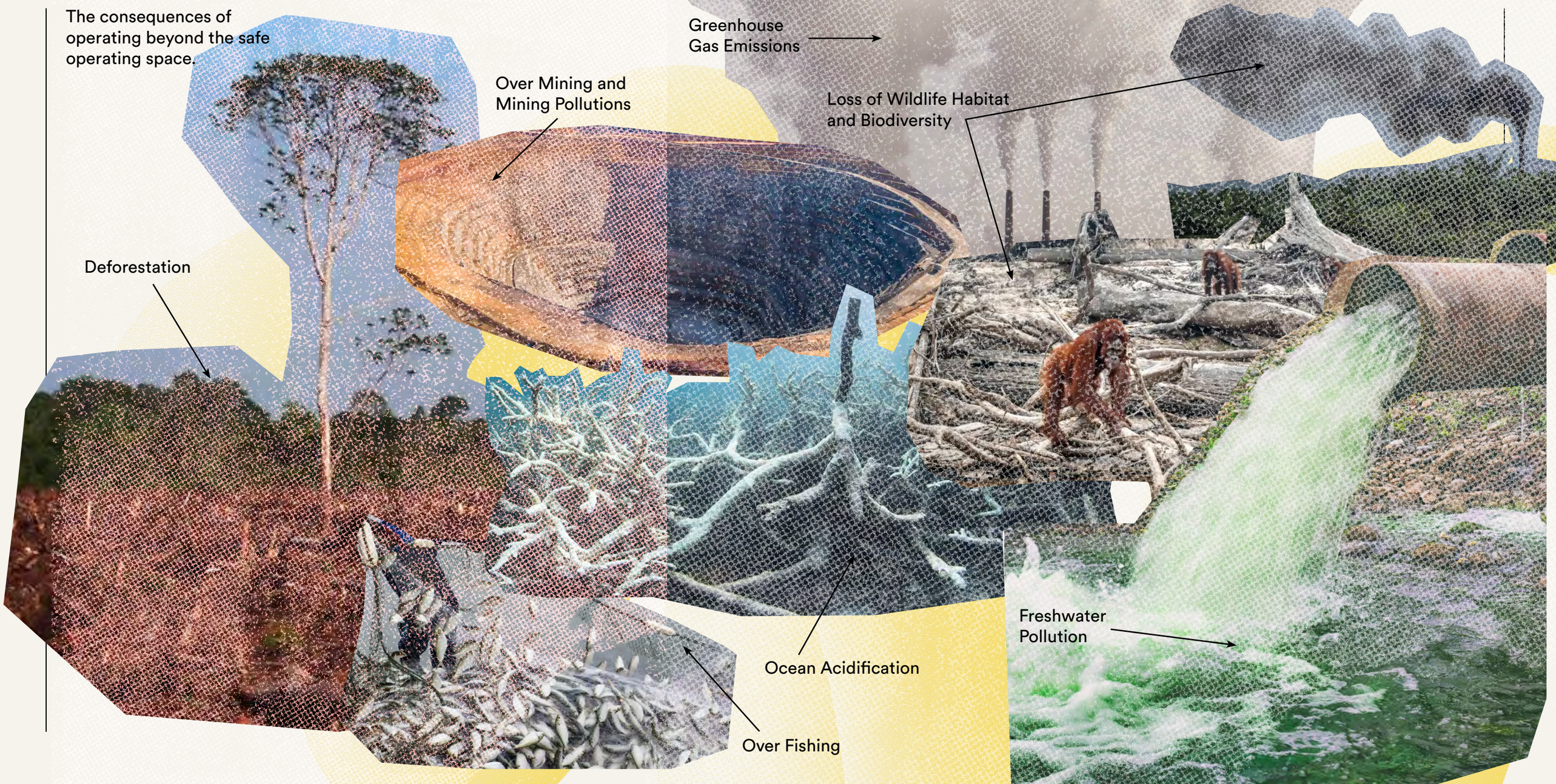
10 Lassaletta, Luis, et al. "50 year trends in nitrogen use efficiency of world cropping systems: the relationship between yield and nitrogen input to cropland." *Environmental Research Letters* 9.10 (2014): 105011.

11 Hussain, Tanveer, and Abdul Wahab. "A critical review of the current water conservation practices in textile wet processing." *Journal of Cleaner Production* 198 (2018): 806–819.

12 Winkler, Karina, et al. "Global land use changes are four times greater than previously estimated." *Nature communications* 12.1 (2021): 2501.

13 Campanale, Claudia, et al. "A detailed review study on potential effects of microplastics and additives of concern on human health." *International journal of environmental research and public health* 17.4 (2020): 1212.

The consequences of operating beyond the safe operating space.



A panacea for all our ecological and social woes is an aspirational dream. Impact generation needs to be holistic, contextualized, and measurable.

To generate planet-positive impact in an age of extremes, and given the breadth and depth of the adverse impact of the textile and apparel, and agrifood industries, this makes investments into these two industries even more crucial.

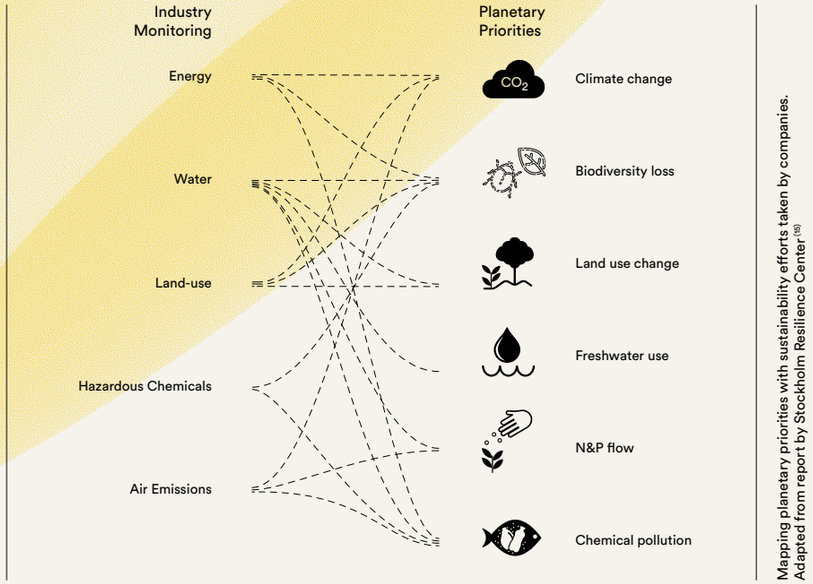
The Mills Fabrica's impact ethos is simple; discover, invest, and accelerate techstyle and agrifood innovations that can help reduce planetary pressure and contribute to social-ecological resilience, ultimately making planet-positive change. The impact potential of a company is also assessed in tandem with its level of technological innovation and business model sustainability so that long-term sustained impact can be achieved.

Part 2 Strategy to Execution

Putting planetary thinking into impact measurement for our investment portfolio

Exploring how we align planetary boundaries into impact measurement to capture the impact of our portfolio companies.

The right measurement framework is essential for Fabrica to curate a portfolio of innovations that can generate planet-positive impact.



Mapping planetary priorities with sustainability efforts taken by companies. Adapted from report by Stockholm Resilience Center[15]

SOCIAL METRIC

The interconnectedness of our earth system means individuals, people, and communities will also be impacted. Capturing this change is equally important. The IRIS+ framework will be the basis for evaluating and measuring the social impact of our portfolio — the generally accepted system to measure, manage and optimize social and environmental impact measurement used globally by impact investors alike. We understand that different business models will generate different indirect and direct social impact. A one size fits all framework would limit the measurability of said impact. Hence, our social impact measurements will be tailored to each specific investment, revolving around the themes of:

- better health
- wellness
- increased sustainability knowledge

ENVIRONMENTAL METRICS

The impact of our investments is only discernible if the right measurement metrics are set in place. Although the planetary boundaries measures the macro-environmental issues on a global scale and is non-linearly related to industry-level measurement,[14] it still merits cross-linking their relationship to discover how startups can generate planet-positive impact.

Mapping transgressed planetary boundaries with industry-level metrics ensures that The Mills Fabrica can curate a portfolio of innovations that address different environmental challenges (see diagram). Thus, the key impact themes and metrics we consider when evaluating the impact potential of companies are:

- Greenhouse gas emissions (GHGs) avoided
- Water use reduction
- Land use change avoided
- Eutrophication avoided
- Microplastic and chemicals avoided

14 For example, each kilogram of CO2 release does not linearly increase the CO2 concentration (ppm) in the atmosphere. And as we continue to develop our measurement framework, ideas of upscaling and downscaling planetary boundaries will be explored.

15 Cornell, Sarah., et al. *A sustainable and resilient circular textiles and fashion industry: towards a circular economy that respects and responds to planetary priorities*. Stockholm University's Stockholm Resilience Centre, 2021.

Having identified our key stakeholders, the long-term positive impact we intend to generate, and the type of measurement metrics to measure — based on our mapping of planetary boundaries with industry-level metrics — we have synthesized them into our theory of change, a logical framework to be used in our impact management and measurement process. This framework is continuously assessed and improved as our investment focus shifts.

The Mills Fabrica's Theory of Change

1. Key Stakeholders

Accelerate the growth of techstyle and agrifood innovators by:

- Providing funding support through Fabrica Fund via our Investment arm (venture capital)
- Providing industry connections, exposure and organized events to bridge meaningful partnerships via our Incubation arm and Marketing support
- Providing co-working and event space, Lab, and Impact Retail showcase opportunities that support the product development cycle of startups; from prototyping to experimentation to commercialization via our Interactive Spaces

2. Intended Impact Outcomes

What we want to achieve to create planet-positive impact.

- Accelerate the textile and apparel industry towards circularity
- Increase the operational efficiency of the textile and apparel supply chain
- Reduce the number of chemicals used in the textile and apparel supply chain
- Reduce freshwater consumption in the textile and apparel industry
- Reduce the carbon intensity of textile and apparel production
- Reduce the use of fertilizers and pesticides used in crop production
- Reduction in waste in the agrifood supply chain
- Mitigating GHG emissions from the agrifood supply chain
- Better Ingredients/foods for a healthier living
- Increase knowledge of sustainable lifestyle

3. Measurable Effects

Measurable effects that capture the intended impact of our investments.

- Increased textile waste recycled in a closed-loop system
- Decreased/avoided GHG emissions per unit of production
- Decreased/avoided textile waste created per unit of production
- Decreased/avoided chemical use per unit of production
- Decreased/avoided water footprint per unit of production
- Decreased/avoided amount of agricultural waste generated
- Decreased/avoided use of fertilizers and/or pesticides per area/unit of production
- Increased agricultural side-streams recycled
- Decreased/avoided land-used change per unit of production
- Increased users/engagement on sustainable platforms

Supporting innovations that are building ecological and social resilience

How our ecosystem of innovations has been disrupting the textile and apparel, and agrifood industries.

Left: Circ's recovered cellulose yarn. Source: Circ
Right: DNA sequences of pigments found in nature are inserted into bacteria to generate the desired colorant for dyeing. Source: Colorifix

Innovation is the key to creating long-term sustainable impact in the textile and apparel, and agrifood industry. By providing the necessary capital, The Mills Fabrica is contributing to the development of different technological fixes to our social and environmental problems. These new technologies and production methods can maintain planetary stability and enhance social-ecological resilience. In fact, our investments are already contributing to the following:

- ACCELERATING CIRCULARITY
  Driving circularity in the supply chain to optimize the use of resources and reduce reliance on virgin materials.

- DEVELOPMENT OF NOVEL MATERIAL, PROCESSES, AND MANUFACTURING SYSTEMS
  Accelerating the development of next-gen material innovation and biological and garment manufacturing that's more energy and resource efficient, and less polluting.

- ADVANCING ALTERNATIVE INGREDIENTS
  Changing how food is produced by using natural processes that reduce pressure on natural resources and better safety profile of food for better health and well-being.

- PROMOTING CONSCIOUS CONSUMPTION
  Leveraging technology to create sustainable platforms and brands that enable a conscious lifestyle and to transfer sustainability knowledge to consumers to bring about behavioral change over time.

Part 4

Impact Realized

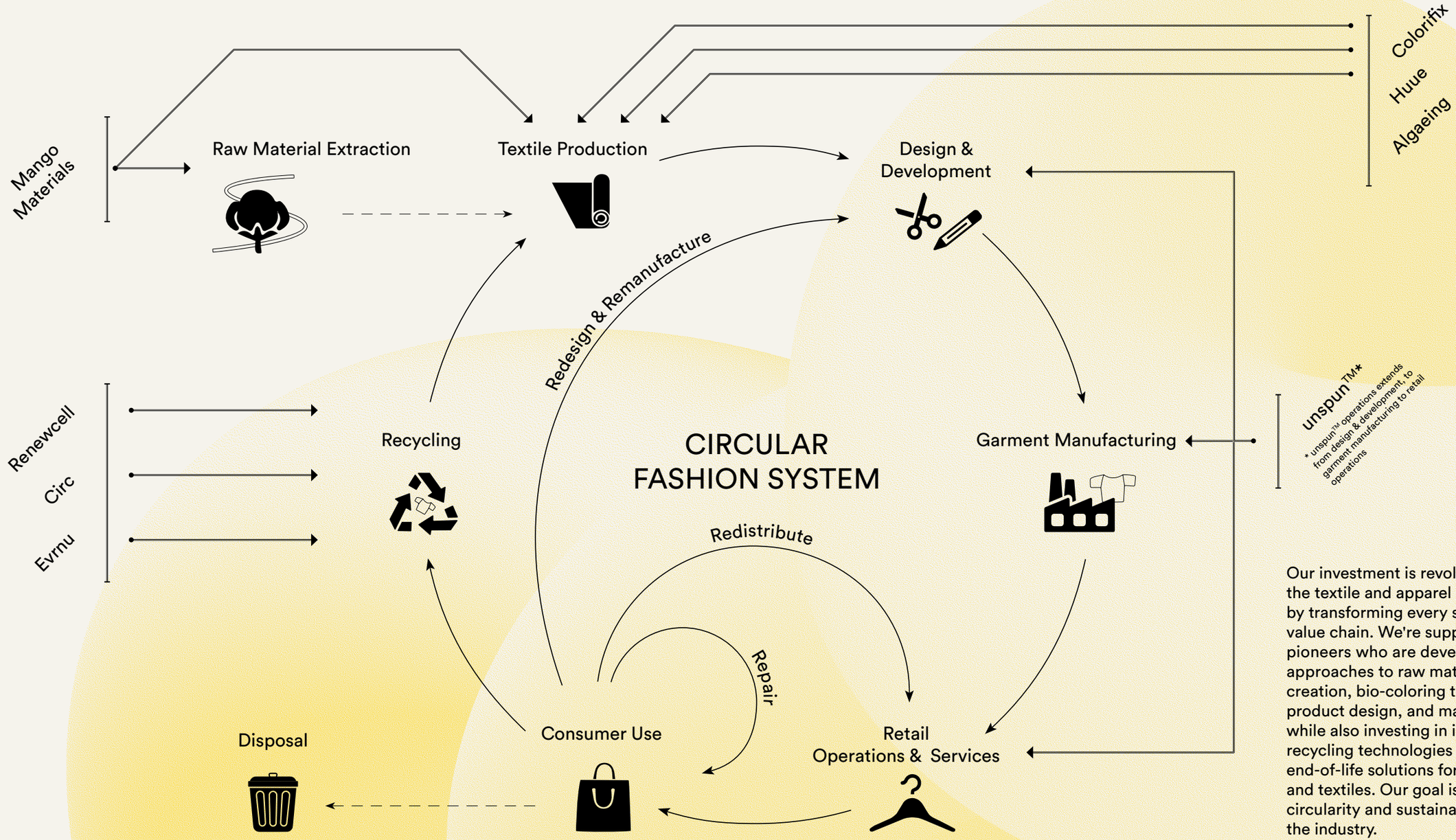
How our portfolio companies are making planet-positive impact

Showcasing the full scope and magnitude of the positive impact that our portfolio companies are making in the real world.

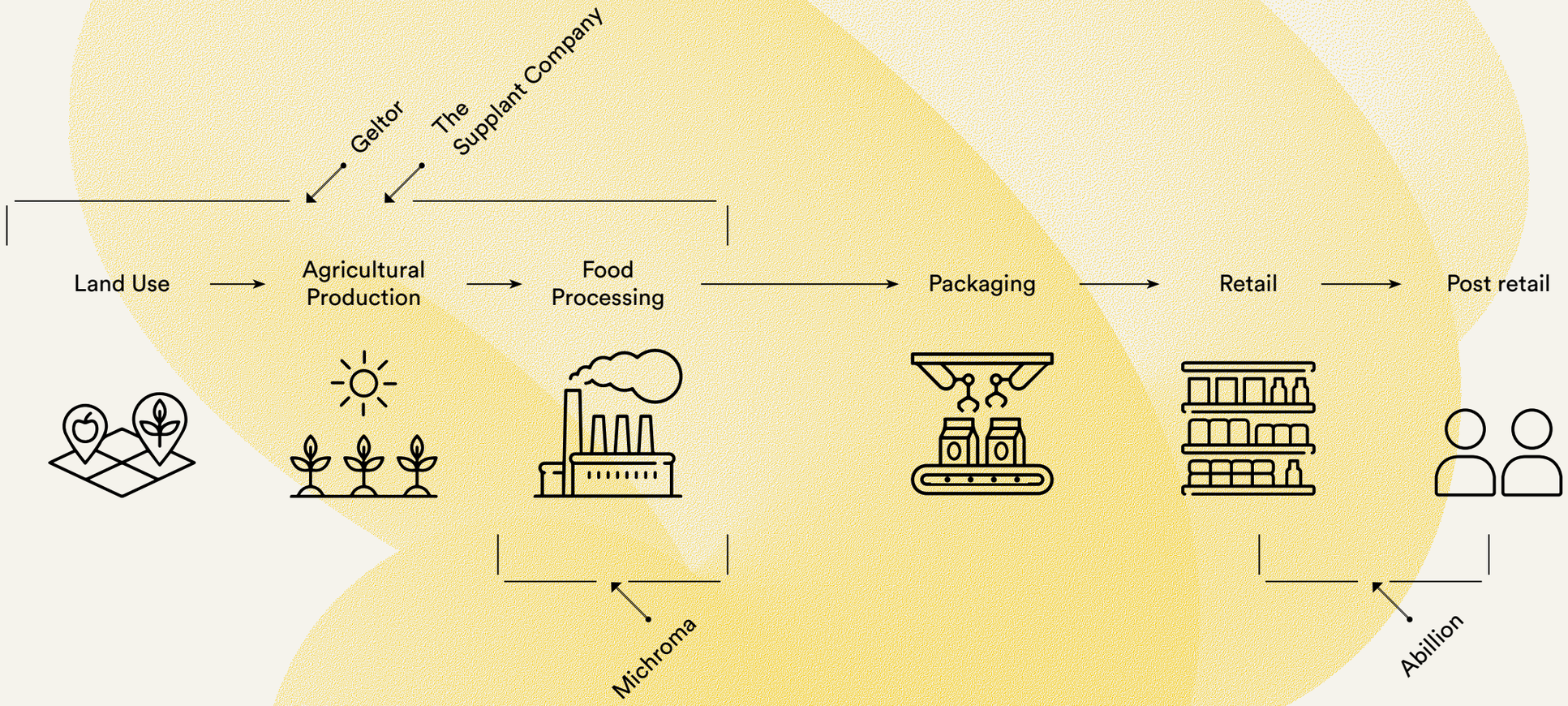
Integrating measurements into our portfolio companies

Each of our portfolio company is generating at least one type of positive impact — harmonized with the planetary boundaries — intrinsic to their business model.

		Techstyle								Agrifood			
		Circ	**Evrnu**	**Mango Materials**	**Renewcell**	**Colorifix**	**Huue**	**Algaeing**	**unspun™**	**The Supplant Company**	**Geltor**	**Michroma**	**Abillion**
Measurable Impact Themes	CLIMATE CHANGE / GHGS Mitigating and reducing greenhouse gas emission from activities	●	●	●	●	●			●	●	●		●
	WATER Reducing water intensity of products	●	●		●	●	●	●	●				
	LAND-USE Reduction in direct and indirect land-use	●	●		●				●	●	●		
	CHEMICALS Reducing the use of chemicals within their value chain					●	●	●		●		●	
	WASTE Reducing the amount of waste generated / increase upcycled materials produced within the value chain	●	●	●	●				●	●		●	
	MICROPLASTICS Prevents, avoids or reduces microplastic pollution	●		●									
	SOCIAL Furthering the sustainability knowledge, health and wellness of individuals									●		●	●



Our investment is revolutionizing the textile and apparel industry by transforming every stage of the value chain. We're supporting pioneers who are developing new approaches to raw material creation, bio-coloring techniques, product design, and manufacturing while also investing in innovative recycling technologies that provide end-of-life solutions for garments and textiles. Our goal is to drive circularity and sustainability across the industry.



Our investments in the agrifood value chain are driving innovation that revolutionizes the way ingredients and food are made. We're also increasing consumer access to sustainable products and food. Ultimately, our investments work hand in hand to drive positive change towards a more sustainable and just agrifood value chain.

The Impact of our fund investments

The Mills Fabrica's fund investments are also aligned with our impact objectives, which ultimately help contribute to making a positive social and environmental impact.

We have invested in six funds in both textile and apparel, and agrifood sectors. These include funds like The Good Fashion Fund and Bits x Bites. Each fund has its strategic positioning and through them, we have supported a range of innovations spanning both sectors' entire value chains. This provides us the opportunity to support a range of innovations, including precision agriculture, crop protection, animal health, alternative proteins, nutrition, plant-based consumer food brands, innovative materials, and bio-based dyes, amongst other innovations within the textile and apparel, and agrifood industry.

Colorifix showcasing at Fabrica X, an Impact Retail store in Hong Kong

Part 5

Portfolio Highlights

In the following section, we will look at the innovations from our investment portfolio. This includes Circ, Colorifix, unspun™, Abillion, The Supplant Company, and Bits × Bites. We will seek to understand how these companies are making a tangible positive impact on the planet and its people.

THE SUPPLANT COMPANY

BITS × BITES

ABILLION

COLORIFIX

CIRC

UNSPUN™

CIRC

On a mission to save the planet from the cost of clothing

Circ's hydrothermal process turns polyester-cotton blend fabrics (left) into cellulose (center) and recycled polyester (right). Source: Circ

The world is buying more clothing than ever. Individuals are buying 60% more clothing than merely 15 years ago.[16] Cotton and polyester fibers are the most widely used materials for textiles accounting for 76% of all fibers produced — of which 54% is polyester and 22% is cotton.[17] As the demand for clothing increases, the environmental, ecological, and social pressure from producing virgin polyester and cotton will continue to rise.

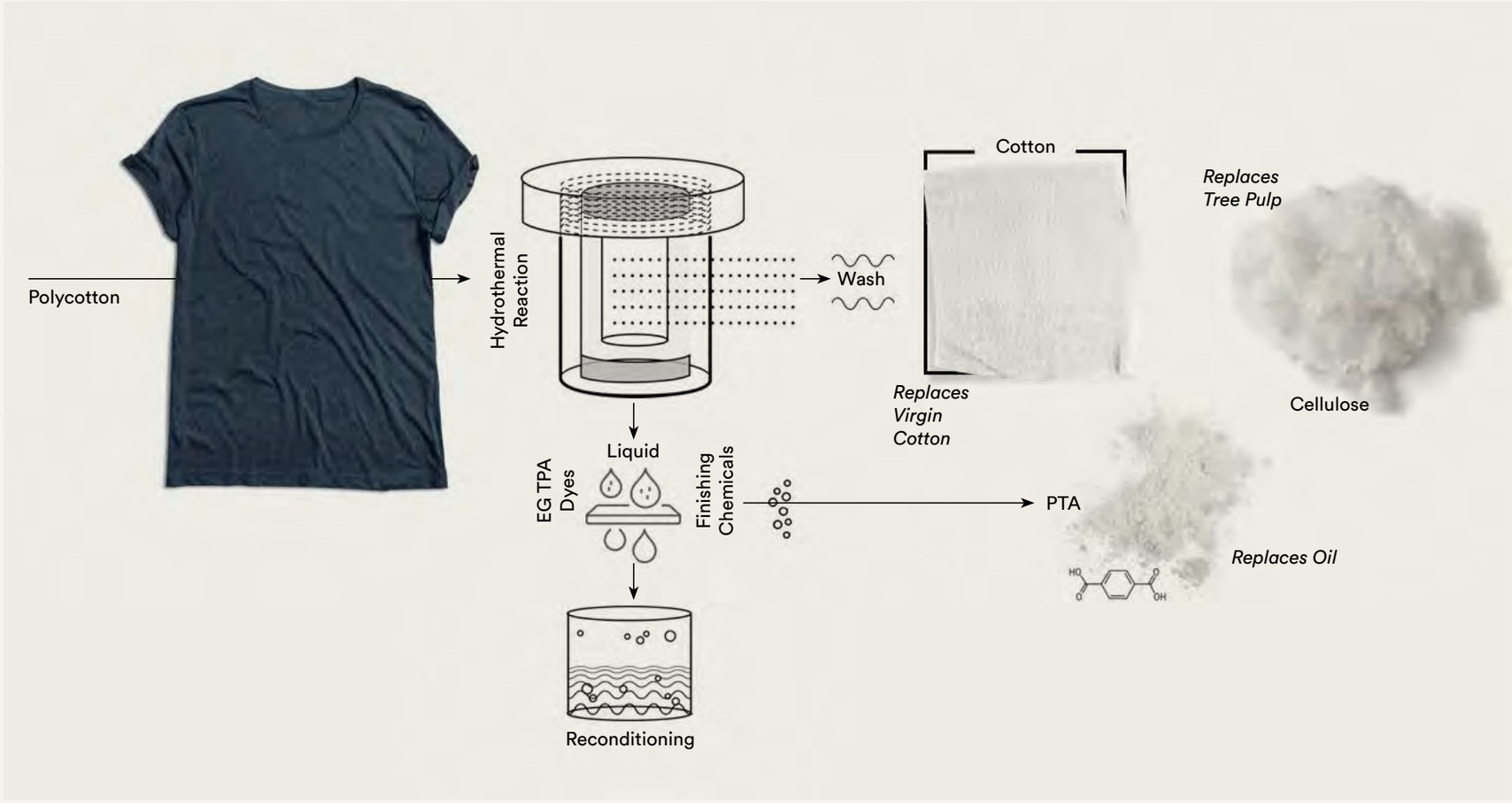
With 80 billion new pieces of clothing made every year and less than 1% of the global fiber market made from pre and post-consumer recycled textiles, 92 million tonnes of textile waste are still being thrown away annually.[18&19] This is due in part to the fact that blended textiles, such as polycotton, are traditionally difficult to separate and thus, impossible to recycle.

This is where Circ comes in. Their revolutionary technology uses hydrothermal processing — which utilizes water, pressure, and responsible chemistry — turning polycotton textiles back into their respective raw material. This represents a breakthrough in chemical recycling technology, fundamentally changing the way textile waste is viewed, moving away from a source of pollution to a source of valuable raw material.

Individuals are buying **60%** more clothing than merely 15 years ago

less than **1%** of the global fiber market is made from pre and post-consumer recycled textiles

16 *UN alliance for sustainable fashion addresses damage of 'fast fashion'.* UN Environment Program, Mar 2019.
17 Textile Exchange. *Preferred Fiber & Materials Market Report 2021.* Textile Exchange, 2021.
18 ibid
19 Chen, Xuandong, et al. "Circular Economy and sustainability of the clothing and textile Industry." *Materials Circular Economy* 3 (2021): 1–9.



The patented recycling technology

In 2022, Circ recycled a total of more than 41 tonnes of materials using their technology. Based on screening of life cycle assessments (LCAs) and industry research, this is expected to save an equivalent of 66 tonnes of carbon dioxide equivalent (MTCO2e). [20]

41 Tonnes

of materials recycled

66 Tonnes

of carbon dioxide equivalent avoided

20 Estimated emissions savings over conventional cotton and polyester based on 65% efficiency factor (McKinsey 2022; Scaling Circularity) and impact of virgin PET (3.2 kgCO2e/kg) and virgin dissolving wood pulp (2 kgCO2e/kg)

With Circ's recycling technology, waste polycotton textiles can be transformed into PTA and recovered cellulose yarn. Source: Circ

With 2.5% of the world's cultivated land used for cotton production and 16% of the world's insecticides used on the crop,[21] the ability to recycle more cotton means less pressure is exerted on these resources. Large quantities of fertilizers are also used during cotton farming making eutrophication a severe concern.

Polyester fiber production is energy-intensive — as high as 125MJ per kg of fiber.[22] Being able to recycle polyester also means more energy is saved. With material production responsible for 38% of total CO_2 in the entire fashion value chain, innovations that drive the sector towards circularity will be crucial in tackling climate change.[23]

The ability to recycle more polycotton blended textile waste in the future means less pressure being exerted on the production of polyester and the cultivation of cotton, ultimately contributing to the reduction in land-use pressure, chemical, and water usage, and an overall decrease in GHG emissions.

21 Environmental Justice Foundation. "The casualties of cotton". Accessed 2023.

22 Muthu, Subramanian Senthilkannan. *Assessing the environmental impact of textiles and the clothing supply chain*. Woodhead publishing, 2020.

23 Berg, Achim, et al. "Fashion on Climate. How the fashion industry can urgently act to reduce its greenhouse gas emissions." *McKinsey & Company and Global Fashion Agenda*, 2020.

COLORIFIX

The world’s first biological colorant that’s radically less environmentally polluting at every stage

Textile dyeing is one of the most polluting processes in the textile supply chain. Using the conventional textile dyeing technique, 1 tonne of fabric results in approximately 200 tonnes of polluted water.[24] It has also been estimated that 70% of the dyes used to dye fabrics are not absorbed by the material and are consequently released into the effluents.[25]

Current conventional water treatment methods cannot entirely remove all chemicals within textile effluents.[26] Where local regulations are laxer, this presents a worrying predicament. As a result, the textile industry has been estimated to be responsible for between 17% and 20% of world water pollution.[27]

Additionally, a large amount of energy is consumed to heat water and dry textile materials. Thereby contributing to the release of CO2 and worsening climate change. The air emission resulting from the heating process also includes nitrogen, formaldehyde, and sulfur oxides from boilers,[28] a potential hazard for workers and the surrounding community.

1 tonne of fabric results in

200 Tonnes

of polluted water

70%

of the dyes used are released into the effluents

24 Lara, Livia, Isabel Cabral, and Joana Cunha. “Ecological approaches to textile dyeing: a review.” *Sustainability* 14.14 (2022): 8353.

25 Sondhi, Sonica. “Sustainable approaches in effluent treatment: Recent developments in the fashion manufacturing.” *Sustainable Technologies for Fashion and Textiles* (2020): 327–341.

26 Yahya, N., et al. “A review of integrated photocatalyst adsorbents for wastewater treatment.” *Journal of environmental chemical engineering* 6.6 (2018): 7411–7425.

27 Nayak, Rajkishore, Tarun Panwar, and Long Van Thang Nguyen. “Sustainability in fashion and textiles: A survey from developing country.” *Sustainable technologies for fashion and textiles* (2020): 3–30.

28 Lara, Livia, Isabel Cabral, and Joana Cunha. “Ecological approaches to textile dyeing: a review.” *Sustainability* 14.14 (2022): 8353.

Colorifix growing engineered microbes in their fermentor with renewable feedstocks. The microbes divides every 20 minutes and results in a large quantity of dye liquor within one to two days

With the global apparel market continuing its growth momentum, the commercialization of a non-toxic, more sustainable textile dye will be crucial to making the fashion industry more sustainable.

Using biotechnology Colorifix has found a way to reduce all these issues. They developed the world's first biological process to produce, deposit, and fix pigments onto textiles on an industrial scale. They seek out colors in nature by using digital DNA sequencing of organisms to identify the gene responsible for that color. The specific DNA code is then translated into their microorganism, and the organism produces the pigments in the same way as its made in nature.

This technological feat means that when compared to the environmental footprint (inputs and outputs) of conventional dyeing, Colorifix's dyeing process:[29]

→ Saves 79% water

→ Reduces 65% of chemical product uses

→ Reduces 51% of natural gas usage

This means the difference in environmental impact when compared to conventional dyeing per 1kg of dyed fabric[30] can be translated into:

→ 31% less carbon-intensive

→ 37% less eutrophication

→ 38% less ozone layer depletion

→ 61% less abiotic depletion (of elements)

The environmental impact is even higher for materials like polyester or nylon. Having proven that their biological dye is more ecological, this could be the defining moment for the fashion industry to move towards the adoption of biological dyes.

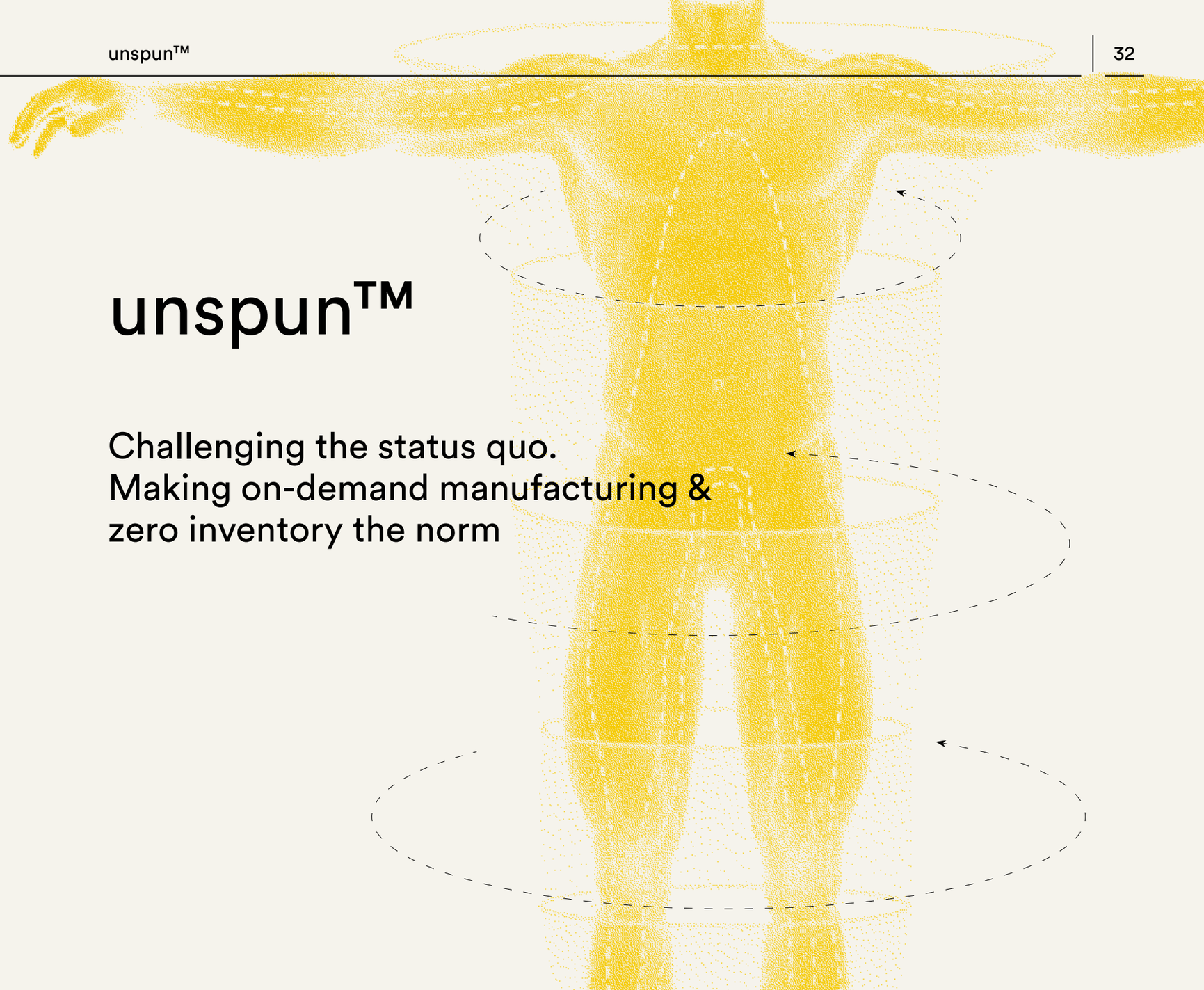
Pinpointing the exact genes that lead to the production of the pigment, and Colorifix then translates that DNA code into their microorganism

29 3rd Party LCA results. LCA calculated based on knitting composed of 52% recycled cotton and 48% recycled polyester for the colour purple. The functional unit being 40kg dye fabric and the figures include the half bleaching, dyeing and final wash stage.

30 3rd Party LCA results. LCA calculated based on knitting composed of 52% recycled cotton and 48% recycled polyester for the colour purple. The functional unit being 1kg dye fabric and the figures include the half bleaching, dyeing and final wash stage.

unspun™

Challenging the status quo.
Making on-demand manufacturing &
zero inventory the norm



unspun™'s 3D scanning technology allows for precise measurements of your body, ensuring a perfect fit for your tailored jeans. Source: unspun

An estimated 15% to 30% [31] of fabric used in garment manufacturing is currently being wasted before reaching customers. unspun™ is disrupting the fashion industry by using innovation and technology to move fashion away from the resource-intensive traditional linear manufacturing model to *more intentional, zero-waste, and on-demand manufacturing* that prioritizes circularity and reducing textile waste.

To achieve this, unspun™ utilizes body scanning technologies where customers 3D scan their bodies to capture 30,000 data points, and the data is analyzed through a combination of machine learning and algorithms. Their software allows them to manufacture bespoke pairs of jeans on an on-demand basis.

The utilization of technological innovations to achieve on-demand manufacturing means the entire process is zero-inventory; no finished inventory will be created, and, thus there will be no unsold garments that could otherwise be turned into waste. This means that on a per-product basis, unspun™ jeans produce 0.34kg less waste when compared to traditional production practices. Overall, unspun™'s jeans emit 42% less CO2 when compared to a traditional pair of jeans.[32]

0

finished inventory

0.34kg

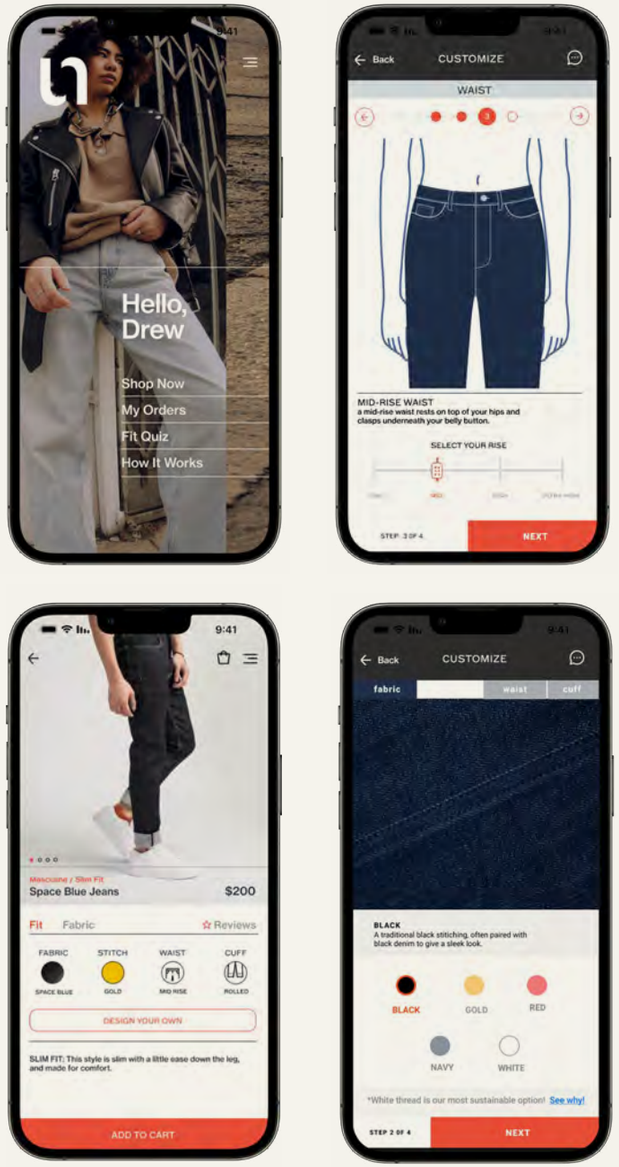
of waste reduced compared to traditional production methods

emit **42%**

less CO_2 compared to a traditional pair of jeans

31 Niinimäki, Kirsi, et al. "The environmental price of fast fashion." *Nature Reviews Earth & Environment* 1.4 (2020): 189–200.

32 Based on 3rd party LCA results with an end-of-life scenario of disposal in landfills.



unspun™'s user-friendly interface makes it easy to order your own unique pair of jeans, tailored to your individual style and fit preferences. Source: unspun

Not only does unspun™ upend the status quo of fashion manufacturing, but their design also embodies circularity ideals. In 2022, Unspun switched their thread range to circular dissolvable thread, Smart Stitch™ by Resortec®, which makes the garment disassembly process more efficient.

If each pair of unspun™ jeans gets recycled into a new pair of jeans via the resortecs® smart stitch technology, the environmental savings when compared to a conventional pair of jeans can be:

→ 70% less carbon emission equivalent

→ uses 98% less water

→ uses 97% less land-use

With a business model intended to minimize ecological footprint and maximize positive impact on the environment, the community, and workers, it's not surprising that they are B Corp certified.[33] If all clothes are made using a zero-inventory business mode, this could reduce the industry's emissions by 20%.[34]

Continuing to push the boundary of fashion manufacturing, unspun™ is full steam ahead in developing an innovative 3D weaving technology that creates zero-waste manufacturing, furthering its mission of eliminating production waste.

33 B Corporations are subjected to rigorous assessments which measure efforts across five impact areas: governance, workers, customers, community, and environment.
34 unspun™'s own analysis.


ShopRealty

ABILLION

Here to help a billion people save the planet while making sustainable living easy and fun

Image source:
Unsplash

Abillion's easy-to-use user interface helps you find the closest vegan dish. Source: Abillion

Abillion is on a mission to tackle one of the most significant contributors to climate change; the way we eat, representing 26% – 34% of global greenhouse gas emissions. (35 & 36) Putting things into perspective, that's multiple times more polluting than the aviation industry, which only represents 2.5% of global CO2 emissions. (37)

Abillion's mission is to make it much easier for individuals to discover plant-based food and earth-friendly products in their city. This is based on a community of members uploading reviews of vegan dishes or products they have eaten or used. With +2.5 million members reviews for +500,000 vegan dishes and products, members, restaurants, and businesses alike can already feel its impact.

+2.5 Million

members reviews

↓

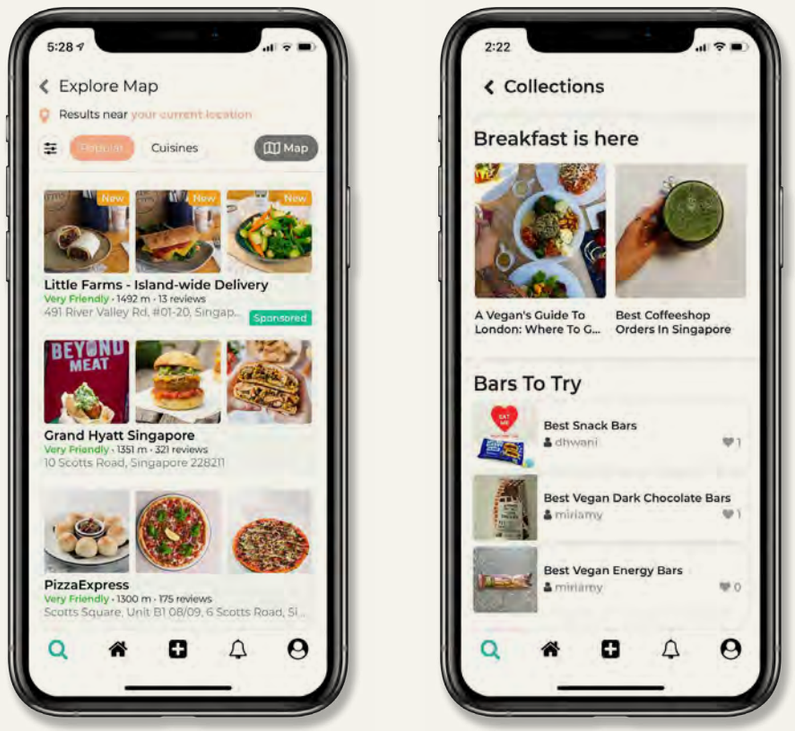
+500,000

vegan dishes and products on the platform

35 Poore, Joseph, and Thomas Nemecek. "Reducing food's environmental impacts through producers and consumers." Science 360.6392 (2018): 987–992.

36 Clark, Michael A., et al. "Global food system emissions could preclude achieving the 1.5 and 2°C climate change targets." *Science* 370.6517 (2020): 705–708.

37 Ritchie, Hannah, "Climate change and flying: what share of global CO2 emissions come from aviation?" *Our World in Data*, 22 Oct, 2020.



Abillion's user-friendly interface not only enables you to locate the nearest vegan dish, but also provides access to reviews of vegan products, curated by the community of members. Source: Abillion

With 65% of its members being meat eaters — both flexitarian and omnivores — the platform is already targeting the most impactful demographic. By making it more convenient and easy to search for restaurants that offer delicious vegan dishes and companies that offer vegan products, Abillion has become the catalyst for individuals to practice conscious consumption. Over time, fundamental behavioral changes can take place, impacting both the well-being of individuals and our environment.

Not only does their business generate social and environmental impact through greater exposure to vegan food and products, but with each review given, their reward program gives members impact credit to support non-profits of their choosing. Since 2018, more than US$2.5 million has been donated to 84 non-profits worldwide,[38] with 76% of the donation going into animal sanctuaries and 11% into animal and vegan advocacy.

+2.5 Million USD

donated to 84 non-profits worldwide

38 As of 31st Dec 2022.

THE SUPPLANT COMPANY

The modern-day alchemist, converting agricultural side-streams into sugars

Employee at The Supplant Company. Source: The Supplant Company

Cobs, husks, and stalks on a farm, under normal circumstances, are considered agricultural side-streams and don't currently make their way into the food system. The Supplant Company is turning this idea on its head. By upcycling agricultural side-streams, they turn plant fiber into a blend of sugars known as Supplant™ Sugars from Fiber — an ingredient for large-scale sucrose reduction that has fewer calories than sucrose, a lower glycaemic response than glucose and is prebiotic like the fiber it comes from.

Globally, there are an estimated 289 million tonnes of collectible agricultural side-streams — even when accounting for existing side-stream use like cattle bedding and bioenergy.[39] The Supplant Company's innovative process means straws/stover from wheat, maize, and rice can all be turned into a blend of fiber-derived sugars, which in turn increases the supply of sugars without needing to use additional land for cultivation. Assuming a side-stream-to-Sugars from Fiber conversion rate of just 50%, the current global sugar production could be increased by 79% if all collectible side-streams were converted.[40]

289 Million Tonnes

of collectible agricultural side-streams

+79%

in global sugar production if all collectible side-streams were converted to fiber derived sugar

39 Internal analysis. Collectable straws is defined as the share of operationally collectable straw from the farms.

40 2021–2022 total global sugar production at 181.18 metric tonnes (Statista 2022).

And, without the need to create more cane and beet sugar farms, upcycling side-streams into Sugars from Fiber could have a massive positive impact on the environment. It's estimated that each hectare of sugarcane emits 1.86 tonnes of carbon dioxide equivalent (CO2eq) per year[41] — including energy use, field nitrous oxide, and other inputs. For example, using sugar cane side-streams to produce Sugars from Fiber could double the output of sugar per hectare or, alternatively, halve the agricultural carbon emissions per unit of sugar produced (assuming a 50% conversion ratio).

Cane and beet sugar cultivation also use substantial fertilizer and other agricultural chemicals. Previously, these have been used excessively to boost yields, resulting in eutrophication and other negative impacts on insects and biodiversity. A food system shift towards Sugars from Fiber has the potential to reduce the need for additional cane and beet sugar farms, thereby avoiding further greenhouse gas emissions and chemical use.

Cane and beet sugar's impact on land use and biodiversity has been well documented. Cane sugar production was responsible for 12.2% of deforestation in the Brazilian Amazon between 2002 to 2012, equivalent to 189.4 million tonnes of carbon emissions.[42] By simply upcycling widely abundant agricultural side-streams to make Sugars from Fiber and reducing the need for further land use, the loss of biodiversity from land-use change could be prevented.

12.2% of deforestation between 2002 to 2012 in the Brazilian Amazon was due to cane sugar

=

189.4 Million Tonnes of carbon emission

Developed by Chef Thomas Keller, this is The Supplant Company's range of premium chocolate bars made from Sugars from Fiber. Source: The Supplant Company

41 Includes diesel. From 3rd party report.

42 Jusys, Tomas. "A confirmation of the indirect impact of sugarcane on deforestation in the Amazon." *Journal of Land Use Science* 12.2-3 (2017): 125–137.

Agricultural side-streams collected to create Sugars from Fiber. Source: The Supplant Company

Additionally, side-streams aren't currently utilized efficiently. Burning agricultural side-streams is practiced globally; 23% of wheat, 24% of rice, and 48% of maize side-streams are estimated to be burnt globally.[43] In-field burning of rice straw post-harvest is estimated to account for 11% of its GHG emissions.[44 & 45] This also releases pollutants, such as PM2.5, which negatively impact the health of farmers and surrounding communities.[46] By finding a use for this material and upcycling it into Sugars from Fiber, undesirable social and environmental impacts can be avoided.

The ability to create Sugars from Fiber without the need for additional on-field natural resources has a disruptive potential that cannot be understated. Not only that, excess refined sucrose intake is associated with a decreased average life expectancy and many adverse health conditions.[47] Broader adoption of Supplant™ Sugars from Fiber by industry will undoubtedly contribute to an overall healthier food system for the planet and its people.

Data illustrating the utilization rate of the four main food crops globally, taking into account the entire crop.
Data courtesy of The Supplant Company

43 Cassou, Emilie, *Field Burning – Agricultural pollution*, World Bank, 2018.

44 Singh, Gurraj, et al. "Rice straw burning: a review on its global prevalence and the sustainable alternatives for its effective mitigation." *Environmental Science and Pollution Research* 28.25 (2021): 32125-32155.

45 Yodkhum, Sanwasan, Sate Sampattagul, and Shabbir H. Gheewala. "Energy and environmental impact analysis of rice cultivation and straw management in northern Thailand." *Environmental Science and Pollution Research* 25 (2018): 17654-17664.

46 He, Guojun, Tong Liu, and Maigeng Zhou. "Straw burning, PM2.5, and death: Evidence from China." Journal of Development Economics 145 (2020): 102468.

47 Prada, Marília, et al. "Perceived associations between excessive sugar intake and health conditions." Nutrients 14.3 (2022): 640.

BITS × BITES

Pioneering Chinese
agrifood tech VC fund

With 18% of the world's total population[48] and a loss of 5% of farmland in just 6 years,[49] China's arable land per capita currently stands at a worrying 0.08 hectares compared to the global average of 0.18 hectares.[50]
China is thus facing an unprecedented dual challenge of increasing food security while aiming to achieve carbon neutrality by 2060.

Soil health:

2.67 Million km²

Area suffering from soil degradation[51]

Biodiversity loss:

49.7%

Terrestrial vertebrates lost over a 40-year period[52]

China's agricultural production alone accounts for 13% of global GHG emissions and 32% of global fertilizer use.[53] Its reliance on food and feed import has a broader environmental impact globally. For instance, as much as 43% of soy-based deforestation emissions in Brazil can be attributed to soy export to China.[54] This means any innovations which accelerate China's sustainable agrifood system will have a wider environmental and social impact on other countries around the world.

48 World Bank, "Population, total – China." 2023.
49 Liu, Zongyuan Zoe, "China's Farmland is in Serious Trouble." *Foreign Policy*, 27 Feb, 2023
50 World Bank, "Arable Land (hectares per person)." 2023.
51 SWCC, "水土保持：进则全胜不进则退" 8 Jul, 2022.
52 Li, Ganjie, et al., *Living Planet Report China 2015 – development, species and ecological civilization*. WWF, 2015.
53 Zhao, Hao, et al. "China's future food demand and its implications for trade and environment." *Nature Sustainability* 4.12 (2021): 1042-105.
54 CDP, "Decoupling China's Soy Imports from Deforestation Driven Carbon Emissions in Brazil." 2019

Our investment and partnership with Bits × Bites — China's first agriculture and food technology VC fund that utilizes the United Nations Sustainable Development Goals as the guidepost — provides the perfect vehicle to generate positive impact in China and beyond as the fund invests in disruptive technology to address challenges in sustainable agriculture, crop and animal health, alternative protein, and human nutrition.

Bits × Bites has since backed 16 companies and is working arm-in-arm with the founders to accelerate their impact toward a more sustainable food system. And as a purpose- and profit-driven fund, the team has created its impact assessment framework to track its impact progress. Through all these efforts, Bits × Bites is playing a pioneering role in propelling an agrifood entrepreneurial ecosystem that helps fuel China's expanding climate economy.

Amongst its portfolio are companies tackling critical challenges along China's agrifood value chain. Starting with the farm, technology precision agriculture company AI GROW has developed China's first agricultural crop model to help local farmers produce more with less. By incorporating meteorological, soil, and seed performance data, AI GROW can accurately simulate how soil types, fertilizers, and other variables can influence seed performance. As of mid-2022, AI GROW serviced over 2.9 million hectares (44 million mu) of corn fields — that's equivalent to 26 Hong Kong.[55]

AI GROW's interface. Source: Bits × Bites

As of mid-2022
AI Grow serviced over

29 Million Hectares

of corn fields

55 Calculated by referencing Hong Kong's landmass as 111,400 ha

MOJIA BIO. Source: Bits × Bites

CHANGING BIO. Source: Bits × Bites

In biomanufacturing, MOJIA BIO replaces chemically synthesized ingredients with its proprietary enzyme and metabolic engineering platform, starting with vitamin B5. This production process enables a safer, cleaner supply chain, removing almost all salt waste byproducts and eliminating petroleum-derived chemical input and the resulting air pollution. Preliminary data shows that electricity use is reduced by 60%, and sodium hydroxide and concentrated sulfuric acid are reduced by nearly 90%.[56]

60%

electricity use is reduced

90%

sodium hydroxide and concentrated sulfuric acid are reduced

In alternative protein, CHANGING BIO ferments microbes into protein to reduce China's reliance on animal dairy and alleviate the resource burden of livestock farming. Preliminary data shows that 1 KG of Changing Bio's protein consumed can reduce 42 KG of CO_2 compared to cow dairy protein.

1kg

of Changing Bio's protein consumed can reduce

42kg

of CO_2 compared to cow dairy protein

56 This is preliminary data that is not reflective of scaled-up production. Actual data will be available after a life-cycle assessment is conducted.

Concluding Remarks

As The Mills Fabrica marks its fifth year anniversary, we are delighted to release our inaugural Impact Report showcasing our investment portfolio companies' contributions to bolstering ecological-social resilience and making planet positive change. Looking ahead, we remain unwavering in our commitment to driving progress toward a more socially and ecologically resilient planet. This commitment includes investment and incubation, as well as greater collaboration through our partnership initiatives. We also prioritize knowledge exchange and collective learning through our interactive spaces and Impact Retail store, Fabrica X.

We believe that it is imperative to encourage ecosystem and industry players to continue to exchange thoughts and knowledge on measuring and ensuring accountability in social and environmental impact. This dialogue is fundamental to driving progress toward more responsible and impactful business practices.

We would like to take this opportunity to express our profound gratitude to our ecosystem partners and innovators for their invaluable contributions to The Mills Fabrica's fifth year of operation and achievements. Together, we have made significant strides, and we remain dedicated to working in concert to effect meaningful change.

At The Mills Fabrica, we are committed to fostering continuous knowledge exchange and collaboration with our ecosystem partners and innovators, as we strive towards a more sustainable and equitable future. We believe that the most pressing challenges facing our world necessitate a collective effort, and we are honored to collaborate alongside partners across sectors in the pursuit of this shared vision.

Key Definitions

Arable Land
This represents land worked (ploughed or tilled) regularly, generally under a system of crop rotation.

Atmospheric aerosols
defined as the concentration of human-made aerosols in the atmosphere that leads to significant changes in regional and global climate patterns.

Biogeochemical flows
defined as the rate of human-induced nitrogen and phosphorus loading to terrestrial and aquatic ecosystems that exceeds the natural background rate, leading to eutrophication and other ecosystem changes. This is measured as the global environmental flows of reactive forms of nitrogen (N) and phosphorus (P), two essential nutrient elements that play a vital role in supporting life.

Biosphere integrity
the global rate of species extinctions is the planetary boundary indicator for the loss of genetic biodiversity and the maintenance of the integrity of the biosphere - the entirety of life on Earth and the complex web of its relationships. The diversity and abundance of living organisms underpin long-term Earth system functioning by regulating natural material and energy flows and by providing resilience to both abrupt and gradual change. The extinction metric for this planetary boundary is now complemented with a more readily operational measure of biodiversity intactness.

- Genetic diversity: defined as the extinction rate, E/MSY (the extinctions per million species-years). < 10 E/MSY (10–100 E/MSY) but with an aspirational goal of ca. 1 E/MSY (the background rate of extinction loss).
- Functional diversity: defined by the biodiversity Intactness Index (BII, not yet quantified), which assesses change in population abundance as a result of human impacts, such as land or resource use, across a wide range of taxa and functional groups at a biome or ecosystem level using pre-industrial era abundance as a reference point.

Carbon dioxide equivalent
A carbon dioxide equivalent or CO2 equivalent, abbreviated as CO2-eq is a metric measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential (GWP), by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential.

Climate change
represented an atmospheric CO2 concentration of 350 parts per million (ppm) and an increase in top-of-atmosphere radiative forcing of +1.0 W m−2 relative to preindustrial levels.

Direct land use (Food Climate Research Network 2018)
The purpose for which an area of land is used by humans: e.g., cropland, urban settlements, forests. Wild or natural land, by contrast, is not used by humans.

Ecological resilience
A measure of how much disturbance an ecosystem can withstand without shifting into a different state. Resilient ecosystems can regenerate themselves if damaged.

Freshwater use
- Green water: represented by the percentage of ice-free land area on which root-zone soil moisture deviates from Holocene variability for any month of the year.
- Blue water: an estimate of the total global volume of ‘blue’ water consumption (that is, the use of water from rivers, lakes, reservoirs, and renewable groundwater sources) that would alter the Holocene functions of the water cycle.

Holocene
The period representing the last 12,000 years during which the Earth System has been in a relatively stable state, with conditions that are particularly accommodating for human wellbeing and development.

Indirect land use (Food Climate Research Network 2018)
Land that is indirectly used via the consumption of goods requires an area of land to make them. For example, pork production uses land indirectly via the consumption of animal feed in the process.

Land-system change
defined as the conversion of more than 15% of the Earth's ice-free land surface to cropland or other uses, leading to significant loss of biodiversity and changes in ecosystem function.

Microplastics
These types of plastics are characterized as plastic particles between 1nm to < 5nm.

Nanoplastics
These types of plastics are characterized as plastic particles of smaller than 1nm.

Novel entities
New substances, new forms of existing substances, and modified life forms, including chemicals and other new types of engineered materials or organisms not previously known to the earth system as well as naturally occurring elements (for example, heavy metals mobilized by anthropological activities).

Ocean acidification
although CO2 is the principal driver of ocean acidification, the indicator used in the planetary boundaries framework is the aragonite saturation, a specialized measure of the geochemical effect of acidification in the oceans. As ocean acidification intensifies, the effects on marine life are complex and poorly predictable but include changes in calcification (shell and coral formation), photosynthesis, metabolism, and chemical signaling affecting organism behavior and structures of ecosystems. The planetary boundaries framework sets a safe boundary for ocean acidification at a pH of 8.2, which is the pre-industrial level. The current pH of the oceans is estimated to be around 8.1.

Resilience
The capacity of a system to deal with change and continue to develop.

Social resilience
The ability of human communities to withstand and recover from stresses, such as environmental change and social, economic, or political upheaval. Resilience in societies and their life-supporting ecosystems is crucial in maintaining options for future development.

Social-ecological systems
Social-ecological systems comprise many human and non-human ‘components’ that interact in diverse ways. These components and their interactions respond to changes in their environment – and their environment changes as a result.

Stratospheric ozone depletion
the reduction of the protective ozone layer in the Earth’s stratosphere to a level that poses a significant risk to human health and ecosystems. The framework sets a safe boundary for stratospheric ozone depletion at 10% reduction in ozone concentrations compared to pre-industrial levels.

Techstyle
The intersection between technology and lifestyle, denoting the future of fashion.

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