

Under their skin



beyond leather

A just transition

[Full leather report](#)
Under their skin:
A just transition beyond leather

April 2023

Other reports in the series:

Leather's impact on people
Leather's impact on the planet
Leather's impact on animals

Authors
Emma Hakansson
Dr Sydney Gladman
Dr Naomi Bailey-Cooper

Editors
Elissa Rosen
Susannah McFarlane

Additional research:
Chessie Oswald-Jacobs
Noa Ben Moshe
Bella Holgate

Analysis:
Julia Zahn
Noa Ben Moshe
Natalie LaBarbera

Design
Very Good Looking

Illustrations
Inma Hortas

Under their skin

Contents

Contents

Introduction to leather	4
Introduction: A just transition beyond leather	10
Shifting perceptions on leather	13
Fashion industry transition and the future of leather	18
What makes leather 'leather'?	24
Currently available and scaling leather alternatives	26
Brand benefits of a transition beyond leather	59
Leather supply chain just transition	66
Transitioning farmlands and workers	74
Shifting beyond slaughterhouse work	82
Reimagining and moving beyond tannery work	84
Conclusion	88
References	92

Under their skin: a report series on leather

Under their skin

Introduction

5

Introduction

Leather has been seen as an unshakably prominent and important aspect of the fashion industry and dressing for millennia.

The oldest intact leather shoe, uncovered by archaeologists in an Armenian cave, is over 5,500 years old, made from cow skin and predating the Pyramids of Giza by 1,000 years.¹ Since this shoe was made, plenty about the fashion industry has changed: today, over 1.4 billion cattle have been bred and stand on once biodiverse land until they are slaughtered for production purposes,² leather is now often coated with plastic or tanned with harsh, carcinogenic chemicals,^{3,4} while the ever-increasing scale of the fashion industry is utterly unsustainable: leather supply chains are highly industrialized, harmfully implicating many workers and surrounding communities, while making luxury and mainstream brands massive profits.⁵ At the same time, very little has changed: animals continue to be exploited and slaughtered for the production of shoes, clothes and other goods, and skins must be fleshed and altered to ensure they do not rot on our feet.

So many centuries later, as we finally come to grips with our responsibility to address not only a human-induced climate crisis, but an animal and social wellbeing crisis built on commodification and endless-growth capitalism, it is time to move beyond leather – a material produced by an industry disproportionately contributing to these serious troubles, compared to other international industries.⁶ Such a move would allow the fashion industry to better align with the Intergovernmental Panel on Climate Change's (IPCC) targets and the United Nations Sustainable Development Goals such as 'clean water and sanitation' (6), 'reduced inequalities' (10), 'responsible consumption and production' (12), 'climate action' (13), 'life below water' (14) and 'life on land' (15).⁷

A human ability to destroy, shown so clearly in the fashion and leather industries, is remedied by a human capacity for innovation and progress. Today, numerous materials replicate many of the properties which made leather so useful to us, produced with a far smaller, less harmful impact on our planet and those living on it. Material innovation only continues to grow, and rapidly, proving the possibility of a total ethics fashion future, one which has evolved beyond the skins we benefited from using millennia ago.

In this report series, Collective Fashion Justice – aided by the work and support of organisations including the Center for Biological Diversity, FOUR PAWS, Material Innovation Initiative, Defend the Wild, Fashion Act Now, Faunalytics, and numerous experts contributing in their specialist areas – explores leather production and its place in the global agricultural and fashion industry, in addition to its impact on domestic and native species, the planet and our fellow humans. The series also outlines available and soon-to-be-available total ethics alternatives, and the practical possibilities of a just transition towards more communally and environmentally beneficial production – a step that is sorely needed in efforts to ensure collective liberation. Fashion cannot be truly sustainable unless it is ethical, too. We cannot sustain environmental degradation, nor injustices facing humans and non-humans.



Leather is not a by-product: the importance of addressing hides

Despite common misconception, leather is not simply a worthless by-product, but a co-product.

While the leather industry likes to claim skins are tanned as a kind of waste reduction initiative, thus supposedly making leather neither cruel nor unsustainable, this is not the case.¹ Leather is a valuable co-product, with even meat and dairy industries labeling it as such.^{2,3}

The leather industry itself states the massive income losses involved in losing skin sales.⁴

Slaughterhouses purchase cattle from saleyards or farms, factoring in the likely profit gains from the flesh, skin and other parts of a cow's body. While some calves are raised specifically for their young, soft skins, even those cattle whose skins are considered a 'co-product' bring in profits for the animal-industrial complex

and fashion industry.⁵ On a micro-scale, individual slaughterhouses have reported multi-million dollar losses and the consideration of closing up when skins don't sell – often due to the rise in leather alternative popularity.⁶⁻⁸ At a macro level, the global leather goods market was valued at \$394 billion USD in 2020, with that number only increasing.⁹ Leather is for-profit business, and the entire leather supply chain, farms included, must be considered when exploring the environmental and ethical implications of fashion's use of it.

Valuing hides versus flesh

Global raw leather and hide exports were valued at over \$18.5 billion in 2019, with an expected rise of 9.46% by the end of 2022,¹⁰ while global beef exports sat at over \$45 billion USD in 2020. Leather can account for up to 26% of major slaughterhouses' earnings around the world.^{11,12}

In India, a leading leather footwear and garment producer, most exports by share go to the United

States and Europe.¹³ Here in India, the skins of bovine animals, including cattle and buffalo, are tanned, with particular complexity surrounding cattle skins given laws banning cow slaughter across the country. Despite these laws and high tariffs on hide but not meat exports, the value of exported hides from animals slaughtered in India is \$3 billion USD, compared to all animal product exports such as meats and dairy equating to \$10.1 billion USD.^{14,15}

In Brazil, slaughterhouses killing cattle in 2020 made \$34.74 billion USD in revenue. Leather sales in the domestic market and through export made up over \$1.1 billion USD, or over 3% of total value. Meanwhile, all beef sales made up approximately 88% of revenue. While it is clear that leather is not the primary product in Brazil, it is the second-most profitable aspect of the industry, and a highly valuable co-product, given it brings in over \$1 billion in revenue.¹⁶ About 80% of Brazil's leather is exported, making the impact of the industry globally relevant.¹⁷

It is important to note that hides once had a much greater value, accounting for a larger amount of the total revenue made from slaughtering cattle. As Meat and Livestock Australia once noted, after yet another price drop for hides, 'the hide market has fallen further as decreased demand, the increase of synthetic leather, and environmental regulations have an impact.'^{18,19}

As noted by Earthsight, some research suggests that prior to the steep rise of leather alternatives, a cow's hide accounted for up to 8% of an animal's total value at slaughter, and a much higher proportion of the sales value.^{20,21} Reduced hide prices are not a justification for further funding a harmful industry: they are a consequence of this harm, in a society evolving beyond a desire for destruction in the name of fashion.

Should the global leather industry lose the billions of dollars worth of revenue made through the sale of skins,

the impact would be significant. Currently, leather sales effectively subsidise beef production, and by removing this 'subsidy', beef would become more expensive. The more expensive meat becomes, while plant-based meat alternatives become more affordable, the sooner price parity will be met – and this is when the meat industry, responsible for massive ecological, human and non-human harm, will significantly shrink.²² In turn, our planet and those living on it will live better.

Industry overview

8

The Leather Council states that 67% of skins used for leather belong to cattle and buffalo, followed by sheep (12%), pigs (11%) and goats (10%).¹ It is estimated that less than 0.5% of leather is made from other animals, such as native kangaroos and even domestic species like dogs and cats.¹⁻³

With labelling laws across the globe largely not requiring species identification for leather,⁴ it can sometimes be extremely challenging to know what species has been killed, given the murkiness of global fashion supply chains.

Alongside these sometimes misleading labeling laws, the lack of transparency across leather supply chains may result in a lack of consumer and industry understanding of where leather really comes from. On this topic, fashion writer Lucy Siegle once wrote for The Guardian that "we're comforted by 'Italian leather' stamps, but this could mean that the leather was imported and finished in Italy. I'm fond of saying that if all the 'Italian leather' merchandise was of true provenance you wouldn't be able to move for cows in that country. They'd be drinking from the Trevi Fountain."⁵

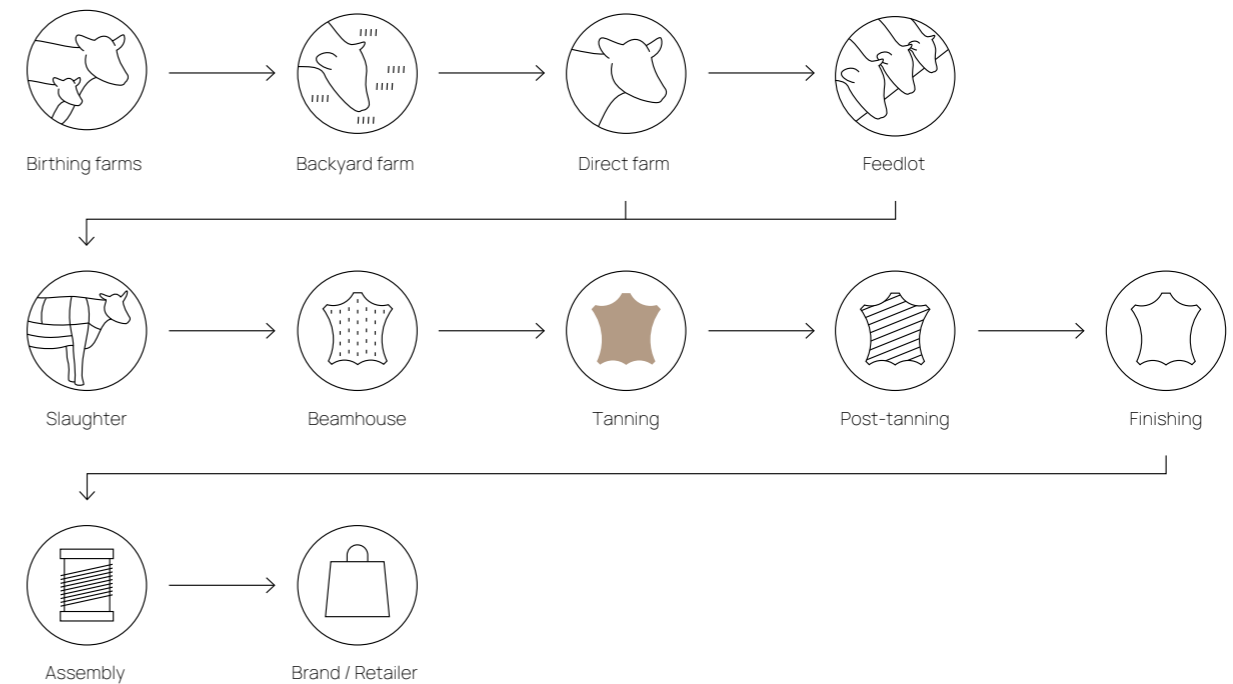
Indeed, Italy is the second largest importer of partly processed skins from cattle ranches in Brazil,⁶ where such production is the leading cause of Amazonian deforestation.⁷ In fact, Brazil is the third most significant producer of bovine skins, with the latest industry statistics citing 40.7 million bovine skins being produced in a single year. Brazil's massive

output is surpassed by China's 47.6 million bovine skins pulled from carcasses in a year, and the output of India, the most significant bovine skin producer, slaughtering and skinning 48.7 million bovines each year. China, Brazil, Russia and India are the major producers of finished, tanned bovine skins.¹

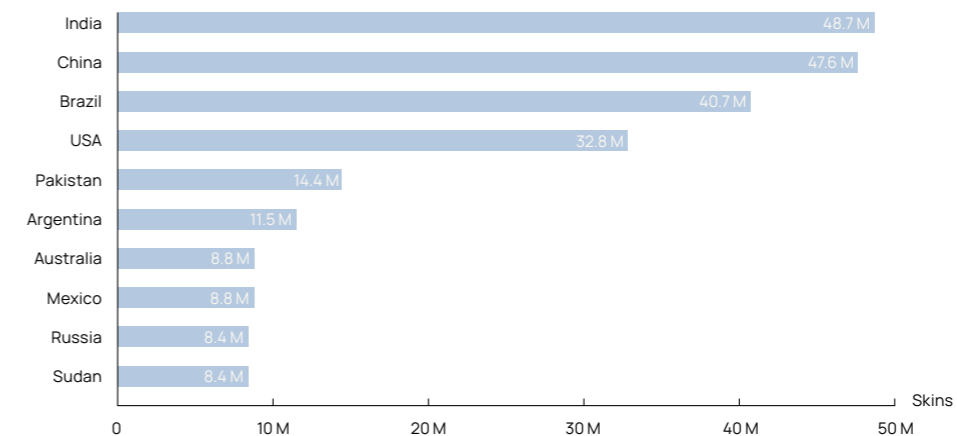
The complexity of global leather supply chains makes it difficult to trace environmental, human and non-human animal abuse and exploitation. Not only does the changing location between cattle farms, slaughterhouses and tanneries make this leather tracing challenging, but so too does the reality of multiple farms and ranches being involved in leather supply chains, due to the use of 'birthing farms', 'backgrounder farms', 'direct farms' and feedlots.⁸

This report will focus on the bovine leather industry across India, China, Brazil, the United States and Australia - as these are all either major production and tannery countries, or countries considered to have 'improved' practices. ■

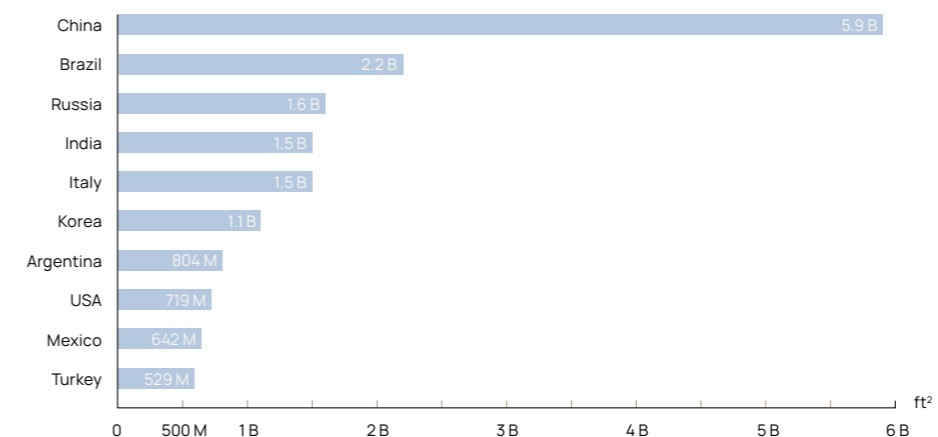
Supply chain



Top cattle hide producing countries*:



Top tanned hide producing countries*:



A just transition beyond leather

A just transition beyond leather

Introduction: A just transition beyond leather

11

Introduction: A just transition beyond leather

We must move beyond the interconnected harms of the leather industry, faced by people, our fellow animals and the planet. As highlighted in Collective Fashion Justice's reporting on leather's impact on the planet, people, and our fellow animals alike, the leather industry can only somewhat reduce the human and wildlife health risks, environmental destruction, emissions, pollution and animal suffering associated with the production of leather.

While the animal-derived leather industry can be marginally improved, it cannot be transformed into one that is genuinely responsible.¹ In order to create a fashion industry which is indeed sustainable, perpetuating the least amount of harm, we must see a just transition beyond leather. Not all leather, but leather as we most often recognise it today, derived from animal skins and, most often, chemically transformed. We must shift past the limitations of leather created in this way, and towards next-generation, circumfaunal (intentionally animal-free) leather which is more environmentally, human and fellow animal friendly, as well as more adaptable, customisable, and creative.

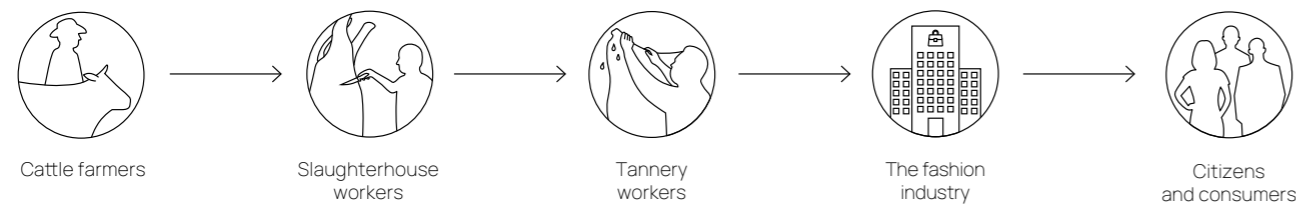
To explore a 'just transition' we must first define it. The concept 'emphasises that large socio-economic shifts in response to climate change should be planned and implemented in a way that is socially fair. The initial conceptualisation of the term, developed by US trade unions in the 1970s, focused on protecting the rights of workers and communities that

would lose jobs and economic opportunities in the face of new environmental regulations'.² While this definition does not relate to our fellow animals, a growing number of academics recognise the importance of also including non-humans and their wellbeing in the view of a just transition.³ Just transitions are not just theoretical; there are examples of just transition progress, related to fuel and coal, found across a number of countries including Poland, Indonesia, Canada and Egypt.⁴

A just transition beyond animal-derived leather must align with the values of a new, total ethics fashion system.⁵ As such, we must ultimately move beyond not only animal-derived leather, but harmful leather-like materials, such as fossil-fuel derived synthetic leather. Too, we must ensure that this transition leaves no person behind, as across the world many millions of people work in the roles of cattle and animal rearing, slaughtering, and hide tanning. While such a transition is undoubtedly complex, the many harms of leather production are interconnected, and thus ►

Shifting perceptions on leather

Some of the communities surrounding current supply chains:



solutions to these problems are too. A shift beyond leather production can help us to create a world with more intact Indigenous land rights, less deforestation and biodiversity destruction, a cooler climate, less pollution, less violent systems and crimes, safer communities and improved physical and mental health of people across the supply chain.¹ It, of course, also helps us to move past the view of any individual as a mere commodity: something which is essential to the creation of a total ethics fashion system, and, indeed, a just society.

A just transition is expensive, requiring significant funds. Fortunately, much of these funds exist and are currently being used to subsidise the harms of leather supply chains.⁶ This report

explores how shifting public funds could benefit a just transition, while also exploring the potential employment adaptations available to farm, slaughterhouse and tannery workers around the world.

Finally, this report highlights the benefits to be reaped by a fashion industry and brands which support a move beyond leather, particularly as consumer perception moves beyond support for the material. These brands gain social currency, commercial rewards, and greater access to the most innovative leather alternatives (referred to as next-gen leather) available. From animal and plastic free MIRUM to mycelium leather alternatives, the future of 'leather' is one to look forward to, and work urgently, diligently and creatively towards.

Consumer interest in leather

There is an innate emotional attachment to materials that appear, feel, smell like or are thought to have come from nature,¹ and leather has the ability to fulfil these requirements on many sensory levels. When leather finishing retains natural grain marks with a certain level of subtlety, this material is also less likely to fall out of style, while coatings with different textures or finishes can become trend-bound and less appealing long-term.

The marketing of leather goods also plays into the idea of leather as an unmatched material, a trickle-down from recent history where leather became associated with the craftsmanship of luxury goods companies such as Louis Vuitton and Hermès – both of which have begun trialling next-gen leather materials. A 2019 report on the intentions behind leather product purchases in fashion found the appeal of the material was tied to its perception as 'prestigious'.² A subjective norm incited by the continued promotion of animal materials by fashion companies was another major driver.² Leather goods have also become

associated with iconic design items and are often passed down through generations due to their durability and classic appeal, imbuing them with history and story. Longevity of use is a powerful factor in terms of overall product sustainability.³ Appeals such as this can serve to inspire the formation of alternative materials with equal longevity, which can be used to create similarly iconically designed shoes and garments that do not come with the same negative production impacts.

Despite animal-derived leather having these appeals, public attitudes towards its use are rapidly changing. In fact, global attitudes towards the use of animal-derived materials in general are shifting, increasingly supportive of a just transition to materials made from other sources. As far back as 2015, polling across six European countries showed that consumers believe that leather alternatives are comfortable and cool, as well as increasingly preferable.⁴ In prominent fashion industry nations France and Italy, 'a noteworthy ethical sensitivity' saw 81% of respondents inclined towards buying animal-free materials, with similar numbers shown across other nations.⁴ Polling across twelve countries in 2021 found that almost 90% of shoppers want the fashion

industry to prioritise animal welfare, with almost one third of people now seeking out products which reflect this or which are totally free from all animal derivatives.⁵ Globally, nine out of ten people want companies to make animal, environmental and social protections alike key priorities.⁵

Year-on-year from 2020, searches for 'leather' have decreased by 3.5%, while searches for 'vegan leather' have increased by 69%, with 'eco vegan leather' searches – likely looking for alternatives made from materials other than conventional synthetics – also on the increase.⁶

New polling on consumer perceptions of leather

Collective Fashion Justice's February 2023-commissioned polling across Australia and the United Kingdom found that while a range of factors, including longevity as well as look and feel continue to persuade a significant portion of people to purchase animal-derived leather, a growing number of consumers said they did not buy leather at all (51% and 52%), or would prefer not to. ▶

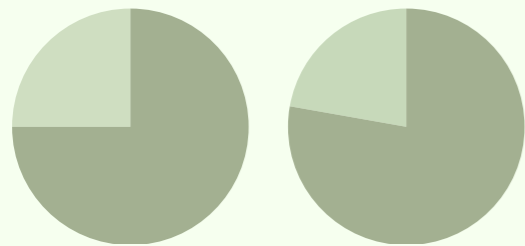
A just transition beyond leather

Shifting perceptions on leather

A just transition beyond leather

Shifting perceptions on leather

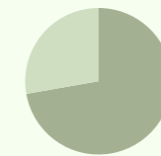
The surveying also showed that:^{7, 8}



75% of Australians and nearly 78% of people in the UK would prefer to choose animal-free leather if it were sustainable and readily available.

Currently, perceived poor quality and price are the primary drivers of aversion to purchasing leather alternatives: a two-pronged problem, as while higher quality, more responsible alternatives are yet to meet price parity with mainstream leather production, fast fashion's use of cheaper synthetic leather has likely

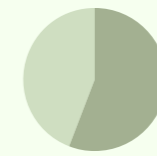
contributed to this perception of poor quality. It's important to note that many cheap leather and synthetic products are only cheap as costs are outsourced to exploited people and ecosystems throughout the value chain, rather than paid for by the consumer. These harms are increasingly understood:



72% of polled people across both Australia and the United Kingdom understand that animal-derived leather cannot be sourced without harm to animals.



53% and 56% of consumers in these markets were likely to avoid leather once they understood the cruelty and killing associated with its production, to avoid this.



A further 47% and 46% did not believe animal-derived leather could be sustainably sourced (with 38% and 36% unsure of what this meant).

These numbers highlight a growing awareness of the negative impacts of leather, as well as an opportunity for the fashion industry to help inform and lead currently confused or uninformed citizens towards more responsible choices.

This new surveying is reflective of shifting perceptions found in other polling around the world. While 17% of surveyed Austrians now avoid leather and other animal-based fashion,⁵ 90% of consumers surveyed across China preferred

next-gen leather which is more sustainable and animal-friendly than conventional leather.⁹ With China being such a major leather producer and fashion consumption capital, this 2021 research is significant. ▶



A just transition beyond leather

Shifting perceptions on leather

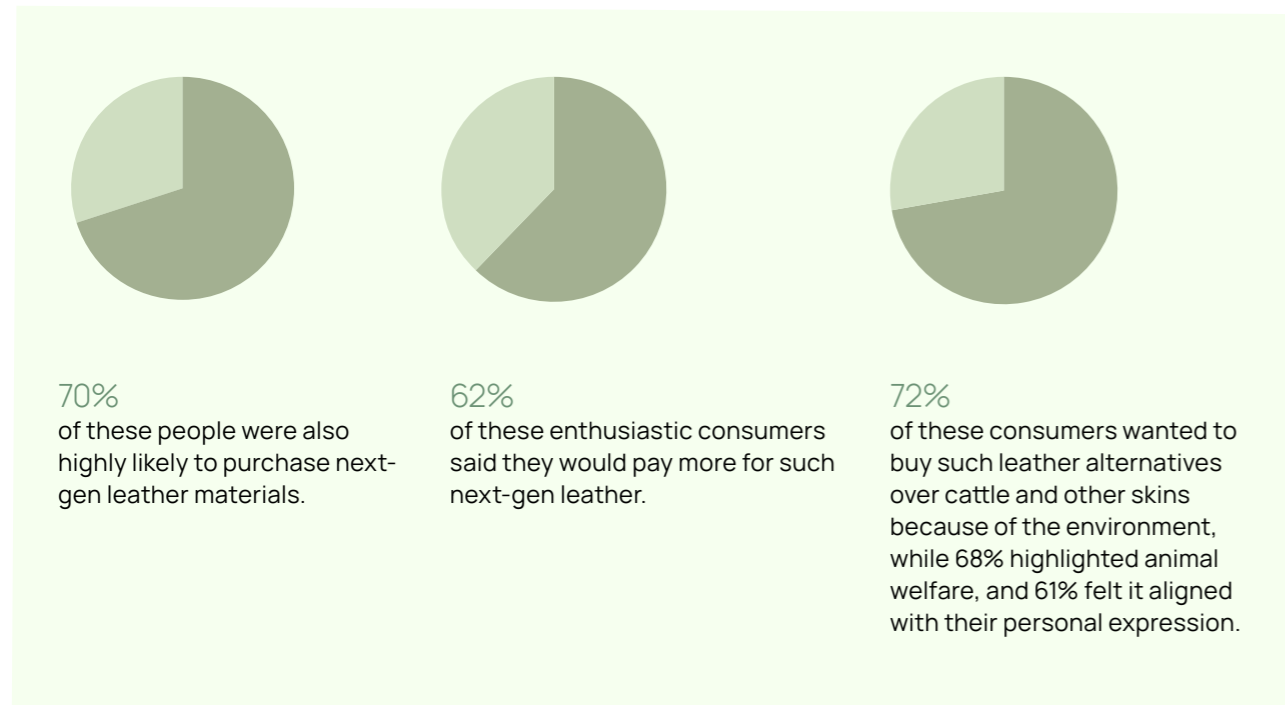
16

A just transition beyond leather

Shifting perceptions on leather

17

The consumer perception data from Material Innovation Initiative and North Mountain Consulting also found that:⁹



by-product, an increase in purchase interest followed, swayed by this dubious claim.¹⁰ However, 9% said that 'nothing' the industry shared would 'change their mind'. Just 13% viewed animal-derived leather as a kind of status symbol, and 16% chose leather as it had less environmental impact than synthetic leather alternatives – despite this being inaccurate, even if synthetic materials are not the solution either.^{10,11} This interest in the environment is, regardless, promising and positive.

These 'early adopters' represented a similar population to the wider US community in diversity of age, gender, region and ethnicity, and were interested in recycled, biodegradable, plant and fungi-based alternatives.¹² Those who currently prefer animal-derived leather will 'be open to switching when next-gen leathers are at a price, quality and performance parity'.⁶ The potential market share for next-gen leather as compared to animal-derived or synthetic is 54%, if the industry could catch up to consumer interest.⁶

Across the pond, 94% of consumers in a United States study from 2021 were open to buying sustainable leather alternatives, with 45% highly likely to purchase, and 39% willing to pay more for sustainable, animal-free leather and other materials.¹²

Leather UK, the marketing and lobbying body of the UK leather industry, has also completed market research on UK consumer attitudes towards leather and alternatives to it. The 2022 research included interesting results. 15% of polled consumers

have never owned or bought leather items, and 9% exclusively bought leather alternative materials. Another 20% stated that they 'no longer' buy or use leather, leaving just over half of consumers continuing to buy and use the material.¹⁰

While Collective Fashion Justice surveying in the UK highlighted the widespread misbelief of leather as a 'by-product' rather than a profitable 'co-product',^{7,8} when Leather UK's surveyed consumers were exposed to industry misinformation of leather as a waste reducing

Fashion industry transition and the future of leather

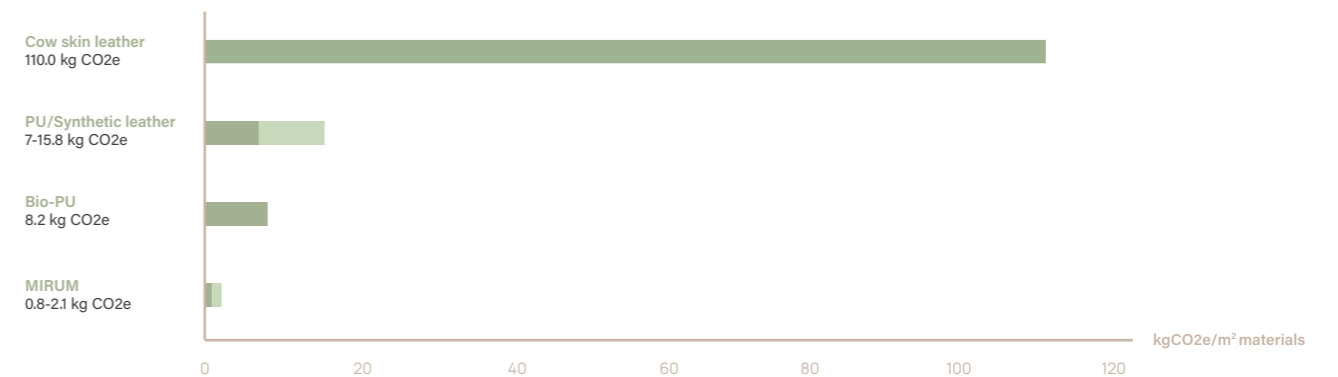
In order for the fashion industry to transition beyond the use of animal-derived leather, we must have total ethics alternatives to it. These alternatives can be described as ‘next-gen leathers’: animal-free and environmentally preferable materials which replicate or exceed the aesthetics and performance of their animal-based incumbents and petroleum-derived, current-gen counterparts.

Next-gen leather uses a variety of biomimicry approaches to replicate the aesthetics and performance of animal-based leather. For a next-gen leather to be actively produced beyond the use of animals alone is not enough. To work towards a total ethics fashion future, we must use materials which holistically consider the wellbeing of people, our fellow animals and our shared planet at once. Our collective wellbeing is intimately interwoven, and efforts to protect one but not the others are ultimately ineffective.

As explored in our 'leather's impact on the planet' report, existing data highlights the significant reduction of land use, water use, climate and other impacts associated with producing synthetic leather over animal-derived leather, however the widespread use of both of these materials is harmful to the planet and those living on it.^{1, 2}

Sustainability is complicated and the fashion industry requires a greater amount of more recent and less contextually specific data on materials used in fashion, alongside consistent agreement on environmental impact analysis methodology, reporting and comparison strategies amongst materials. As a result, there is a dearth of usable data relevant to how next-gen materials compare to synthetic and animal-derived leather today. However the data which does exist and can be appropriately used, indicates clearly that next-gen leathers are poised to have far smaller environmental impacts than all animal-derived and conventional synthetic leathers.¹ Importantly, many next-gen producers are addressing not only production impacts, but the importance of biodegradation, reuse and recycling at a material's end-of-life.

Comparing animal-derived, synthetic and next-gen leather's climate impact*:



* (2022, Natural Fiber Welding LCA assessment and 2017, Leather Panel data. All data is 'cradle-to-gate', except for the higher synthetic calculation, which includes end-of-life incineration.)

The next generation of leather must be free from all animal and fossil fuel inputs alike. But they must also be able to function effectively within a circular economy in which materials either effectively biodegrade, compost, or are upcycled and recycled. They must have environmental footprints which are as small as possible when considering climate, land, biodiversity, deforestation, chemistry, water and other resource usage impacts, and should be made in supply chains in which humans are treated and paid

fairly for safe work, too. They must also be desirable and economical.

The next-gen leather industry has grown significantly since 2013, when there was only one major next-gen leather company. Today there are over 65, many of which were formed in the past three years. MII has projected that the global wholesale market size for next-gen materials, including next-gen leather, will be approximately \$2.2 billion USD by 2026.⁵ This increase is due to significant interest from fashion, automotive,

and home goods brands, alongside significant interest from investors.

The most notable funding in next-gen leather in 2022 included MycoWorks, Natural Fiber Welding (NFW), and Cultivated leather startup VitroLabs, whose investors include global luxury fashion group Kering. ►

Notable funding in next-gen leather:⁶

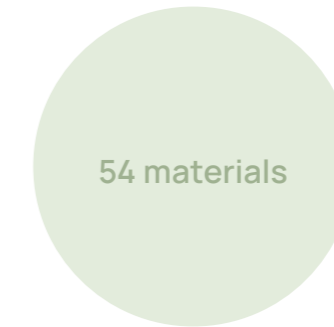
Company	Product	Investment round	Financing	Date closed
MycoWorks	Mycelium leather	Series C	\$125M USD	October 2022
Natural Fiber Welding	Plant-based leather	Series B	\$83M USD	April 2022
VitroLabs	Cultivated leather	Series A	\$47M USD	May 2022

The main material input categories replacing leather

The diversity of technology and processes used to make next-gen materials is significant. We expect materials made from similar technologies to have similar advantages and disadvantages. As such, the availability of a broad range of technologies allows brands to explore a range

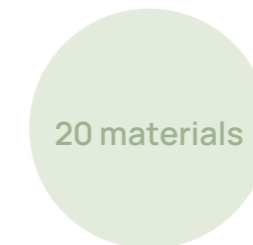
of options suitable for different applications. To simplify the broad landscape of formulation and processing approaches for next-gen materials, the Material Innovation Initiative (MII) categorises next-gen innovation by main input (greater than 50%): plant-derived, mycelium, cultivated animal cells, microbe-derived, recycled material, and blend.⁷

Plant-derived:



Applies to next-gen materials derived from plant matter of virgin or otherwise wasted, or viewed as 'by-product' origin. For simplicity, fungi (fruiting body), and algae inputs are included in this category, even though they are not plants.

Microbe-derived:



Applies to next-gen materials that utilise cellular engineering approaches such as cell culture or fermentation processes that yield products such as proteins and biopolymers for next-gen material formulations.

Mycelium:



Applies to next-gen materials that utilise the root-like structure of some fungal species called mycelium. This category is separated out from the plant-derived category due to the rich activity of next-gen innovation involving mycelium.

Blended:

9 materials

Applies to next-gen materials that use a blend of components not well-captured by any of the other described categories.

Recycled material:

7 materials

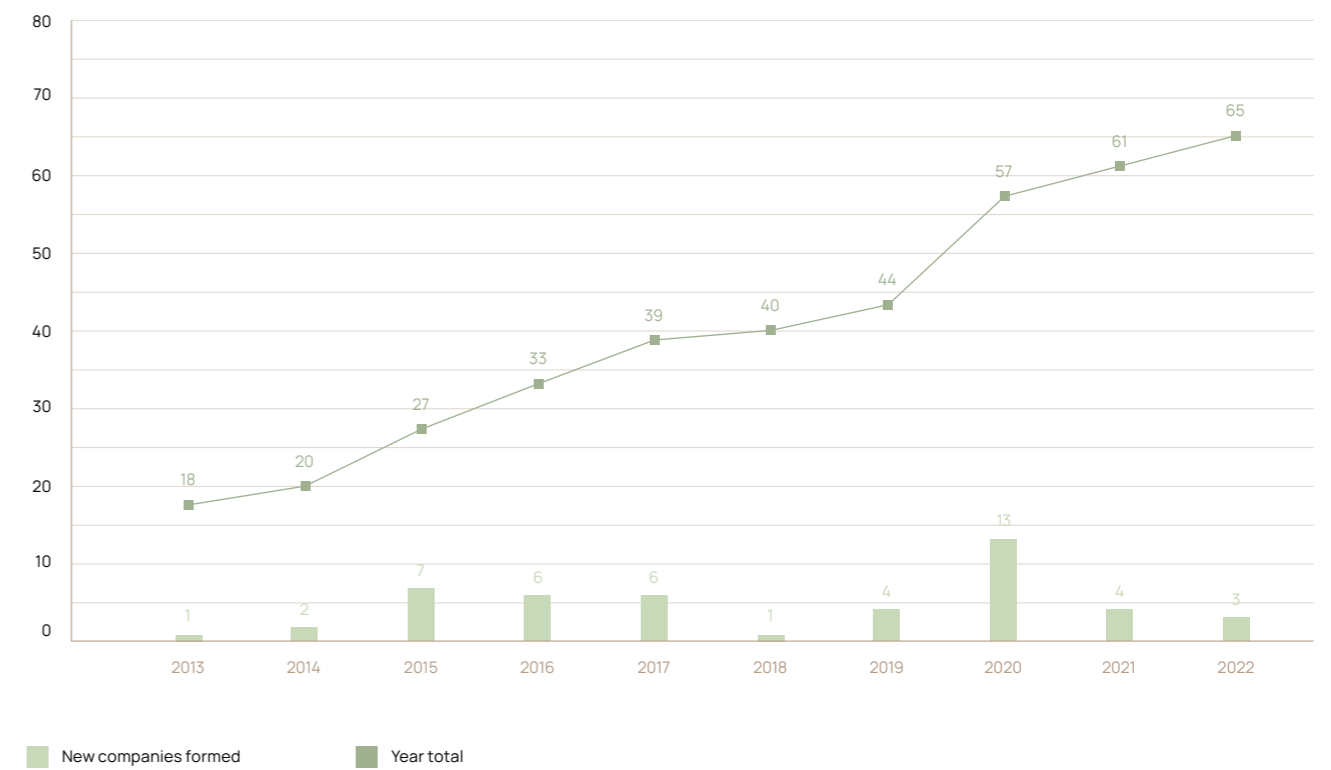
Applies to next-gen materials that utilise recycled plastic or recycled textile feedstock as a main input.

Cultivated animal cells:

4 materials

Applies to next-gen materials that utilise tissue engineering approaches to grow animal cell constructs (such as skin) in the laboratory.

Number of next-gen leather companies by year founded:⁸



As interest in the impact which materials have on the environment, our fellow animals and the people producing them increases, MII anticipates the creation of more next-gen material companies, further investment in the industry by both investors and brands, and significant improvement in the performance and aesthetic of these materials. This increase is already visible. ■

What makes leather 'leather'?

Designers and consumers do not use leather because it comes from an animal: they use it because it has certain properties which make it a good fit for its applications.

In order to produce the most effective alternatives to animal-derived leather and its fossil fuel-derived alternatives, we must understand the qualities which make leather desirable to the fashion industry and people who buy into it. For example, when we design or buy a leather shoe, why are we choosing leather? What is it about leather that makes it desirable in a shoe?

Animal-derived leather is durable, so it can both protect and withstand pressure from our feet while walking. It is moisture resistant, keeping our feet dry in rain or while stepping through puddles. It is breathable, reducing sweat. Societally, we have also come to appreciate the

aesthetic qualities of leather as we know it today. Fortunately, considering its wide and significant impacts, leather derived from processed animal skins is not the only material which meets these properties. In many cases, these properties are also not inherent in the material themselves but are added through processes like bindings and coatings, which can often be fossil-fuel and plastic based.¹

Next-gen material companies must and are seeking to meet or exceed the performance requirements for animal-derived leather including, but not limited to, the following categories for the materials' relevant application:

- Colour fastness including light, crock, water spotting, solvent spotting, and perspiration
- Durability including elongation and tensile strength, flexibility and adhesion of finish, standard crack
- Strength/toughness including tear strength, stitch tear strength and seam slippage, and abrasion resistance
- Stability and flammability

Many products are also 'over-engineered', the specific qualities of the materials used being higher than is needed for the application. For example, the material needed for formal, heeled dress shoes worn infrequently in largely indoor, clean conditions is very different from the material needed for a sneaker worn almost every day ongoingly. But, in many cases, these products are made from the same materials. While this may be insignificant, the choice can have negative implications for a product's end-of-life, in which the requirements for durability and biodegradation, for example, may be contrasting. It is important these major sustainability considerations are balanced.

Companies currently using animal leather to create shoes, bags, accessories and other products should be encouraged to consider whether the material properties required for those products could be found in another textile. This thinking may allow for more innovative and creative material sourcing, which is tailored to specific design needs, especially in light of wider environmental concerns. Leather alternatives are already being tested to fulfil air and vapour permeability and seam appearance, good crease and abrasion resistance, or tensile

strength,² for a variety of products that would usually be made with animal leather. A performance-driven shift beyond animal-derived leather has already occurred in some parts of the sector. For example, in the early 1960s all ski boots were made of conventional leather, but today the proportion of leather ski boots is 0% due to synthetic materials providing enhanced waterproofness, stability, warmth and support.³

Advancing leather alternative products will require more time and effort dedicated to sourcing, as well as developing an understanding of new materials and how they can be used. At present, next-gen leather materials are often not accessible at the required volume or speed that the industry has become accustomed to. However, an essential shift in business models in the fashion industry, in line with planetary boundaries, has become widely acknowledged.⁴ As a consequence, there is an opportunity to create a profitable marketplace which favours production processes and materials which do not strain the natural environment or life within it. In addition, there is space to customise the qualities of leather alternatives to facilitate longevity of use, as many luxury brands move to repair, rental, and resale models for their products.

UK luxury footwear designer Nicholas Kirkwood is currently exploring leather alternatives that fit within a slower and more considerate fashion system. Previously known to use materials including stingray skin, manipulated cow skin leather and suede, he is now focusing on next-gen, green manufacturing and non-animal materials aimed at being carbon neutral.⁵ Currently on the advisory panel for Soarce, he sees particular value in 100% fossil free materials that have the ability to regenerate soil health post consumer.

"I'm excited by the immense innovation in fossil-free alternatives for fashion's largest offending materials. In particular I'm most interested in some of the viable and truly fossil-free leather alternatives coming to market soon."

— Nicholas Kirkwood⁶

As part of the implementation of advanced technologies in fashion manufacturing, also known as the fourth industrial revolution or 'Industry 4.0',⁷ a rise in technologies that align with next-gen materials, such as 3D printing or bio-manufacturing is highly likely. ■

Currently available and scaling leather alternatives

When exploring a move towards next-gen materials, brands are likely to consider availability, aesthetic, performance and sustainability metrics of the new material. Since the next-gen material industry is young and rapidly developing – with the vast majority of companies, if not all, consistently improving their material, changing the cost, availability, and metrics behind them – it is important to look at the most recent information for each company.

The Material Innovation Initiative has a free online database which tracks publicly available information about next-gen material companies.¹ Both Collective Fashion Justice and MII also consult with brands individually, in order to support their sourcing needs.

Below is a list of next-gen leather materials and the companies behind their development. Many

of these materials require further development before aligning with a total ethics fashion system, and should be seen as stepping stones to further innovation. As noted, ultimately fashion must move beyond animal-derived, petrochemical and plastic inputs alike. Please note that some companies have less developed public presentation than others, while they focus on their material innovation. ►



Company name:

Adriano di Marti

Material name(s):

**Desserto[®], Deserttex[®],
Desserto[®] BIO+**

Year founded:

2019

Main input:

Blend



Input and process information:

Responsibly and organically-grown Nopal cactus is harvested without killing the plant, before 'leaves' are ground into a pulp and combined with chemicals and polymers made partly from organic and renewable compounds. The material is set on a backing of recycled polyester, (recycled) cotton or a combination of the two. Different materials offer different percentages of bio-inputs, currently ranging from lower amounts to 65 and even 90%. The material is free from phthalates and PVC. An e-LCA shows significantly decreased cumulative energy, CO₂e and water impact compared to both animal and purely synthetic leathers.

Qualities:

- Variety of thicknesses and textures available and customisable
- Reportedly able to biodegrade under anaerobic thermophilic conditions depending on formulation

Examples of use:

Strong and flexible, applicable to a range of products already created: footwear, apparel, accessories, sportswear, automotive and furnishing.

Availability:

- Currently available on market without MOQs for catalogue materials
- Custom materials available with varied MOQs. Alteration for aesthetic, sustainability, and technical purposes offered
- Used by brands including Adidas, Fossil, Karl Lagerfeld and Givenchy

Company name:

Amadeu

Material name(s):

LaVeg[™], TEA

Year founded:

2016

Main input:

Plant-derived



Input and process information:

Latex sap from rubber trees naturally occurring in the Amazon Rainforest is harvested by local communities also employed to process the rubber. The company aims to combine social and environment support together, protecting land. The final material is a blend of rubber and cotton and is plastic-free, heavy-metal free, biodegradable and recyclable. Non-toxic pigments aligned with ISO 140001 standards are used in a 'zero-waste' production system.

Qualities:

- Typically produced in large sheets
- Waterproof
- Customisable to produce varying colours, shapes and textures.

Examples of use:

Boots, bags, jewellery and a range of products have been produced with the material.

Availability:

- Currently available
- Company has worked with brands including Reformation, Vivienne Westwood, Rick Owens and Nayla

Company name:

Amazkin

Material name(s):

Amazkin

Year founded:

2022

Main input:

Plant-derived



Input and process information:

Latex sap is harvested from indigenous trees without harm to them, by Indigenous partner communities. Latex is mixed and the Amazkin formula is spread onto an organic cotton backing before finishing. This company also prioritises environmental and social protection and partnership.

Qualities:

- High level of biodegradability
- Recyclable
- Produced in a number of colours and textures.

Examples of use:

With more to come, currently Amazkin has been used for garments such as pants and jackets, as well as shoes.

Availability:

- As a new material on the market, availability is limited to select brands for partnership
- Co-founder Ana Tafur's brand SAKE currently uses the material

Company name:

Ananans Anam

Material name(s):

Piñatex[®]

Year founded:

2011

Main input:

Plant-derived



Input and process information:

Otherwise wasted and burnt pineapple plant leaves are harvested, supporting farming communities. Leaves are felted into a non-woven substrate. This is coated with polylactic acid and polyurethane from water and bio-based sources, making up 20% of the final material. The material is highly land efficient, with a lower climate, biodiversity and water impact.

Qualities:

- Performance and fashion customised inputs
- Metallic, original and mineral colours available
- Smooth and textured finishes
- Biodegradable under controlled industry conditions.

Examples of use:

Piñatex has been used for a range of garments, shoes, bags and accessories, as well as in furniture and other interiors.

Availability:

- Currently available with an MOQ of 1 linear metre without customisation
- Custom material production available
- Brands including Hugo Boss, Mashu, as well as some major fast fashion brands



Company name:
Arda Biomaterials

Material name(s):
New Grain™

Year founded:
2022

Main input:
Plant-derived



Input and process information:

Spent grain produced as a brewery by-product gains value when used to create a plastic-free leather alternative. This grain normally could be fed to farmed cattle: repurposing grain supports a just transition to a more efficient and local production system.

Qualities:

- Biodegradable
- More information to be provided as innovation develops

Examples of use:

As a new company, this information is not yet available.

Availability:

Not on the market yet

Company name:
ATMA Leather

Material name(s):
Banofi Leather

Year founded:
2022

Main input:
Plant-derived



Input and process information:

Upcycled banana crop waste from India is transformed into a socially supportive leather alternative in a nation currently polluted by leather production. Composition is 50% banana stem waste fibre, 30% 'natural additives' and 20% polymer, primarily from recycled sources. Innovation to reduce polymers reliance persists, and the current material claims 90% less CO₂ emissions than cow skin leather.

Qualities:

- Promises to not only look but feel and smell like leather
- Able to be embossed
- Variety of colours and finishes, including metallics, available

Examples of use:

The material has been used primarily for accessories so far, with other applications possible.

Availability:

Available and in use by a number of small boutique brands, with large fashion houses exploring the material

Company name:
Beyond Leather

Material name(s):
Leap™

Year founded:
2016

Main input:
Plant-derived



Input and process information:

An 84% bio-based material, with aim to create Leap™ which is 100% bio-based and biodegradable by 2024. Derived from cider production, apple waste (64%) combined with natural rubber and other bio-additives (36%) backed onto Tencel. Coated with bio- and fossil fuel-based finish currently. A full LCA is in process, with current estimates suggesting Leap™ uses 99% less water and emits ~85% less CO₂ than traditional leather production.

Qualities:

- End-of-life layer separation for recycling available
- Available in various colours, using responsible pigments. Printing options possible
- Waterproof and heat resistant up to 90°C.
- Thickness ranges from 1.1-1.4 mm

Examples of use:

Prototype accessories, bags, interior products and furniture have been successful.

Availability:

- Market launch expected in 2023
- Material sampling at a range of sizes available
- Custom colouring available

Company name:
BioFabbrica LLC
(affiliated with Modern Meadow)

Material name(s):
Bio-Tex™

Year founded:
2011

Main input:
Plant-derived



Input and process information:

USDA BioPreferred certified, this Italian made 'lab to brand' material is derived from plant-based proteins – derived from non-GMO soy – and bio-based polymer finished in a scalable and traceable process molecularly blending the two. Up to 64% bio-based currently, LCA results show a 90% smaller CO₂ footprint than conventional leather, and largely renewable energy is used in production.

Qualities:

- Durable
- Smooth
- Adjustable weight
- Breathable
- Colour fast

Examples of use:

Bags, accessories and other fashion items have been produced with the material.

Availability:

- Currently available with an MOQ of 1 linear metre without customisation
- Currently available for select brands
- Used by brands including Everlane, Tory Burch and SENREVE

Company name:
Bioleather

Material name(s):
Bio-Tex™

Year founded:
2019

Main input:
Microbe-derived



Input and process information:

A material made up of 50% cotton backing, 30% tomato waste, and 30% bio-polymer. The brand claims production requires 94% less land and 90% less greenhouse gas emissions.

Qualities:

- Polyurethane free
- Soft to touch

Examples of use:

The company sells their own range of footwear and accessories from the material.

Availability:

- Available for small and larger brands, with MOQ ranging from 20 to 100 linear metres
- Custom colour, texture and thickness available from MOQ of 300 linear metres

Company name:
Biophilica

Material name(s):
Treekind™

Year founded:
2019

Main input:
Plant-derived



Input and process information:

A plastic-free alternative, Treekind™ is made from lignocellulosic feedstocks captured from dead wood in urban parks and gardens, as well as inedible agricultural feedstocks. Free from hazardous chemicals, synthetic dyes and substances and phthalates, as proven by testing. Low carbon production makes use of existing raw materials.

Qualities:

- 100% biodegradable and home compostable
- Natural plant and non-toxic pigment colour options
- Water resistant and repellent
- ISO tested for excellent tensile, elongation, flex, double edge tear, water spotting, UV, colour fastness qualities
- Available embossed and in a range of thicknesses between 1-2.5 mm
- Proven ability to be recycled into new material

Examples of use:

Bags, watch straps and others accessories have been produced.

Availability:

- While scaling continues the material is only selectively available for partnerships
- BEEN and Hype have made products with the material

Company name:
Bolt Threads

Material name(s):
Mylo™

Year founded:
2009

Main input:
Mycelium



Input and process information:

Primarily made of mycelium, this material is certified bio-based, and not derived from petro-chemicals, though not yet 100% plastic free, due to a water-based PU finish for longevity.

Mycelium is grown in under two weeks in 100% renewably powered vertical farms. Harvested mycelium is processed into a bio-material finished by a tannery with a gold rating from the Leather Working Group using 'green chemistry' and zero chromium.

Qualities:

- Soft and supple
- Mycelial fibres functionally replicate collagen, giving a warm handfeel
- Can take colour or emboss
- Mechanical performance allows use similar to animal or synthetic leather

Examples of use:

Mylo™ has been used to create bags, garments, yoga mats, shoes, and other accessories.

Availability:

- Currently in-use by adidas, Stella McCartney, lululemon, GANNI, Harizury, and more
- Available to select customers in 2023-2024. Brands can reach out to request samples and/or prototyping material

Company name:
Bucha Bio

Material name(s):
SHORAI™

Year founded:
2020

Main input:
Plant-derived



Input and process information:

100% bio-based and free from petrochemicals, SHORAI™ is bacterial nanocellulose- and plant-based. Bio-polymer finishes are used, with production using existing machinery used for plastics manufacturing, supporting scaling.

Qualities:

- Independent testing shows good tensile strength and tear resistance
- Sheets 1" to several feet wide and infinitely long are available
- Market-ready material promises to be able to be sewn, embroidered and embossed as needed
- Vast colour options, primarily using algae-based dyes

Examples of use:

Brands have sampled the material for use as watch straps, in automotive industries, for accessories and clothing.

Availability:

- Estimated to be market ready in Spring 2023
- Currently working privately with a number of luxury brands

Company name:
Carbonwave
(formerly known as C-Combinator)

Material name(s):

Vega

Year founded:
2020

Main input:
Plant-derived



Input and process information:

Sargassum seaweed has bloomed as a result of human-induced environmental pressures, and Vega makes use of these blooms which can otherwise suffocate ecosystems. A polyurethane-free material reliant on the extraction of structural polymers to form strong films derived from seaweed, which sequesters carbon as it grows. The company promises to produce plastic-free, carbon-neutral materials that minimise waste.

Qualities:

- Natural dyes used, currently offering natural tones
- Aiming to offer a strong material

Examples of use:

Currently no products have been shared publicly.

Availability:

Not available to the public, but accepting expressions of interest from brands

Company name:
Ultraw Leather

Material name(s):

Eori™

Year founded:
2021

Main input:
Plant-derived



Input and process information:

With zero plastic inputs, this material is 98-100% bio-based depending on the variant. Making use of wood cellulose and existing cotton t-shirts, the basis of the material is reportedly produced without harmful discharges.

Qualities:

- Tested for high resistance to wear and tear, as well as water
- Designed to be breathable and moisture wicking
- Simple to clean
- Wide colour variety options
- Designed to be recyclable

Examples of use:

Footwear, small goods, upholstery, auto interiors and bags are listed as some of the diverse applications possible with the material.

Availability:

Not currently available

Company name:
Coronet

Material name(s):

BioVeg, Maison, Innovaction

Year founded:
1966

Main input:
Blend



Input and process information:

BioVeg is a partly bio- and partly synthetic material which life-cycle analysis reporting states results in reduced global warming impact, resource depletion and land use compared to conventional animal and synthetic leathers. The highest bio-input of option is 81%, mixed with post-consumer recycled synthetics. Coronet works with water-based resins and GMO-free biopoly oils, too.

Qualities:

- Good flexibility and stretch
- Coronet highlights its continued performance and technicality innovation

Examples of use:

As a long established, many brands across numerous industries have used Coronet materials.

Availability:

- Brands including Louis Vuitton, Moncler and Armani have used Coronet materials

Company name:
Ecovative

Material name(s):

MycoFlex™, Forager™ Hides

Year founded:
2007

Main input:
Mycelium



Input and process information:

Grown in just nine days, this plastic-free, pure mycelium material is produced with minimal emissions and only water and compost as by-products. The material is tanned by leading environmentally conscious tanneries, without petroleum coatings or harsh chemistry.

Qualities:

- Naturally customisable high tensile strength, tear resistance and durability
- Grown as large as 60 m long and 4 m wide
- Finishes include reptilian embossed options and a variety of grain looks

Examples of use:

Suitable for a wide variety of applications across the fashion, automotive and interior industries.

Availability:

- ECCO Leather has partnered with the company, with new products from the brand likely to come soon
- Accepting brand expressions of interest

Company name:
Faircraft

Material name(s):

Faircraft

Year founded:
2020

Main input:
Cultivated animal cells



Input and process information:

Leather derived from stem cells, grown in a lab before being tanned like a slaughter-derived hide.

Qualities:

→ Faircraft promises 'endless' pattern creation, dyeing and textural possibilities

Examples of use:

This material has not yet been shared publicly in product form.

Availability:

Not currently available

Company name:
Fruitleather Rotterdam

Material name(s):

Fruitleather Rotterdam

Year founded:
2016

Main input:
Plant-derived



Input and process information:

Mangoes diverted from food industry waste streams are pulped and blended with additives, dried and coated with a water-based polyurethane before being backed onto GOTS certified organic cotton.

Qualities:

→ Water repellent
→ Custom dyeing and embossing
→ 110 × 110 cm and 56 × 38 cm sheets available
→ Tested for tear and tensile strength, rub fastness and flexibility

Examples of use:

Furniture, shoes, bags, and accessories have all been produced with the material.

Availability:

→ Available for public purchase
→ Used by brands including Luxtra, Saye, Claudio Pavone and more
→ Capacity is currently limited while scaling continues

Company name:
Frumat

Material name(s):

Appleskin™

Year founded:
2008

Main input:
Blend



Input and process information:

Otherwise landfilled waste from the fruit, jam and juice industry is dried and milled into a fine powder, mixed with synthetic inputs and rolled onto cotton backing to create a leather alternative. Apple inputs replace polyurethane inputs, reducing the CO₂ impact of the material. The material is composed of 38% PU, 26% apple waste, 20% polyester and 16% cotton. The final material is certified by Oeko-Tex with Standard 100. A bio-based PU alternative is in development.

Qualities:

→ Flexible and hardy
→ Available in a variety of

Examples of use:

Wide use by the fashion, furniture and automotive industries has created a diverse range of AppleSkin™ products.

Availability:

→ Available to purchase via Mabel Industries
→ Brands including Tommy Hilfiger, Samara, Virón, Alohas and others have used the material

Company name:
Gozen Institute

Material name(s):

Xylozen™

Year founded:
2020

Main input:
Microbe-derived



Input and process information:

Made with bacterial nanocellulose through fermentation, the company claims zero chemicals are released during the production process. The fine fibres grown to create a leather-like material from culture are then vegetable tanned. The final material is plastic-free, with a promise of far reduced climate, land, water and biodiversity impacts.

Qualities:

→ Biodegradable
→ Natural dyes for a variety of colours

Examples of use:

The company describes this material as perfect for fashion, automotive and interior industries, due to its high performance characteristics.

Availability:

Not currently available

Company name:
Gunas New York

Material name(s):
Mulbtex™

Year founded:
2009

Main input:
Plant-derived



Input and process information:

Mimicking a lamp-making process originally from Korea, Gunas NY pulps mulberry leaves into paper in South Korea, before compressing and laminating the 'paper' over cotton canvas, and glazing the final material with tree sap. The final material is plastic-free.

Qualities:

- Water resistant
- Textured finish similar to leather
- Light weight
- Effectively dyed

Examples of use:

Gunas NY offers bags, wallets and other accessories made with the material, which could be used for home furnishings and other goods.

Availability:

Currently only available for sale as Gunas NY products

Company name:
La Quara

Material name(s):
La Quara

Year founded:
2017

Main input:
Microbe-derived



Input and process information:

Microorganisms are used to cultivate a leather-like material in a circular, non-toxic process. Production residues can be used as liquid compost, eliminating waste.

Qualities:

- Biodegradable
- Breathable
- High resistance
- Effectively embossed

Examples of use:

Bags, accessories and other small goods have been produced with this material.

Availability:

Not currently available beyond sampling

Company name:
Hemp Black

Material name(s):
HEMP BLACK™ / hide

Year founded:
2017

Main input:
Blend



Input and process information:

Combining hemp extract with post-consumer recycled plastics, a 100% recycled backing and 60% recycled upper forms the material. The material's production is reportedly 90% less energy intensive and uses 80% less solvents than conventional synthetic leather. The entirely US based production process is free from PVC, phthalates and heavy metals. Solution dyeing reduces water waste

Qualities:

- Antimicrobial and odour neutralising
- Tested for durability, heat and cold cracking, tensile strength, and abrasion resistant
- Available in various stretches, finishes, hand-feels and colours which do not bleed

Examples of use:

The company lists fashion accessories, footwear, luggage, automotive, wall coverings, furnishings, marine and airline seating as the materials' best applications.

Availability:

- Available for sourcing
- Used by brands including Oroton

Company name:
Luckynelly

Material name(s):
Berriestex, Citrustex, Cabbtex

Year founded:
2012

Main input:
Plant-derived



Input and process information:

Over-ripe strawberries, stalks and leaves, as well as pectin-rich citrus skins and scrap cabbage leaves are all made into leather alternatives in Berlin, coated with plastic-free, plant- and water-based, organic coatings, after a blending and drying process.

Qualities:

- Unique, natural finished look
- Water resistant

Examples of use:

Used to create accessories and bags.

Availability:

- Currently used to create Luckynelly brand bags
- Open to small-scale partnerships

Company name:

Miko

Material name(s):

Dinamica®

Year founded:

2015

Main input:

Blend



Input and process information:

A microfibre made from up to 73% recycled polyester and water-based PU, emissions are reduced compared to virgin raw material production. Made through a renewably powered process, chemical products can be partly reused. The ability to recycle used material is in development.

Qualities:

- Customisable
- Breathable
- Washable and resistant
- Light and hypoallergenic

Examples of use:

Suitable for fashion, automotive and interior use.

Availability:

- Available at scale
- Used by Land Rover and many global brands

Company name:

Mink Materials

Material name(s):

Mink Materials

Year founded:

2000

Main input:

Plant-derived



Input and process information:

Derived from upcycled fruits and vegetables, this plastic-free material is entirely Italian made. Inputs include avocado peels, bean pods, banana peels, olive stones and other dried scraps.

Qualities:

- Customisable colours and textures

Examples of use:

Used to create shoes for MINK, which is also a footwear company.

Availability:

Publicly launching soon

Company name:

Modern Synthesis

Material name(s):

Modern Synthesis

Year founded:

2020

Main input:

Microbe-derived



Input and process information:

Bacteria-grown, cellulose-based composite materials are microbially woven into finished leather alternatives. Genetic engineering allows for self-dyeing bacteria. No petrochemical inputs are involved in the fast process.

Qualities:

- Compostable

Examples of use:

A prototype shoe has been produced through this process.

Availability:

Still in development

Company name:

MycaNova
(Citribel)

Material name(s):

MycaNova

Year founded:

1929

Main input:

Plant-derived



Input and process information:

Mycelium powder produced as a by-product of citric acid manufacturing is mixed with recycled, natural or synthetic (such as bio-base PU) binders and backings. Up to 64% bio-based.

Qualities:

- Naturally coloured options, with a wide range of colour and texture options
- Customisable technical properties

Examples of use:

Suitable for a variety of applications, with prototypes fashion accessories already made.

Availability:

Open for collaboration while scaling

Company name:
MYCL – Mycotech Lab

Material name(s):

Mylea™

Year founded:
2015

Main input:
Mycelium



Input and process information:

Agroforestry by-product and agricultural waste is used to support mushroom farming, where mycelium is developed. Mycelium structures are direct-bonded onto an enforcement backing material. A 100% natural bio-polymer composed largely of chitin, cellulose and protein supports the material's integrity. LCA assessment shows significant global warming potential reduction, while tanning toxicity and waste is reduced.

Qualities:

- Tested for tear and tensile strength, colour fastness, and elongation
- Natural and dyed colourways

Examples of use:

Bags, shoes, watch straps, jewellery and other products have been successfully sampled, with longevity testing ongoing.

Availability:

- Currently available and scaling
- Apakabar and Bro.do brand products are available for sale

Company name:
MycoWorks

Material name(s):

Reishi™

Year founded:
2013

Main input:
Mycelium



Input and process information:

Reishi™ is made from Fine Mycelium™, tanned and finished using MycoWorks' own proprietary chrome-free tanning and dyeing technologies. Mycelium cells are engineered as they grow, allowing for property adjustments. Containing no synthetic inputs, traditional leather tanning techniques are used. Hundreds of tests, samples and protocols match the Gold standard for leather.

Qualities:

- Variety of finishing, texture and dye options
- Improved strength compared to conventional mycelium
- Customisable properties

Examples of use:

Suitable for fashion, footwear, automotive, and decor industries.

Availability:

- Currently available
- Hermès has most notably used Fine Mycelium™

Company name:
MycoFutures

Material name(s):

MycoFutures

Year founded:
2020

Main input:
Mycelium



Input and process information:

Fungal fibres are used to develop a plastic-free material. This company is still in early development.

Qualities:

- Natural and varied texture in early samples
- Compostable

Examples of use:

This material has not yet been shared publicly in product form.

Availability:

Not currently available while scaling

Company name:
Mylium

Material name(s):

Mylum

Year founded:
2018

Main input:
Mycelium



Input and process information:

A plastic-free, mycelium-derived alternative to leather produced with a bioreactor and bound with other natural ingredients. This natural mixture is mechanically shaped into sheets before drying and finishing. Designed for circularity and waste reduction and produced in a short, local and transparent supply chain.

Qualities:

- Available in rolls
- Consistent quality
- Adaptable thickness, flexibility, finishing and colours

Examples of use:

This material has not yet been shared publicly in product form.

Availability:

Available exclusively for select partners which receive prototypes

Company name:

Napee

Material name(s):

Napee Vegan Leather

Year founded:

2020

Main input:

Plant-derived



Input and process information:

Made from powdered hemp waste combined with a cashew nut shell and vegetable oil-based bio-polymer which is backed onto a textile, such as hemp. Hemp powder makes up between 20 - 50% of the final material. Processed without harmful solvents or toxins, material production is reportedly zero-waste with minimal carbon footprint.

Qualities:

- Breathable, antibacterial and thermoregulatory
- Tear resistant and waterproof
- Printable and embossable

Examples of use:

Suitable for fashion, automotive and interior production. Early trials have included a bag made from the material.

Availability:

- Currently unavailable with potential for large scale production
- Currently developing partnerships, including with automotive and fashion brands

Company name:

Newlight

Material name(s):

AirCarbon™

Year founded:

2003

Main input:

Microbe-derived



Input and process information:

Derived from microorganisms found in the ocean which convert air and greenhouse gas into a bio-material. Free from synthetic polymers and reportedly produced in a carbon negative, renewable powered system. AirCarbon™ products currently available are blended with bio-based and synthetic materials.

Qualities:

- Home compostable if not blended
- Biocompatible and hypoallergenic

Examples of use:

The material is being developed in the fashion industry, currently used and sold as accessories.

Availability:

- Currently available for partnerships
- Currently collaborating with brands such as Nike and H&M

Company name:

Natural Fiber Welding

Material name(s):

MIRUM®

Year founded:

2015

Main input:

Plant-derived



Input and process information:

Made from nutrients from agricultural waste streams, and completely free from plastic. While inputs vary due to customisation capacity, these include rice hulls, corn, coconut husks, charcoal, clays, vegetable oils and other natural ingredients, which can be backed onto recycled and natural materials in Natural Fiber Welding's patented biofabrication process.

Qualities:

- Highly customisable thickness, colour, shine, texture, grain, temper and fabric backer options
- Highly durable and easy to clean
- Recyclable into new MIRUM® material
- Biodegradable

Examples of use:

Suitable for a wide range of applications and industries, already in use as footwear, garments, accessories.

Availability:

- Currently available and scalable
- Customisation available through NFW's Signature Collection
- Partnered with a number of brands including Pangaia, Allbirds, Richemont, Stella McCartney, and New Balance

Company name:

NEXT-GEN LEATHER SL.

Material name(s):

BacLEATHER™

Year founded:

2012

Main input:

Microbe-derived



Input and process information:

Still in development, BacLEATHER™ aims to culture a leather-like material in a time, water, land, chemistry and energy efficient system. Cell culture and biofabrication science is utilised in the 6 - 8 week long production process.

Qualities:

- Biodegradable
- Promise of durability, strength and elasticity

Examples of use:

Marketed as suitable for footwear, accessories, clothing, furniture, automotive, and sportswear production, with sample shoes and accessories produced.

Availability:

Not currently available while developing and scaling

Company name:
Nova Kaeru

Material name(s):
beLEAF™

Year founded:
2019

Main input:
Plant-derived



Input and process information:

Derived solely from the alocasia macrorrhiza or 'elephant ear' plant, this material supports reforestation in Brazil and is finished through tanning. The farming and tanning process is entirely organic and free from heavy-metals, with minimal climate impact and compostable waste outputs

Qualities:

- One-of-a-kind markings on each tanned leaf
- Dyed into a variety of colours

Examples of use:

Used in a wide range of applications from clothing, footwear, accessories, and furniture.

Availability:

Not currently available except through exclusive partnerships

Company name:
NUVI Releaf

Material name(s):
NUVI

Year founded:
2014

Main input:
Plant-derived



Input and process information:

Bio-material made from a range of EU-sourced raw materials including tobacco, chalk and marble, no plastics of any kind are used. A Oeko-tex 100 certified flax textile backing supports the material, which testing reports to result in 90% fewer carbon emissions compared to conventional leather.

Qualities:

- Highly customisable colours, thicknesses and textures
- Different inputs offer different benefits such as flexibility and durability
- Tested for durability
- Biodegradable

Examples of use:

Suitable for fashion, footwear, interior and automotive industries, with hats, watch straps and accessories produced already.

Availability:

- Currently available, with industrial scaling in progress
- Samples available
- Competitive pricing

Company name:
Ohoskin

Material name(s):
Ohoskin

Year founded:
2020

Main input:
Plant-derived



Input and process information:

Made in Italy, orange and cactus waste from the food and cosmetics industries are processed and backed onto organic cotton. Material composition is made up of 32% bio-based inputs, 43% green solvents, 20% non-fossil and phthalate-free PVC from recycled plastic and 5% additives and pigments.

Qualities:

- Tested for durability and abrasion resistance
- Custom colours available
- Capacity for end-of-life recycling

Examples of use:

Suitable for fashion, automotive, furniture and nautical applications, the first products available for purchase made from Ohoskin are bags.

Availability:

- Currently available and highly scalable
- GANNI is Ohoskin's first partnership brand

Company name:
Oleago

Material name(s):
Oleatex™

Year founded:
2021

Main input:
Plant-derived



Input and process information:

Derived from ground olive industry waste, this material is solvent-free, made in a localised supply chain. With a carbon footprint reportedly six times smaller than conventional leather, olive waste biomass is blended with polymer to create a USDA bio-certified material. Between 63 – 91% bio-based content is certified for the materials. Backing materials include organic cotton, linen and recycled polyester.

Qualities:

- Available in any Pantone colour
- Customisable thicknesses and finishes.
- Capacity for end-of-life recycling
- Independent testing highlights strong material qualities

Examples of use:

This material has been used to create bags, shoes, upholstery, bookbinding and clothing.

Availability:

- Currently available at scale and made to order with a three week production period
- Custom options for brands reaching MOQs
- Used by small accessories brands such as Mianqa and Souleway

Company name:
Panama Trimmings

Material name(s):

Viridis®

Year founded:
1981

Main input:
Plant-derived



Input and process information:

Made from 69% corn and Forest Stewardship Certified viscose combined with polyurethane, this material is REACH compliant. By reducing fossil-fuel inputs and methane, significant emission reductions are recorded.

Qualities:

- Matte and smooth, silky nubuck, custom grains and vintage-toned, soft, glossy and printed options available
- Highly customisable

Examples of use:

Used across garment, footwear and accessories production.

Availability:

- Currently available with no MOQ
- Used by brands including Jack & Jones, Kuyichi and Etéreo

Company name:
PersiSKIN

Material name(s):

**PersiSKIN
Vegan Leather**

Year founded:
2020

Main input:
Plant-derived



Input and process information:

Derived from surplus and otherwise wasted persimmon crops, 85% of this finished material is plant-derived.

Qualities:

- A range of finishes and colours is available, including one mimicking ostrich skin

Examples of use:

Suitable for use in fashion, for accessories, upholstery and more.

Availability:

Currently available for prototyping

Company name:
Phool

Material name(s):

Fleather

Year founded:
2009

Main input:
Microbe-derived



Input and process information:

Made from fermented flower waste from temples and mosques in India, reducing waste and associated chemicals, while supporting rural livelihoods.

Qualities:

- Delicate and smooth to touch
- Variety of colours and finishes

Examples of use:

The company has developed a prototype bag using the material.

Availability:

In development and scaling, not currently available

Company name:
Polybion

Material name(s):

Celium®

Year founded:
2015

Main input:
Microbe-derived



Input and process information:

Lab-grown bacterial cellulose is produced with locally produced fruit waste feedstock. Material production is EPA, REACH, and ZDHC compliant and concentrated within a 30-mile radius. No hazardous chemical outputs or significant biomass outputs are created in material production, which is finished through tanning.

Qualities:

- Light, strong and highly adjustable for thickness, texture and even smell
- Tested for water resistance, colour fastness, stretch and rub fastness
- Colour and finishing options available

Examples of use:

This material has been used to create a range of shoes and accessories.

Availability:

Currently available with an aim to achieve full scalability by the end of 2023

Company name:
Provenance Bio

Material name(s):

Provenance Bio

Year founded:
2012

Main input:
Microbe-derived



Input and process information:

A patent-pending microbial platform creates collagen which can be used to produce cow skin as well as reptilian leather. With a significantly reduced environmental impact, this lab-developed leather can support biodiversity, climate and animal protection.

Qualities:

- Programmable strength, thickness, size and surface texture
- Intended to be structurally matched to skin
- Biodegradable

Examples of use:

This material has not yet been shared publicly in product form.

Availability:

Not currently available while developing

Company name:
Proyecto Menos es Más

Material name(s):

Bambuflex©

Year founded:
2010

Main input:
Plant-derived



Input and process information:

This 100% renewable and bio-based material is derived from bamboo and dyed with plant-based pigments. With a significantly smaller climate and environmental impact than current-gen materials, this material is grown without agrochemicals.

Qualities:

- Biodegradable
- Currently in development to improve flexibility
- Significant colour and texture variety

Examples of use:

Suitable for fashion, furniture, upholstery, transport accessories, and interior use.

Availability:

Not available while scaling

Company name:
Qorium

Material name(s):

Qorium

Year founded:
2015

Main input:
Cultivated animal cells



Input and process information:

Lab-grown leather, first derived from the cells of a single living cow and now grown without animals and with significantly less land, climate and water impact.

Qualities:

- Designed to replicate all the qualities of cow skin, as it is in fact cow skin, grown in a lab
- Able to be grown in any shape or size, without defects found in slaughter-based leather

Examples of use:

Suitable for fashion, footwear and automotive industries.

Availability:

Not available while scaling

Company name:
Really Clever

Material name(s):

Really Clever

Year founded:
2022

Main input:
Mycelium



Input and process information:

A plastic-free, mycelium-based leather-like material made from a blend of fungi and algae inputs.

Qualities:

- Tough durable and flexible but light
- Customisable colours, textures and finishes
- Biodegradable
- Highly cost and time efficient

Examples of use:

Customisation allows for wide and varied application possibilities.

Availability:

- Open to brand partnerships
- Large brand partnerships in development

Company name:
RevolTech

Material name(s):
LOVR

Year founded:
2021

Main input:
Plant-derived



Input and process information:

Made from hemp residues, this plastic-free material uses plant matter leftover from organic German hemp harvests for CBD oil and seeds. This agricultural waste is combined with plant-based additives.

Qualities:

- Biodegradable
- Recyclable

Examples of use:

Applicable for use in furniture, fashion and automotive industries.

Availability:

Currently available for prototypes and sampling

Company name:
Scoby Tec

Material name(s):
ScobyTec BNC

Year founded:
2014

Main input:
Microbe-derived



Input and process information:

Made from a symbiotic colony of bacteria and yeast, fermentation is used to produce a cellulose material similar to leather.

Qualities:

- High tear and abrasion resistance
- Hydrophilic

Examples of use:

Early samples have been used to create clothing and accessories.

Availability:

Only currently available in sample form

Company name:
Slow Factory Labs

Material name(s):
Slowhide

Year founded:
2021

Main input:
Microbe-derived



Input and process information:

A plastic-free material produced without synthetic chemicals and toxins with minimal carbon footprint. Organic waste inputs are fed to bacterial cultures which are spun into nanocellulose and cured.

Qualities:

- Biodegradable
- Early samples have a more rigid texture, suitable for hard accessories
- Strong and supple
- Plant dyed

Examples of use:

An early sample by Slow Factory Labs trialled the material to make a bag.

Availability:

In development and scaling, not currently available

Company name:
Soarce

Material name(s):
Soarce

Year founded:
2020

Main input:
Plant-derived



Input and process information:

Developed from an extracted biopolymer derived from seaweed and other low-carbon plant sources, material production requires no land or freshwater. This material is plastic-free and renewable.

Qualities:

- Capable of high levels of heat, UV and bacterial resistance
- Customisable at a nano-scale

Examples of use:

Suitable for accessories, hardy motorsports, workwear and outerwear, footwear and more.

Availability:

- In development and scaling, not currently available
- Currently partnering with footwear designer Nicholas Kirkwood

Company name:
Spora Biotech

Material name(s):

Sporatex

Year founded:
2017

Main input:
Mycelium



Input and process information:

Mycelium-based leather alternative still in development

Qualities:

→ Individual characteristics and properties are altered by type of mycelium used

Examples of use:

In development for fashion and automotive industries.

Availability:

In development and scaling, not currently available

Company name:
Sqim

Material name(s):

EPHEA™

Year founded:
2015

Main input:
Mycelium



Input and process information:

A fermentation-based mycelium material finished with green chemistry tanning. Mycelium production is time and resource efficient, requiring minimal emissions, water and land.

Qualities:

→ Consistently reproducible
→ Stable and homogeneous colour, density, composition and thickness
→ Effectively embossed

Examples of use:

Suitable for fashion and 'endless' other opportunities for multiple markets.

Availability:

→ Launched with Balenciaga
→ Currently scaling

Company name:

The Center for Renewable Materials (UC San Diego)

Material name(s):

The Center for Renewable Materials (UC San Diego)

Year founded:
2020

Main input:
Microbe-derived



Input and process information:

A material made from a symbiotic culture of bacteria and yeast and coated with an algae-based finish.

Qualities:

→ Biodegradable and nutrient-rich
→ Waterproof properties are altered by type of mycelium used

Examples of use:

Suitable for use across automotive and fashion industries.

Availability:

In development and scaling, not currently available

Company name:

Uncaged Innovations

Material name(s):

Uncaged Innovations

Year founded:
2020

Main input:
Plant-derived



Input and process information:

A bio-material made in both totally plastic-free and plant-based polyurethane options. Dyed during material production and requiring no tanning, no toxic chemical pollutants are released during this efficient production.

Qualities:

→ Consistent and customisable
→ Scalable

Examples of use:

Suitable for automotive, fashion and other leather goods production.

Availability:

→ In development and scaling, not currently available
→ Samples available and seeking partners

Company name:
Vegea

Material name(s):

Vegea

Year founded:
2016

Main input:
Plant-derived



Input and process information:

Grape waste from wine production is mixed with a water-based polymer in a production system free from toxic solvents, heavy metals and dangerous substances. Vegea is Global Recycling Standard certified and offers as much as 70% bio-content.

Qualities:

- Available in a range of thicknesses and finishes
- Bespoke colours available

Examples of use:

Suitable for fashion, furniture, automotive and other production.

Availability:

- Currently available
- Used by brands including Tommy Hilfiger, Cavin Klein, H&M and Le Coq Sportif

Company name:
VegSkin

Material name(s):

VegSkin

Year founded:
2020

Main input:
Plant-derived



Input and process information:

Made from plant waste such as banana and mango skins which are supported by a cotton backing, this material is plastic-free and petrochemical-free.

Qualities:

- The material's rigidity makes it suitable for harder goods such as structured bags
- Customisable finishes and resistance specifications

Examples of use:

Suitable for footwear and other fashion applications.

Availability:

- Currently available

Company name:
Vitro Labs

Material name(s):

Vitro Labs

Year founded:
2016

Main input:
Cultivated animal cells



Input and process information:

Lab-grown leather, first derived from the cells of a single living cow and now grown without animals and with significantly less land, climate and water impact.

Qualities:

- Designed to replicate all the qualities of cow skin, as it is in fact cow skin, grown in a lab
- Able to be grown in any shape or size, without defects found in slaughter-based leather

Examples of use:

This material has not yet been shared publicly in product form.

Availability:

In development and scaling, not currently available

Company name:
von Holzhausen

Material name(s):

Banbū Leather

Year founded:
2015

Main input:
Blend



Input and process information:

Made from fast-growing bamboo that is transformed into a yarn and coated with synthetic inputs. This material has a climate impact reportedly five times smaller than animal-derived leather.

Qualities:

- Non-toxic and antimicrobial
- Water, stain and scratch resistant
- Light-weight
- Biodegradable

Examples of use:

Designed for luxury leather goods, used by Von Holzhausen in a range of bags.

Availability:

Currently available

Company name:

Zvnder

Material name(s):

Fungiskin

Year founded:

2017

Main input:

Plant-derived



Input and process information:

Plastic-free and derived from untreated
Tinder fungus sponge, backed onto a cotton
material.

Qualities:

→ Natural and unique

Examples of use:

Suitable for accessories, interiors and other
uses.

Availability:

- Currently available
- Not designed for mass production

*As of December 31, 2022

References are only listed if the information cannot
be found directly on the company's website or
communication platforms.



Brand benefits of a transition beyond leather

While the benefits of a just transition beyond leather are clear in relation to the planet, humans and our fellow animals, such a transition will not be eagerly worked towards unless it also benefits fashion brands. Making bold commitments to move beyond a material which has been used since the Stone Age can feel daunting to brands keeping their public appearances, marketing and profits in mind. However, it's clear that brands which take these steps past animal-derived and towards more ethical and sustainable leather alternatives are rewarded for their commitment to environmentally and ethically sound material sourcing.

As a result, a number of leading fashion brands with a historically significant use of animal-derived leather have already used next-gen materials, including but not limited to Adidas, Alexander McQueen, Capri Holdings Limited (which owns Versace, Michael Kors and other brands), Fossil, GANNI, Gucci, Hermès, Hugo Boss, Karl Lagerfeld, Louis Vuitton, Lululemon, Nike, Oroton, Other Stories, Ralph Lauren, Reformation, Salvatore

Ferragamo, Stüssy, Timberland, The North Face, and UGG.¹ The reason behind this uptake in the use of next-gen materials is simple: these brands expect to increase revenue by exemplifying their positive effect on the environment and animals.

Community and consumer rewards

Research from Faunalytics found that corporate commitments to practices which better protect animals generally receive more positive comments than other comparable social media and online content.² Any criticisms related to such announcements were tied to long transition timelines or goals which were considered not to be progressive enough.² While brands reducing their use of leather may be nervous about such public concern, these kinds of comments can be mitigated through honesty. As noted in Vogue Business, 'consumer trust and forgiveness' is built by brands which refer to their steps forward as just that, steps, rather than as perfect achievements of sustainability and ethics.³

Brands that have taken positive steps beyond conventional leather also often receive a significant amount of press celebrating and exploring their progress. Collective Fashion Justice analysed the press coverage (not including social, print or broadcast) of four brands which either made commitments related to a leather phase-out, or which released a new product or collection using next-gen leather.⁴



* Search words were individually surrounded by inverted commas to ensure only articles which include all searched words are produced, making them highly relevant to the topic of interest.

Estimated views calculated using the CoverageBook tool which predicts lifetime views of coverage based on audience reach and engagement rate. Potential audience reach calculated using the CoverageBook tool, combining the total of publication-wide figures for all outlets featuring coverage.

A just transition beyond leather

Brand benefits of a transition beyond leather

60

A just transition beyond leather

Brand benefits of a transition beyond leather

61

<p>Brand</p> <p>Gucci</p>	<p>Keyword search results</p> <p>"Gucci" + "Demetra" + "vegan" + "leather"</p>	<p>Potential audience reach of media coverage</p> <p>84.7 million</p>
<p>Progress</p> <p>GUCCI released a product line created with their own partly bio-based leather alternative, named Demetra. The material is 77% derived from plants.</p>	<p>Pieces of media coverage</p> <p>at least 27 articles</p> <p>Estimated views of media coverage</p> <p>245,000</p>	<p>Noteworthy quote</p> <div style="border: 1px solid #ccc; padding: 5px; margin-top: 10px;"> <p>"Gucci's new material is the zenith of luxurious quality, durability, softness and scalability"</p> </div> <p style="text-align: right;">— ELLE Magazine</p>

<p>Brand</p> <p>Adidas</p>	<p>Keyword search results</p> <p>"Adidas" + "mylo" + "leather"</p>	<p>Potential audience reach of media coverage</p> <p>199 million</p>
<p>Progress</p> <p>Adidas is one of four companies making up The Mylo™ Consortium, which has invested in innovation company Bolt Threads' mycelium-derived leather alternative, 'Mylo', producing products including the iconic Stan Smith sneaker from the material.</p>	<p>Pieces of media coverage</p> <p>at least 43 articles</p> <p>Estimated views of media coverage</p> <p>510,000</p>	<p>Noteworthy quote</p> <div style="border: 1px solid #ccc; padding: 5px; margin-top: 10px;"> <p>"Adidas has reached the moon with the Stan Smith Mylo"</p> </div> <p style="text-align: right;">— Forbes</p>

<p>Brand</p> <p>Allbirds</p>	<p>Keyword search results</p> <p>"Allbirds" + "plant" + "leather"</p>	<p>Potential audience reach of media coverage</p> <p>842 million</p>
<p>Progress</p> <p>The brand partnered with material innovation company Natural Fiber Welding to release a collection of products made from 'Plant Leather', the brand's name for NFW's biodegradable and plastic free leather alternative named MIRUM.</p>	<p>Pieces of media coverage</p> <p>at least 55 articles</p> <p>Estimated views of media coverage</p> <p>3.73 million</p>	<p>Noteworthy quote</p> <div style="border: 1px solid #ccc; padding: 5px; margin-top: 10px;"> <p>"The timeless cues and futuristic sustainability make them enjoyable to wear and style for everyone"</p> </div> <p style="text-align: right;">— Insider</p>

<p>Brand</p> <p>GANNI</p>	<p>Keyword search results</p> <p>"GANNI" + "phase out" + "leather"</p>	<p>Potential audience reach of media coverage</p> <p>1.74 million</p>
<p>Progress</p> <p>In 2021, GANNI made what is likely the most significant commitment related to leather in its sector of the fashion industry: to phase out virgin animal-derived leather within two years, moving instead towards bio-based alternatives.</p>	<p>Pieces of media coverage</p> <p>at least 10 articles</p> <p>Estimated views of media coverage</p> <p>21.1 K</p>	<p>Noteworthy quote</p> <div style="border: 1px solid #ccc; padding: 5px; margin-top: 10px;"> <p>"Grape stomping never looked this good"</p> </div> <p style="text-align: right;">— Vogue</p>

Access and technology rewards

Brands which not only explore alternative leather collections, but which make meaningful steps towards a future fashion industry free from animal-derived leather, are increasingly rewarded by some alternative producers. For example, mycelium leather alternative producer Bolt Threads launched their Greener Pastures Pledge in late 2022, offering brands which commit to eliminating animal-derived leather from use preferential access to the company's Mylo™ material.⁵ With materials like Mylo™ – which is certified bio-based, animal and chromium free, as well as grown with renewable electricity in a vertical agriculture facility – under 'extraordinary demand' to scale at the pace of interest in its use, this is a powerful incentive.⁵

those brands who are daring enough to make a real change by committing to high-quality, animal free alternatives – not only for their customers but also for our planet.”

– Dan Widmaier, CEO and founder of Bolt Threads.⁵

As total ethics fashion values become more widespread in the industry, some material producers are also prioritising material access to brands making their products in factories with strong labour and other ethical standards. One such factory is Veshin.⁶ Based in Guangzhou City, China and founded by Joey Pringle, the factory began as a partnership with an existing factory that had ten years of experience producing leather goods. The existing factory owner, Hongliang Yu, now a Veshin business partner, had become interested in making a 'positive environmental change'. Specialising in producing bags and accessories made from animal-derived leather did not align with this new interest, and today, Veshin only works with brands committed to aligning with the factory's sustainable values.⁶ The factory exclusively uses innovative

alternatives to leather and as a result, has received earlier access to next-gen materials like MIRUM. In turn, Veshin – which adheres to just payment and working practices – offers brands that are either exclusively free from animal-derived materials or interested to produce large collections of responsible products ready access to these next-gen materials.

Brands willing to explore newer materials are also able to benefit from technical improvements within these sooner. While both animal leathers and leather alternatives stretch more in width-direction than in length, leather alternatives tend to exceed animal leather by elongation, drape ability, and crease recovery.⁷ Due to the distinctive dyeing processes, synthetic leather often has better colour fastness than animal leather, which is also prone to fade when exposed to the sun for extended periods of time. Furthermore, leather alternatives made from natural materials rather than synthetic materials, which must also be phased out, have been found to have greater durability, abrasion resistance, breathability and vapour permeability when tested.⁷ While animal-derived leather

“We know how challenging it is for brands to alter their supply chains, and the brands that dare to do so in an effort to minimise their environmental impact deserve to be rewarded for their trailblazing efforts. The Greener Pastures Pledge is an incentive for

today is sometimes heavily coated with synthetic inputs to achieve durability and light-fastness,^{8,9} next-gen materials should hold these qualities innately. As material science progresses, these design-driven benefits will only increase.

The emerging brand that moved from vegetable-tanned to next-gen leather

When Casey Dworkin founded luxury shoe brand Sylven New York in 2017, she exclusively used vegetable-tanned bovine leather, in an effort to produce sustainably. Her consideration of non-animal materials was limited by her opposition to the use of conventional synthetic alternatives, as well as to textiles which would not be seasonally appropriate. While keeping up to date with processing and material innovation in the space, Casey discovered a blended material derived partly from otherwise discarded apple cores, seeds and skins. In 2019, after testing the material and appreciating both the aesthetic and environmental qualities of it, Casey made a bold decision: she split her collection and SKUs in two, producing half from animal-derived leather and half from the next-gen material. ▶



This decision allowed for a deeper understanding of what Sylven New York customers really wanted in a way that she felt a more limited capsule collection or one-off product offering may not have done. The sale of the products was split 50/50: shoes made from both materials sold equally well. As Sylven began to release new designs, it became clear that more interesting colours, silhouettes and designs would sell better, regardless of the material. An analysis of customer behaviour showed that even those who had only ever bought animal-derived leather products before would buy the next-gen material if it was used on a more innovative design.

Interestingly, the brand received many emails from customers asking which material they should purchase, to which customer service would supply a list of 'pros and cons' for each material, leaving the customer to decide. At this point, Casey noted:

"I realised I had this opportunity to help people shop differently because they were more interested in the colour, and the product and the innovation of the material, which allowed me to see that while for the longest time people in the industry told me that consumers equate luxury with leather, I got to see first hand and disprove that: people equate luxury with innovation, with newness of creativity, style and expression."

After in-depth research into the environmental impact of the brand's resource utilisation as a whole, Casey realised the brand's use of vegetable-tanned leather could no longer be justified. It was no more profitable than the animal-free alternative and its production was tied to immense biodiversity destruction, methane emissions, water use both at tier one and during the tanning process, and a host of other negative impacts – including a major lack of transparency and traceability in the leather supply chain. These impacts far outweighed those she found with the partly apple-derived material, even if it was not perfect yet either.

"Being a responsible brand, instead of continuing to put that decision onto the consumer themselves, I knew that the single largest impact that I could make up front was to move away from animal products entirely."

Aware that her new materials still included some fossil-fuel derived inputs, Casey noted that "there is so much plastic use in genuine leather and in shoe production more broadly", especially when animal-derived leather is treated to be more scratch or water resistant, or for aesthetic purposes. Ultimately, she asked herself "what makes the most sense" when considering the overarching environmental impacts of her resource utilisation? Her decision was clear:

"If we just eliminate leather use, even if it's not a perfect alternative, the impact is significant."



While Sylven New York's material costs were marginally reduced in their move from Italian vegetable-tanned leather to (still costly) next-gen leather, investment was put into retraining the traditional artisans they already partnered with, who had not worked with the material before. This investment paid off, and the brand has – even in the midst of a pandemic and recession – healthily grown its community, in part thanks to a major increase in press, editorial and other brand perception improvements.

Today, Sylven works with a number of next-gen materials. Perhaps more comfortably able to "really sit with what it means to use animal skins" as a designer now that she had moved beyond it, Casey is now also solidified in her decision from an ethical perspective.

"I think people respond to a strong sense of identity, to clear messaging which shows that when you learn new information, you can make new decisions."

Sylven New York told its community that its "value system is built on trying to be as responsible for the

planet as possible" and that their choice to move beyond animal-derived leather was "a way we can step towards that". She said "It felt like a very natural dialogue with our community"; that it was useful to be able to "promote our values as opposed to just pushing product", and to focus on considered and authentic storytelling about the entire making process, not only in relation to their materials.

"Fashion is about innovation. The planet isn't getting any colder, and there's a way to leverage the right time and right place – which is what fashion has always done for its longevity. When we look at the next generation, animal leather will become obsolete, especially with a clear way forward made by these alternatives that are really close to completely outperforming leather. In the world right now it feels as though everything has to be meaningful to be desirable, and there's such an opportunity to interact with your customer in a more meaningful way which will drive your bottom line".¹⁰

Leather supply chain just transition possibilities

66

In a much-needed just transition beyond leather, it is not enough to supply the fashion industry with more sustainable and ethical leather alternatives, if we are not also supporting a shift which allows all people currently working in leather supply chains to make a fair and decent living in work which is more communally beneficial.

Just as with an equally-needed transition beyond fossil fuel mining and fracking for gas, the people who work within the leather supply chain should not be punished by or left behind in a broader evolution of fashion and society. People who work as miners, slaughterhouse workers, tannery workers and cattle ranch workers are all entitled to contribute to a total ethics fashion system, and to be supported in their transition to more positive work which can support their lives. This transition should be relevant not only to what is both more sustainable and protective of our fellow animals, but to the cultural contexts of these workers.

For a just transition beyond leather to be realistic, it must be highly-funded. Retraining of working people, the setup and development of new supply chains and systems, rewilding: all of these required steps require financing. Fortunately, there are several streams of funding from harmful industries which could be diverted to support this just transition.

Shifting subsidies from harmful to helpful

According to the United Nations, 90% of global farm subsidies fund 'harmful' operations, with the largest sources of emissions, such as cattle ranching, also receiving the biggest subsidies.¹ Government subsidies for animal agriculture are 'price-distorting and largely harmful to the environment',² according to the UN's Food and Agricultural Organization, which released an analysis in 2021 stating that support for the industry in rich countries must be reduced. In fact, FAO deputy director Marco Sanchez noted that 'there is no way' wealthy countries such as the United States can align with the Paris Agreement climate targets while subsidising the industry as it does today.¹

67

The harm done by these subsidies is not only climate-related. Food and Land Use Coalition analysis found that up to \$6 trillion USD worth of damage has been caused to nature through such subsidy regimes.^{3,1} Meanwhile, senior Oxford University researcher Marco Springmann says that agricultural subsidies help prop up a system that is both unsustainable and unjust. "Worldwide, more than \$200 billion USD of public money (that is, money collected through taxes) is given to farmers every year in direct transfers".⁴ Springmann notes that how governments currently provide subsidies exacerbates global environmental issues and injustices.⁴ As published in the journal of Nature Communications, this means every fifth subsidy dollar is used to rear farmed animals who are slaughtered for meat and skin sales, and every tenth dollar to dairy industries – in which highly valuable calf skin leather is also produced.⁵ On top, many subsidies, such as land-based payments for fodder crops, indirectly benefit animal farming.⁵

Bank-rolling the climate crisis

Big banks around the world also fund the leather supply chain. Changing Markets Foundation's 'hot money' report found that 40 major financial institutions around the world are heavily funding cattle industries, disproportionately contributing to the climate crisis through their fiscal support of methane-emitting production.⁶ These institutions share a combined investment of over \$115 billion USD in equities within these farmed animal supply chains, with just one investment group, Vanguard, responsible for a methane footprint of 21 megatonnes of carbon equivalent emissions as a result. The top 20 banks and

their methane footprints from these investments is larger than the CO₂ footprint of the United Kingdom or Australia. As a result, it is not only a shift in government subsidies that is required, but a shift in institutional investment, which can be brought about by investors and collective calls from those who keep their money within these banks and companies.⁶

With our public and private funds shifted away from harmful industries in the leather supply chain, increased financing is available to support a just transition beyond animal-derived leather production and other harmful industries, while supporting community and environmental health.



Global data relating to cattle industry subsidies specifically is unable to be accessed, with this lack of transparency itself being part of the problem. However, data on subsidies provided to all industries rearing ruminant animals for slaughter (cattle, buffaloes, sheep and goat, all of whom are skinned for the leather industry) is available, and newly analysed by Collective Fashion Justice.⁷

Across the top ten cow skin producing countries (except for Sudan and Pakistan, which do not have available data) according to the Leather Council, government subsidies of over \$9 billion USD were paid to ruminant rearing industries producing meat and leather in 2014, when data was most recently available.^{7,8} The ranking for top ten hide producing countries differs when sheep and goat skins are counted too, as they are in FAO's most recent world statistical compendium for raw hides and skins, also from 2014. The top ten skin producing countries listed here provide subsidies of over \$9 billion USD as well, though four of the listed countries did not have available subsidy data.^{7,9}

When ruminant animal herds raised in the dairy industry are added into

this equation, subsidies rise even higher between these top hide producing countries, to a total of \$15.1 billion USD. Just as skins from the meat industry are considered valuable co-products, calf skins are highly valuable to the luxury fashion industry, while spent dairy cows are skinned for cheap leather. Beyond these top ranks, further subsidies are provided to those countries known for producing 'high quality' and luxurious calf and lamb skins, such as France and Italy, with industries subsidised by \$1B and \$408M USD respectively.⁷

In many of these listed nations, additional subsidies fund the live export of these animals, the growth of monoculture crops for animal feed, and even slaughterhouses, to an unknown total sum.¹⁰⁻¹² This massive amount of money fuels immense harm to the planet, people and animals alike, and is directly pulled from our pockets, as government subsidies to industry are made possible by tax-payers and their hard earned taxable income. As a global community, our money should contribute to the development of a liveable, sustainable and just world - not to systems which run counter to such a world.

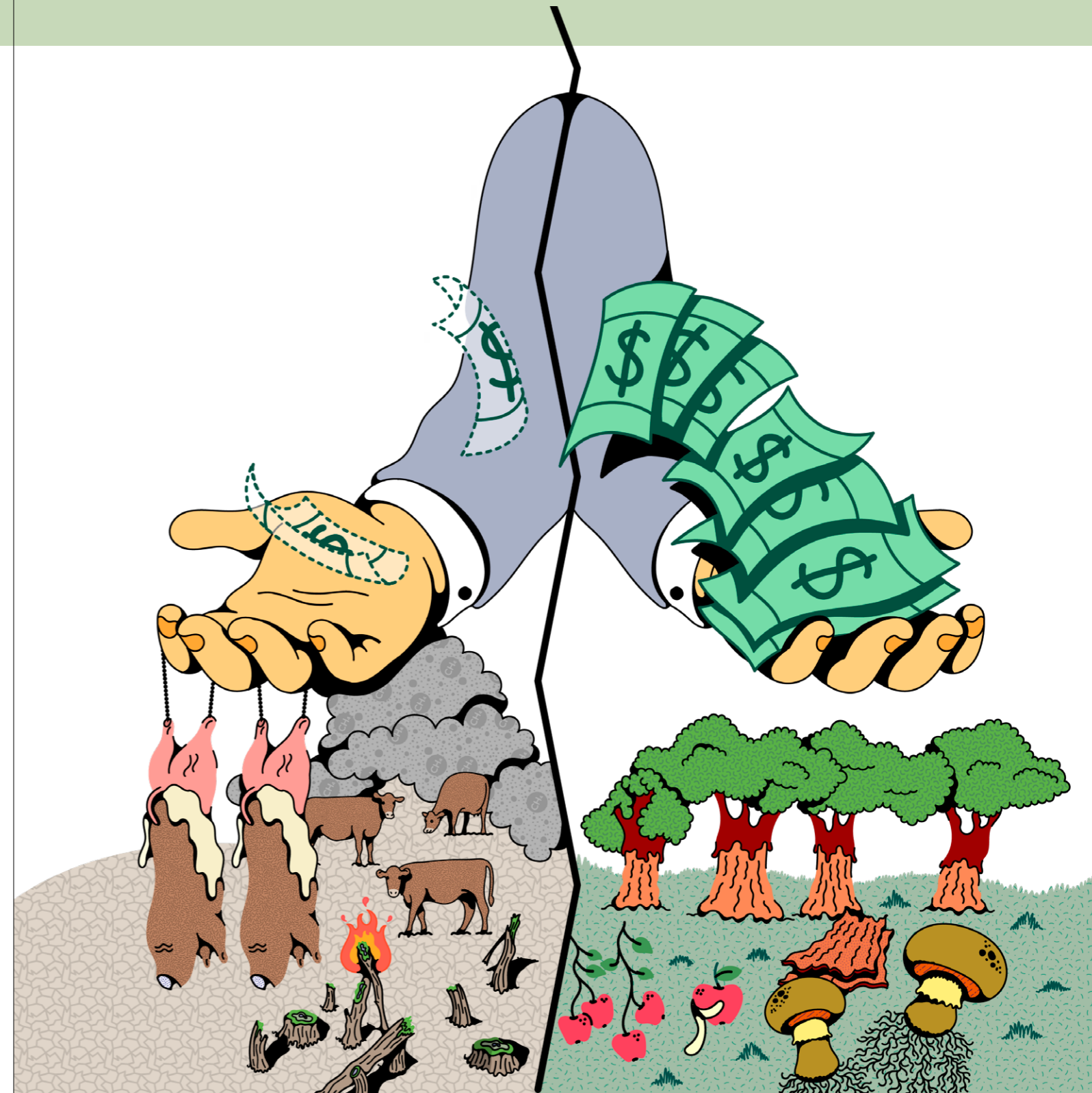


Table of subsidies in top ten cattle skin producing countries:⁷

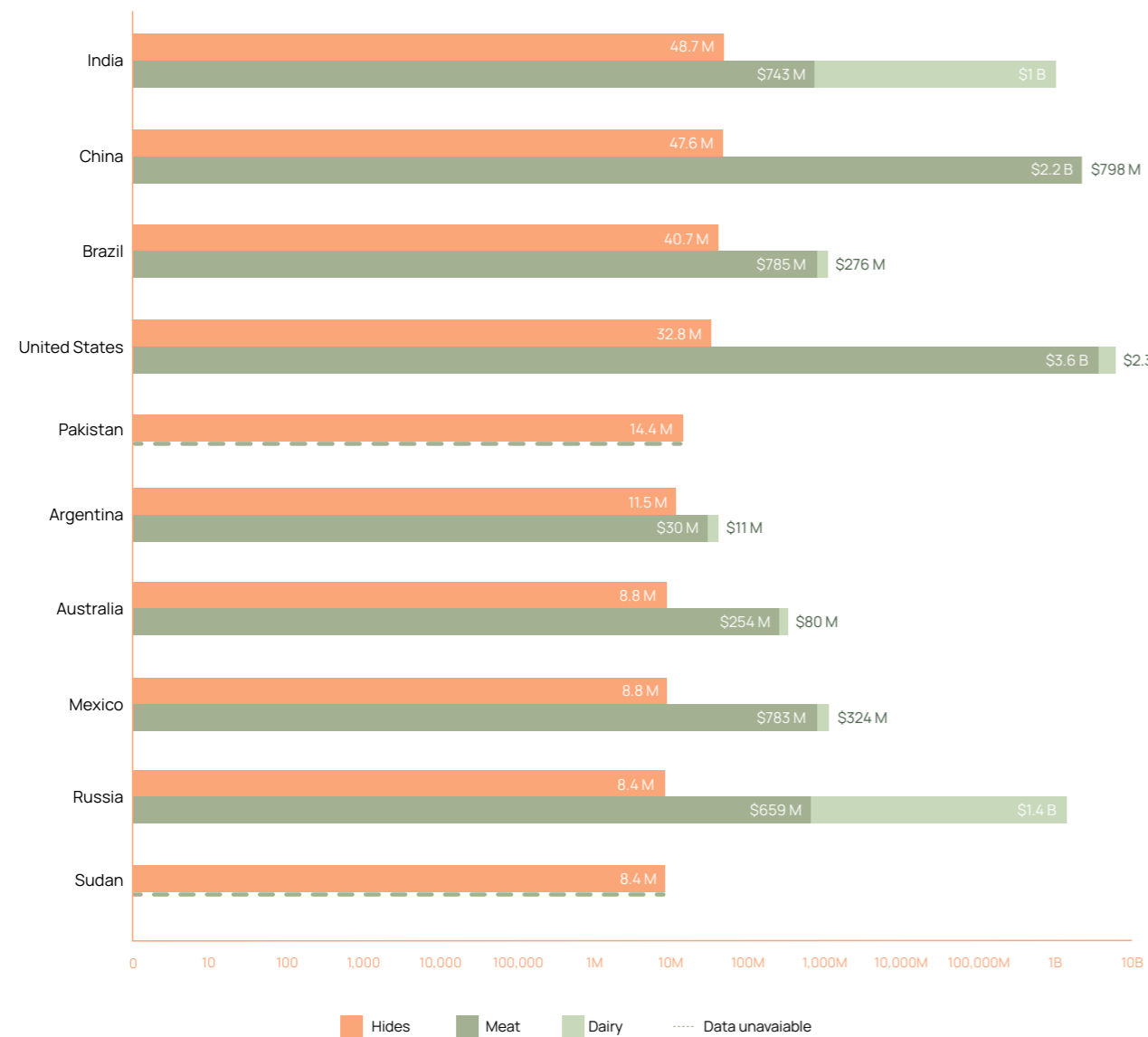
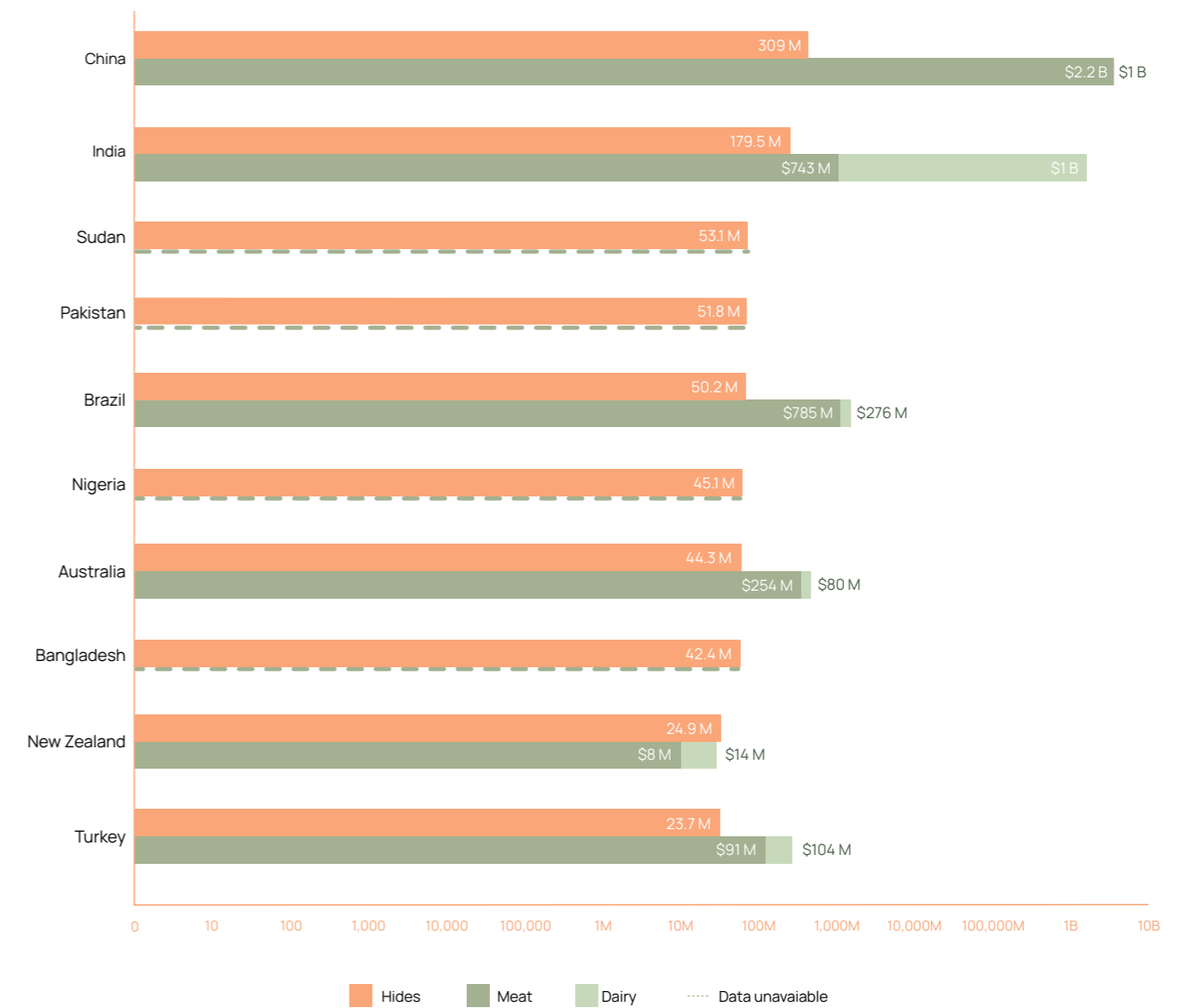


Table of subsidies in top ten ruminant skin producing countries:



Similar subsidies are also handed out to the cattle industry in most other nations. As much as a near fifth of the EU's total budget – at least €28.5 billion in taxpayers' money – goes to upholding the

unsustainable farmed animal industry across Europe, for example, as highlighted by 2019 Greenpeace research.¹³ These subsidies could be better utilised to support a just transition in which:

- New, sustainable, bio-based or recycled material manufacturing infrastructure development could be supported
- Sustainable plant-based agriculture is better financially supported to increase public access to healthy and beneficial products

- Meat, dairy and leather supply chain workers are trained to transition into more sustainable and economical roles
- Cattle farms transition into eco-tourism.

Shifting subsidies away from these harmful industries and towards a just transition helps to end the externalisation of production costs, helping total ethics leather alternatives reach price parity sooner. Essentially, it requires the leather and related industries to end its outsourcing of cost, allowing for public funds to be better spent. As highlighted in the Stockholm

Environment Institute's report on a just transition beyond animal production, such a just transition should hold the Global North accountable as its starting point, given the unevenly distributed product consumption, wealth and harm caused by nations in this part of the world which have lower need and higher capacity for much needed global change.¹⁴

A tax on leather?

Not only must public funds be shifted away from industries producing leather and other ruminant animal products, these industries could also be taxed. This would force industries to not only pay their own production costs, but to be responsible for the cost of its harms on the planet, our fellow animals, and people, too.

Such taxes have had some success on other environmentally harmful production systems. For example, Britain's use of coal-powered energy fell by 90%

following the government's introduction of a carbon tax in 2013.¹⁵ Some researchers, such as Professor Cameron Hepburn and Franziska Funke of the University of Oxford and Potsdam Institute for Climate Impact Research even call a tax on products from ruminant animal systems 'inevitable to decarbonise agriculture at the necessary pace for limiting global heating to at least 1.5°C' as required in the Paris Agreement to combat climate crisis.¹⁶ Global policy to support a just transition beyond coal, such as the United States Inflation Reduction Act, continues to

develop and garner support.¹⁷ If the negative costs involved in fashion production across the entire supply chain – not only at the raw material stage – were paid by the industries responsible for them, the consumer market would look very different. More environmentally beneficial products would no longer be more costly than those which are bad for the planet but well subsidised. As a result, more responsible purchasing could follow suit, especially as the financial barrier to more sustainable consumption is clear in consumer attitude polling.¹⁸

Transitioning farmlands and workers

Those in the work of rearing cattle and calves for slaughter in leather supply chains must be considered in a just transition to more responsible materials.

As the cattle industry as a whole becomes less profitable, farmers continue to see smaller margins returning to them when animals are sold to slaughter. As the market share for non-animal protein and milk products rises alongside leather alternatives, these margins are only going to reduce further, making already difficult and unsustainable work economically unviable.^{1,2} Defra and the National Audit Office have estimated that without EU subsidies, 40% of farms would make a loss.^{3,4} Now is the time to invest in just transition opportunities for the people in this work.

"A handful of government initiatives have begun to pave the way for the transition as a result of livestock emissions. For example, the government of Flanders (Belgium) is planning to close its most polluting livestock farms by 2025, and in 2021 the new Dutch government announced a €25 billion initiative that included plans for livestock farmers to cease farming, providing assistance for others to transition to more extensive farming methods."

– Stockholm Environment Institute⁵

While more surveying is required around the world, farming community views are not monolithic and resistance certainly continues;⁵ existing surveying and qualitative data highlights the willingness of many farmers to make a transition beyond animal rearing. For example, a qualitative survey provided to Scottish farmers during the 2021 – 2022 period, explored receptiveness to a transition beyond animal rearing for agriculture.⁶

64% of farmer respondents with rough grazing and permanent pasture said they would consider transitioning out of animal rearing entirely.

moving into carbon farming to help the land return to its natural state. There was only one caveat: these farmers would only be willing to make the change if financial support was provided to them.

While 86% of respondents said they would consider changing their farming practices to help mitigate their climate impact, another 56% said they would reduce their herd size for this purpose.

Several farmers had already reduced their herd size out of economic necessity, while one was seeking to remove a grazing tenant due to her concerns about methane emissions.

While Scotland is not a major producer of skins, these findings highlight the views of a growing number of farmers and ranchers throughout other countries, found by those working in the field of farm transition support. Across other parts of the United Kingdom, as well as Europe, the United States and Australia, these themes and the perceived value of a transition persist.⁷⁻¹¹ Animal farmers in Europe have shared 'worry over their precarious

Another 86% of farmers said they were happy to consider changing their practices to align with changing consumer preferences.

economic position⁹ and their exploitation under increasingly imbalanced contract farming systems run by large corporations which ate up the majority of income.¹² Meanwhile, those in the United States who have successfully transitioned beyond animal rearing and towards plant-based production have shared that they have moved from feeling 'angry', 'troubled' and 'broken' to feeling 'joy' in their farm work.¹²

"Almost everyone involved in food and farming across the UK accepts that significant transformation is necessary if we are to have a food system fit for the future... insecurity, low paid jobs and disastrous environmental impacts all flow from the system we currently have—an animal-based agriculture that is out of date. If starting from a blank sheet of paper, no one would design the system we currently have."

— Dr Alex Lockwood, Senior Lecturer at the University of Sunderland¹³

for the farmers and, more so, for the farmhands whose job is to care for the calves during calving season. I have spoken with ex-farmhands suffering from PTSD and farmers who have become emotional and overwhelmed when discussing the stresses of their farming. One farmer even admitted that he was no longer able to eat cows. This is a systemic problem with our agricultural system – we need to overhaul this system, together, with a focus on long-term sustainability."

— Krystal Camilleri, director of Farm Transitions Australia.¹⁴

(The dairy supply chain is intimately linked to luxury leather production which uses calf skins)

"Climate change is here, it's already happening. For our sake but also for the sake of every other species on this planet, we need to take action to mitigate its effects by adopting an 'all hands on deck' approach. This means opening up the dialogue to different stakeholders. The agriculture sector has one of the highest

levels of emissions, and therefore must become part of the solution. The transition to sustainable production methods and re-naturalisation of agricultural areas must inevitably be considered."

— Italian MEP Eleonora Evi⁸

There are a number of opportunities for a transition beyond cattle farming available.

Supporting plant-based agriculture

The environmental benefits of a transition to plant-based production, as highlighted in our report on leather's impact on the planet, is paired with positive opportunities to feed and clothe our global community in a way that is not only more ethical and sustainable, but more beneficial to farmers themselves. Peer-reviewed research highlights the opportunities available to rural communities currently reliant on animal agriculture,¹⁵ which could 'transition to systems that are more equitable and fair for farmers and rural workers than the status quo'.

"I have met many dairy farmers and developed a deeper understanding of the complex problems around animal farming and our food and fashion systems. For some farmers, sending newborn calves to slaughter and sending spent cows to market is an incredibly tough decision. Although they believe and have accepted it is a necessary part of farming, the arrival of the bobby calf truck is never easy

These opportunities include a growth in demand for crops which are more healthy, environmentally and economically beneficial, and other alternative agricultural work. Interviewees in this research also noted that a transition to animal-free production could 'reduce some of the health risks faced by rural communities, which are associated with animal agriculture.'¹⁵ Finally, this study also flagged the importance of a just transition beyond animal agriculture that did not replicate existing monopolisation and corporate greed in the industry, which has contributed to the consolidation of mega-farms and the continued disappearance of smallholder farms.⁵

There are a number of avenues for success in a transition beyond cattle farming. Some are more specific to our food system, such as those transitions similar to Mike Lanigan and Edith Barabash's in the United States. The cattle ranch, which had been operated by third-generation rancher Mike for 30 years, is now Farmhouse Garden, a vegetable farm which serves as their primary source of income. Their farm covers 100 acres, 28 of which are used for vegetable cropping, 12 as a sanctuary for remaining cattle to live the rest of

their lives on, and much of the rest able to develop into a more natural state.¹⁶ Other US cattle ranchers have successfully transitioned to growing pulses, oats, a wide range of vegetables and plant-proteins, as well as hemp, which can be used for fibre and textile production.¹²

Other opportunities can help cattle and other animal farms providing skins to transform into farms providing improved feedstocks for more sustainable and ethical materials. A number of animal agricultural production facilities have and are transforming into mushroom farms,^{17,18} highlighting the opportunity for a transition towards mycelium growth for next-gen leather production. While cattle farmers note falling margins and struggle to stay open,¹⁵ these transition opportunities are a solution to these stressors which can result in improved economic gain from systems with smaller environmental footprints.¹⁹

In Queensland, Australia, where the leading cause of deforestation is cattle ranching,²⁰ tropical fruit farms growing pineapples, mangoes and grapes thrive. Waste outputs from the production of all such fruits are currently used as ingredients in partly bio-based

leather alternative materials such as Piñatex, VEGEA and Fruit leather overseas.²¹ Partnership between companies producing these materials, farmers growing these fruits, farmers rearing cattle on land suitable for such fruit growth, and governments which could support the development of further manufacturing facilities to allow for local production, could prove valuable from an economic, environmental and wellbeing perspective.

Such partnerships would allow these materials to further improve and scale up, while providing farmers improved income with multiple, diversified streams: selling not only fruit for direct consumption and juicing, but plant leaves, seeds, skins and other outputs otherwise wasted at a cost. As farmers call for solutions to address economic losses associated with fruit waste, this is an exciting opportunity.²² Some proposed bills and policies exist globally which would help support this transition, and these should be implemented with reallocated government subsidy funds.^{23,24}

In the Amazon Rainforest, where modern slavery is common on unsustainable cattle farms ▶

which forcefully displace First Nations people,²⁵ material producers Amazkin and Amadeu are working with local Indigenous communities to protect land from deforestation by the leather and other industries. Both operations produce next-gen leather by harvesting natural latex from Shiringa trees. This latex forms a rubber which is used alongside sustainably sourced cotton to create the final material. The conservation agreements and partnerships between these producers and the Indigenous communities which use their knowledge of the land, alongside their artisanal practices, is a strong example of how material innovation can support a just transition. Amazkin co-founder Jorge Cajacuri says that their petrochemical and animal-free material collaboration exists to 'empower the consumer to see the Amazon through the lens of activism and conservation', the material an 'educational tool for intentional consumerism' that builds rather than breaks down, and which recognises the importance of Indigenous land rights and protection.²⁶ With support, there could also be potential for vulnerable people currently labouring on cattle ranches to be assisted in a move towards fair and safe participation upstream in the supply chains of such materials.

"I'd happily have no beasts at all"

"Oh yes! If we got as much money... then I would give it up!"

"We know these changes are coming, so we have to be willing to change too"

— Scottish farmers asked if they would prefer to move beyond animal rearing⁶

Eco-tourism and regeneration

Along the value chain of alternative animal products, Nature published reporting shows that over 87% of surveyed experts agreed that new jobs would be created in their areas. Considering estimates that just 40% of the meat market will be derived from animal slaughter products (produced in interlinked supply chains with leather) by 2040, these experts also estimated the workforce impact of alternative meat production on animal farm jobs to result in a reduction by 20% in Brazil, 30.7% in Europe and 39.2% in the United States.²⁷ For this reason, alternative opportunities beyond the production of other foods and materials will likely be required.

The International Labor Organization notes that 'tripling investment in nature-based solutions by 2030 to achieve climate change mitigation, biodiversity and land restoration goals – as called for in the State of Finance for Nature 2021 Report – can generate an estimated additional 20 million jobs.'²⁸

Rewilding the approximately 3 billion hectares of land made available in a shift beyond animal-based production, largely used up by industries exploiting cattle and sheep skinned in leather supply chains,²⁰ is an opportunity for eco-tourism and other nature based solution employment roles. Eco-tourism can support local economies and peoples, and operates with many First Nations peoples around the world in current major hide producing countries, while fostering their important connection to land.²⁹⁻³¹ If more sustainable, community-driven and plant-based agriculture develops, they could do so alongside eco-tourism, with farms diversifying their income through hospitality, recreation and agritourism.⁵

In the United Kingdom, billions of pounds in agricultural subsidies have been shifted into support



for environmental goals – but a just transition must be a part of such goals globally.³² If subsidies currently supporting the leather supply chain were diverted into Indigenous communities and current farm workers, farmlands which are currently degraded could be revitalised by people working on the land not to raise cattle for slaughter, but to foster the land, and in turn invite people to enjoy the land. When a growing number of people feel disconnected to nature,³³⁻³⁶ and research shows the critical human health need for connection to nature, the benefits of this approach are multi-faceted.³⁷⁻³⁹ For farm owners who would not be interested to participate in this industry, government buyouts similar to those proposed in the Netherlands – where the government is working

to cut the scale of the animal industrial complex by one third for the sake of ammonia emissions reductions – could be offered.⁴⁰ This government bought land should then be returned to Indigenous communities, or at least unlimited access to such lands should be provided. This has occurred in some parts of Australia, the United States, Indonesia and other nations, supporting sovereignty and subsequent ecological health.⁴²⁻⁴⁴ In other instances, land currently occupied by the cattle industry producing leather is done so illegally, and Indigenous leaders such as Pablo Sibar Sibar, from Costa Rica work to reclaim the land.⁴⁵ In many instances, such a transition would diversify and grow the number of people who benefit and profit from operations on these lands. ►



Australia as a case study for eco-tourism driven just transition

Defend the Wild's report, 'An investment in nature is an investment in our future', highlights how a just transition beyond these systems could improve employment rates in more personally and communally beneficial work.⁴⁶ For example, in Australia, the sector rearing ruminant animals for meat and skins employs just one person for nearly every 1,980 hectares of land used for these production purposes. 0.7% of the total population is directly employed in this work. The number of farms and farming employment in this system has decreased significantly in the past decade, too.⁴⁶

Meanwhile, the report also outlines nature-based tourism as one of the fastest growing sub-sectors of Australia's already booming

tourism industry, with two-thirds of international visitors engaging in some form of nature-based tourism, and 70% indicating they would like to travel more sustainably.⁴⁶ At the same time, Australia's stunning – some even World Heritage Listed – National Parks are often under-resourced.⁴⁶ Due to this under-resourcing and following the release of Australia's 2022 State of the Environment report – which spoke to the need to protect more land – some cattle farmers shared criticisms, with even the National Farmers Federation's President unreasonably claiming that more land protection could have an adverse impact on biodiversity.⁴⁷ However, shifted subsidies from unsustainable agriculture and towards land protection could support these farming communities and a larger number of people than can be employed within their sector, moving into nature based work protecting and supporting the flourishing of these natural environments. Land once used for cattle and

other animal grazing could be newly protected, rewilded and used as wildlife preserve and responsibly managed tourism attractions, in turn supporting jobs.

The benefit of such a transition is not only an opportunity for increased employment, but increased mental and physical health. Currently, many farmers face mental health crises, tied not only to economic factors, but environmental factors. 'Sostalgia' is the 'emotional response to the negative transformation of a loved familiar environment', and is described by farmers who see continued environmental degradation on the land they work on.⁴⁸ Natural disasters and droughts exacerbated by the climate crisis, which grazing industries disproportionately contribute to, have been reported to lead to increased suicides for men in rural farming communities. Seriously, the average rate of suicides for farmers is almost 59% higher than that of other communities.^{49, 50} These impacts are deeply concerning and critical to

address, and a just transition to work in which farmers can become focussed on environmental protection may be a critical solution well received by many, alongside increased mental health support access.⁵¹ Exposure to healthy nature has been proven across numerous peer-reviewed studies to benefit both mental and physical health; reducing depression, stress and anxiety levels, blood

pressure and nervous system arousal, to name a few.^{38, 39, 52} Over time, a just transition beyond cattle ranching to allow people further access and involvement in healthy natural environments could improve public health. In turn, some of the \$60 billion AUD cost to the Australian economy tied to mental health care may be able to support ongoing nature-based solutions.⁵³

Shifting beyond slaughterhouse work

A shift beyond the use of animal-derived leather in fashion would result in financial loss for slaughterhouses, and in turn, less employment roles available in these slaughterhouses.

As slaughterhouse work records are not shared publicly separated by species, how many people work killing cattle and other animals skinned for leather is unquantifiable but undoubtedly significant.

Most people who work in slaughterhouses in top cow skin production countries live in rural or semi-rural areas outside of capital cities, limiting employment access.¹⁻⁴ While some people may be willing or interested to find work in metropolitan areas, the majority of jobs available to past slaughterhouse workers in a just transition must also be available rurally.

A 2022 study from the journal Nature explored industry, academic, government and other expert views

on how the rise of alternatives to animal products (particularly meat, but with high relevance to leather, too) would alter employment across Brazil, the United States and Europe.⁵ Nearly 92% of experts agreed that 'investment in training and development of people is necessary to create employment opportunities' in a just transition beyond animal products derived from slaughterhouses, with 64% disagreeing with the notion that these people already have sufficient qualifications to work in other sectors. This was particularly true in Brazil, where only 72% of workers had completed less than five years of formal schooling, with 23% reportedly unable to read or write.⁵ This represents a broader issue, particularly as low literacy is associated with increased health risks and lower access to services which can improve life quality.^{6, 7}

Many experts agreed that, with retraining support, slaughterhouse workers could be shifted into employment in systems creating alternatives to previously animal-derived products.⁵ Such alternatives could include plant-based and cultivated meats which offer improved environmental, health and ethical outcomes, and roles in agricultural production which exist

as part of the food and fashion system.⁵ Roles within carbon farming, eco-tourism, and other nature based solution work, as have been outlined for the farming community, could also be available to these rurally living people.⁸

However, a just transition should not limit people currently working in harmful systems to move into systems which exist as a direct alternative path forward. Brave New Life Project is a United States-based not-for-profit organisation which exists to support workers struggling to transition out of slaughterhouse and other animal industrial complex work, moving into alternative employment of their interest.⁹ With their support, Elly, a young Black American woman, moved out of slaughterhouse work, which she decided to leave 'after they asked her to work with knives at a very fast [and dangerous] rate'. Today, Elly is enrolled in college to support her future ambitions, while also working in retail to support herself in the meantime.⁹ Support in creating a path to more just work should be readily available to people interested in all kinds of new work, throughout a total just transition which will inevitably occur over decades, at least, based on some current estimates.¹⁰ In Australia,

one political party, the Animal Justice Party, already has policies to develop and support such just employment transition.¹¹

Given the significant rate of trauma, mental illness and subsequent violent crime (often in a domestic setting, and particularly harming women) which can be caused by the job, as explored in our 'leather's impact on people' report,¹² a just transition beyond slaughterhouse work should also support the mental health of people leaving it.

"No. Not at all. Not in any way, shape, or form" was the response of one ex-slaughterhouse worker asked whether they were provided any system for mental health support, before going on to share that the industry "preys" on desperate people who have no other opportunity, and who are not given "any heads up that you're gonna be witnessing hell on Earth".¹³

With similar sentiments, some particularly noteworthy ex-slaughterhouse workers have moved into roles of total opposition to their past work. One is Mauricio Garcia Pereira, who after years of trauma associated particularly with the killing of calves in the French luxury leather supply chain, contacted an animal rights organisation to film inside, contribute to a televised investigation and write an autobiography titled 'Animal abuse: human suffering'.¹⁴ Another is ex-cattle slaughterman Craig Whitney, based in Australia, who now studies and works on his hopes to move from a punitive to rehabilitative and transformative justice system, after having dealt with it as a result of trauma and violence connected to his slaughtering work.^{15, 16} While just transition support will require investment, it could be reasonably hypothesised that the likely reduced rates of mental ill health, violent crime and physical health impacts surrounding slaughterhouses may be reflected in reduced need for public funds to address these.^{17, 18}

Not all costs would or should be shouldered by public funding, particularly as major companies which own slaughterhouses and tanneries alike invest in the development of alternative supply chains which create products free from animals.⁵ JBS, for example, invested \$100 million USD into lab-based cultured meat production and related facilities in 2021, following earlier investment in other plant-based production.¹⁹ Again, it should be noted here that a just transition must not allow for harmful monopolisation. In fact, given the wealth accrued by companies such as JBS from animal slaughter and associated ethical and environmental crises,^{13, 20} these businesses could even be taxed, similar to a carbon tax for mining companies,²¹ in order to support the subsidisation of a just transition beyond slaughtering supply chains in leather and other production.

Reimagining and moving beyond tannery work

84

Across the ten most significant tanned leather exporting countries, more than an estimated 541,000 people work in tanneries.¹⁻¹¹ While data, particularly from poorer countries, is less readily accessible and as a result the age of data varies, there is no doubt that a significant number of people rely on this industry to make a living.

However, many of these people are exploited or made to work in unsafe conditions which can cause chronic illness, as highlighted in our report on leather's impact on people. All people deserve work which is safe and performed for no less than a living wage. In a just transition beyond animal-derived leather production, the occupation of these hundreds of thousands of people must be carefully considered.

Even as some parts of the fashion industry have evolved their tannery practices for hides, retraining of working people has had to occur, or must still occur. For example, the International Labor Organization noted in their 2018 'Skills for green jobs: Bangladesh' report that with tanneries acting as one of the country's major pollution problems, 'changes in technology as well as in the knowledge and practice of employees can play a pivotal role' in transforming the industry.¹¹ The ILO noted that new types of skills were required, with 'training and retraining' needing to be facilitated. Unfortunately, the ILO also noted that currently, no 'green training' existed within the industry, but

that there was great potential for 'greening existing jobs'.¹¹ These 'greening' efforts must address the current chemical loads required to tan leather, allowing for the production of materials which are at once long-lasting as well as sustainable, unlike the leather of today, which is long-lasting in part, due to elements of its unsustainability.

Tannery workers in next-gen leather supply chains

The combination of the fashion industry's growing interest in improved tannery standards in relation to chemical use,¹² along side its rapidly growing investment into next-gen leather material innovation which requires tanning may help to 'green' these existing jobs, as the ILO states is needed.¹¹ A number of companies producing mycelium alternatives to leather, such as MycoWorks, Ecovative, and Sqim (to name a few), work with tanneries that have previously only ever worked with animal skins.¹³⁻¹⁵

As these materials begin to scale, their production will be able to fill and support an expanding

85

number of tanneries and those working inside them. What's more, while these companies are currently working with some of the most sustainable, industry-leading tanneries in the world,¹⁶ their growth could also act as an opportunity to provide new technology, new training, and improved worker health and safety to tanneries that are currently operating in an unjust and polluting manner. Because of this potential for transferable skills in the tannery industry, a just transition may be most simple at this tier of the existing leather supply chain: it is about significant improvement to protect working people as well as communities and environments surrounding tanneries, rather than total transformation.

The intersection of fashion production's legacy and innovation represents a new chapter for fashion, and can be seen in partnerships such as that between Bolt Threads and tannery Heller-Leder, which after 100 years of working with animal skins, is finishing Mylo™.¹⁷ As heritage tanneries committed to sustainability recognise the

direction of the fashion industry, they are offering their superior ecological technology to mycelium production companies. For example, ECCO Leather is using their DriTan™ tanning process, which requires less chemicals and water compared to traditional tanning, with AirMycelium™ technology to create 'custom-tuned' and advanced materials.¹⁸ Waterless, chromium-free, aldehyde-free, waste-reduced and other improved tanning technologies are also being developed, and must be used on raw materials which do not have extremely high environmental impacts, as cow and other animal skins do.¹⁹⁻²¹ As these methods continue to evolve, biodegradability potential, dyeability and other factors will improve.^{22, 19}

It's not only mycelium leathers which are being produced with traditional cow skin leather finishing partners: some next-gen leathers derived from microbes, or partly from fruit waste, such as Rotterdam's FruitLeather made with mangoes, are also finished by tanning companies which previously had only worked finishing animal skins.²³

Recognising the value of these partnerships, Vogue Business reported in 2021 that the 'race for fashion's leather alternatives' is heating up.²⁴ Brands willing to lean hard into the future of fashion are being prioritised for available material as scaling continues. One brand, Balenciaga, stated that the EPHEA™ mycelium material engineered specifically for the brand following their investment, had been created to "respect the safety of people and our environment, offering technical performance and a low ecological footprint without compromising quality."²⁵ The EPHEA™ material is organic and coated with a non-toxic finish, looking just like the historical leather it aims to replace.²⁵ In response, some industry publications such as Leather International Magazine have even taken a 'if you can't beat them, join them' position, even while continuing to justify the use of inherently inefficient, unsustainable, unethical and unimaginative animal-derived leather.²⁶

It is critical that these tannery partnerships extend to nations ►

with dire need for improved tannery practices, such as India, Bangladesh and China, to name a few, in order to protect more environments and people.²⁷ The global fashion industry must work together to ensure no one is left behind as tanneries improve and begin to be filled with mycelium rather than skins.

Moving beyond tannery work

Despite all of this, not all leather alternatives are produced in supply chains which require tanning. As a result, further retraining will be required for a large number of tannery workers. Potentially, such retraining is more suitable for people working in tanneries that are so out-dated that to reconstruct them with improved technology would be more or just as cost intensive as a just transition to alternative production and employment. Tannery work is considered an entry-level role for a large number of working people. Labour Market Insights in Australia states that the work requires a number of skills, such as critical thinking, active listening, coordination with others, steadiness, physically active work capacity, and others which would

be useful in a wide range of other roles with training.²⁸ In areas suffering environmental degradation as a consequence of unsustainable tannery production, work in natural based solutions may be a path forward, as previously outlined and explored.²⁹ Interestingly, while a number of Asian countries are currently major tannery production areas, they are also hotspots for these kinds of nature based solution roles, highlighting an opportunity for further transition.²⁹ Most of these roles are in productive agricultural sectors, which can also produce feedstock for additional leather alternatives, as previously noted.

Atma Leather, a next-gen leather company created by Jinali Mody, is developing bio-based leather from otherwise discarded banana plant fibres in India, with the intention of providing an alternate material supply chain in order to reduce pollution from tanneries in the country. This kind of localised, socially supportive and more responsible innovation must be supported.³⁰

Critically, the ILO also recognises that inaction to create these job opportunities by global governments could “result

in missed opportunities for businesses and decent work, thereby deepening existing inequalities, reducing productivity, and increasing social discontent.”²⁹ As such, a just transition from unjust industries producing unjust materials not only benefits the fashion industry, but the global community.



Conclusion

In this report series we have outlined the many harms leather production causes to people, our fellow animals and the planet. We have highlighted the growing eagerness for next-gen leather materials which replicate the aesthetic and tactile qualities of animal-derived leather, but none of the negative impacts of it. Finally, we have outlined the possibilities for those impacted by a just transition beyond leather, how this could be funded, and the benefit such a transition would have on us all.

Even still, many may consider a just transition beyond leather to be too radical. However, with the interwoven crises caused by the industry in mind, to continue with this destructive and harmful system would be irresponsible and myopic. There is no sustaining a fashion industry which accepts the inefficiency, blighting and cruelty of the way leather is produced today, which is both unethical and out of alignment with efforts to exist within planetary boundaries. As with all needed society-wide transitions, such as the transition beyond fossil fuel mining, challenges will undoubtedly be presented as we move forward, but this is a part of progress. The environmental and moral benefits of this process are invaluable.

We have advanced before and we will again: we have created unions and the 40-hour work week as well as rendered a number of fashion-driven and endangering wildlife trades illegal – while Hermès persists with reptile and cattle skins, the Beluga whale skin the brand once sold is no longer accepted,¹ and tortoise shell sunglasses are no longer genuinely

so. A vast number of jobs no longer exist across society today: telegraphists, lamplighters, town criers, clock keepers and leech collectors to name a few.² All of these people moved into new roles as the global community innovated for our collective betterment.

When the fashion industry, policy-makers and individuals consider this just transition, a timeline is important to consider. James Arbib, the co-founder of RethinkX – an independent think tank forecasting the speed and scale of technology-driven disruption – states that while cost and distribution vary the speed, it can take about 15 years for a new product to effectively disrupt a market.^{3,4} Positive feedback loops can allow for such disruption to begin following a tipping point in which 10% of a market is made up of such a new, more sustainable solution.⁵ In the case of circumfaunal, next-gen leather, these materials will not be widely available for another few years, even with existing investment. Nicole Rawling, CEO of Material Innovation Initiative, estimates that with this in mind, and with a healthy, expected ►

growth of investment in the space, broad disruption will likely occur around 2040.⁶

RethinkX also estimates in their agricultural report that by 2030, demand for some cow-based products will have fallen by as much as 70%.⁷ This shift will greatly help us reach IPCC goals of reducing methane emissions by about one third.⁸ Meanwhile, experts suggest that the fashion industry must work to reduce in size fourfold in order to stay within planetary boundaries, and these critical calls cannot be ignored.⁹ With this in mind, it is entirely reasonable to recommend the following actions from fashion:

1. Fashion industry initiatives, certifications and media publications, alongside the not-for-profit ethical and sustainable fashion sector, should update their language to acknowledge the harm leather production causes to the planet, as well as the humans and non-humans living here. Terms like 'ethical', 'conscious', 'sustainable', 'natural', 'circular', and 'eco-friendly' should not be used in reference to animal-derived leather.

2. Fashion brands should publicly commit to reducing leather use by at least 50% by 2027, fully phasing out leather no later than 2035. These timelines should be used as conservative targets when more immediate change is both critically needed and achievable for many brands.

3. In phasing out animal-derived leather, brands should embrace alternatives that support a much needed just transition beyond fossil fuels, too, and towards greater circularity.

4. Large fashion brands should invest in the research and development of leather alternative material innovation – ensuring these materials consider the need for a just transition, and will ultimately be open-source and available for wider industry use.

These recommendations are certainly significant asks of the fashion industry, but their substantial scale is reflective of the urgent need to divest from the interconnected harms of leather production, and from

the environmental crises which it perpetuates, as explored throughout this report series. Brands which primarily profit from leather goods will find more challenges in attempting to fulfil the outlined time-based recommendation than brands which include leather goods as just one of many offerings. This recommendation should be seen and used as a clear target for what is hypothetically possible for a large portion of brands, should the industry act together effectively and quickly, as it must. For those brands which could not feasibly reach this particular recommendation, serious consideration as to what the closest practical possibility is should be explored and set as a brand-specific target. Immediate interim action to improve traceability and the fair treatment and payment of leather supply chain workers is essential.

It's time for the innovation which has always existed within the art of fashion to be put towards a just transition beyond leather, as well as other harmful materials and practices, for the benefit of us all. As an industry which considers itself bold, future-thinking and trend-setting, fashion is perfectly positioned to design a new path forward – and one we urgently need.

References

References

93

Introduction

- 1 'Oldest leather shoe' discovered. [Internet]. Glasgow: BBC News; 2010 [cited 2022]. Available from: <https://www.bbc.com/news/10281908>
- 2 Number of cattle. [Internet]. Oxford: Our World in Data; 2018 [cited 2022]. Available from: <https://ourworldindata.org/grapher/cattle-livestock-count-heads?tab=table>
- 3 Labelling legislation database. [Internet]. Northampton (UK): Leather Council; c2022 [cited 2022]. Available from: <https://leather-council.org/what-we-do/labelling-descriptions-of-leather/labeling-legislation-database/>
- 4 Hedberg Y, Lidén C, Wallinder I. Chromium released from leather – I: exposure conditions that govern the release of chromium (III) and chromium (VI). Contact Dermatitis. 2015; 72 (4): 206–215.
- 5 About Global Fashion Agenda. [Internet]. Copenhagen: Global Fashion Agenda; c2022 [cited 2022]. Available from: <https://globalfashionagenda.org/about-global-fashion-agenda/>
- 6 Climate change: a threat to human wellbeing and health of the planet. Taking action now can secure our future. [Internet]. Geneva: IPCC; 2022 [cited 2022]. Available from: <https://www.ipcc.ch/2022/02/28/pr-wgii-ar6/>
- 7 Do you know all 17 SDGs?. [Internet]. Geneva: United Nations Department of Economic and Social Affairs; c2022 [cited 2022]. Available from: <https://sdgs.un.org/goals>

Leather is not a by-product: the importance of addressing hides

- 1 Essay one: hide and skin production around the world. [Internet]. Liverpool: Nothing to Hide; c2014 [cited 2022]. Available from: http://nothing-to-hide.org/LeatherFacts/Hides_&_skins:_use_or_lose
- 2 Co-product market report, June 2021. [Internet]. Melbourne: Meat and Livestock Australia; 2021 [cited 2022]. Available from: <https://www.mla.com.au/globalassets/mla-corporate/prices-markets/documents/trends-analysis/co-products/mla-co-product-market-report-june-2021.pdf>
- 3 Hakansson E. Is leather a by-product of the meat industry? [Internet]. Sydney: Good On You; 2020 [cited 2022]. Available from: <https://goodonyou.eco/is-leather-a-by-product-of-the-meat-industry/>
- 4 Hide and skin production around the world. [Internet]. Liverpool: Nothing to Hide; 2021 [cited 2022]. Available from: http://nothing-to-hide.org/LeatherFacts/Hides_&_skins:_use_or_lose/Summary
- 5 Mulvany L. There are not enough cows to produce luxury leather. [Internet]. London: Business of Fashion; 2018 [cited 2022]. Available from: <https://www.businessoffashion.com/articles/luxury/there-are-not-enough-cows-to-produce-luxury-leather/>
- 6 Honan K. Northern Co-operative Meat company shoulders a \$7 million loss after a challenging year. [Internet]. Sydney: Australian Broadcasting Corporation; 2018 [cited 2022]. Available from: <https://www.abc.net.au/news/rural/2018-12-17/casino-meatworks-reports-multimillion-dollar-loss/10620072>
- 7 Kelly J. Hide and skin prices drop significantly as synthetics take off. [Internet]. Melbourne: The Weekly Times; 2019 [cited 2022]. Available from: <https://www.weeklytimesnow.com.au/agribusiness/livestock-sales/hide-and-skin-prices-have-dropped-significantly-during-the-past-year-as-synthetics-take-off/news-story/eaec1cd0fa2b519016565f8aa9d676850>

- 8 Roberts O. Livestock hide disposal threatens processor viability. [Internet]. Alberta: Canada; 2019 [cited 2022]. Available from: <https://www.realagriculture.com/2019/05/livestock-hide-disposal-threatens-processor-viability/>
- 9 Leather goods market size, share and trends analysis report. [Internet]. San Francisco: Grand View Research; 2020 [cited 2022]. Available from: <https://www.grandviewresearch.com/industry-analysis/leather-goods-market>
- 10 Global trade of raw leather significantly contracted. [Internet]. Ahmedabad (IN): Fibre2Fashion; 2020 [cited 2022]. Available from: <https://www.fibre2fashion.com/news/textile-news/global-trade-of-raw-leather-significantly-contracted-270354-newsdetails.htm>
- 11 Trade value of leading beef exporters worldwide in 2020. [Internet]. New York: Statista; 2021 [cited 2022]. Available from: <https://www.statista.com/statistics/917207/top-exporters-of-beef-global/>
- 12 Libera C, Marote S et al. Brazil's path to sustainable cattle farming. [Internet]. Boston: Bain & Company; 2020 [cited 2022]. Available from: <https://www.bain.com/insights/brazils-path-to-sustainable-cattle-farming/>
- 13 Sagar R. Sector – leather. [Internet]. New Delhi: Invest India; c2022 [cited 2022]. Available from: <https://www.investindia.gov.in/sector/leather>
- 14 India hides and skins exports, imports, tariffs. [Internet]. Washington: World Integrated Trade Solutions; 2019 [cited 2022]. Available from: https://wits.worldbank.org/CountryProfile/en/Country/IND/Year/2019/TradeFlow/EXPIMP/Partner/All/Product/41-43_HidesSkin
- 15 India animal exports, imports, tariffs. [Internet]. Washington: World Integrated Trade Solutions; 2019 [cited 2022]. Available from: https://wits.worldbank.org/CountryProfile/en/Country/IND/Year/2019/TradeFlow/EXPIMP/Partner/All/Product/01-05_Animal
- 16 Beef report: profile of Brazilian livestock 2021. [Internet]. São Paulo: Associação Brasileira das Indústrias Exportadoras de Carnes; 2021 [cited 2022]. Available from: <http://abiec.com.br/en/publicacoes/beef-report-2021-2/>
- 17 Nowhere to hide: how the fashion industry is linked to Amazon Rainforest destruction. [Internet]. Vancouver: Stand.earth; 2021 [cited 2022]. Available from: <https://www.stand.earth/publication/forest-conservation/amazon-forest-protection/amazon-leather-supply-chain#slidedeck>
- 18 Sothmann S. Hide economics: leather's status as a byproduct. [Internet]. London: Leather Working Group; 2021 [cited 2022]. Available from: <https://www.leatherworkinggroup.com/news/latest-news/hide-economics-leather-s-status-as-a-byproduct>
- 19 Hide prices reflect oversupply. [Internet]. Melbourne: Meat and Livestock Australia; 2019 [cited 2022]. Available from: <https://www.mla.com.au/prices-markets/market-news/2019/hide-prices-reflect-oversupply/>
- 20 Revealed: European leather industry peddling misinformation in bid to escape deforestation-free law. [Internet]. London: Earthsight; 2022 [cited 2022]. Available from: <https://www.earthsight.org.uk/news/analysis/european-leather-industry-peddling-misinformation>
- 21 Garnett T. Meat and dairy production and consumption. [Internet]. Oxford: Food Climate research Network; 2007 [cited 2022]. Available from: https://tabledebates.org/sites/default/files/2020-11/TGlivestock_env_sci_pol_paper.pdf

Industry overview

- 22 Chafin C, Larson B. Plant-based protein: parity on the horizon. [Internet]. Chicago: Kearney; c2022 [cited 2022]. Available from: <https://www.kearney.com/consumer-retail/article/-/insights/plant-based-protein-parity-on-the-horizon>
- 1 Statistics and sources of information. [Internet]. Northampton (UK): Leather Council; c2022 [cited 2022]. Available from: <https://leather-council.org/information/statistics-sources-of-information/>
- 2 Dogs slaughtered for leather. [Internet]. Norfolk (US): People for the Ethical Treatment of Animals; c2022 [cited 2022]. Available from: <https://investigations.peta.org/china-dog-leather/>
- 3 Weissman A. Is your leather from China? It might be made of dog or cat skin. [Internet]. London: The Guardian; 2016 [cited 2022]. Available from: <https://www.theguardian.com/business/2016/jul/31/dog-cat-leather-china-us-congress-trade-peta>
- 4 Labelling legislation database. [Internet]. Northampton (UK): Leather Council; c2022 [cited 2022]. Available from: <https://leather-council.org/what-we-do/labelling-descriptions-of-leather/labeling-legislation-database/>
- 5 Siegle L. Is it time to give up leather?. [Internet]. London: The Guardian; 2016 [cited 2022]. Available from: <https://www.theguardian.com/fashion/2016/mar/13/is-it-time-to-give-up-leather-animal-welfare-ethical-lucy-siegle>
- 6 Mammadova A, Masiero M, et al. Embedded deforestation: the case study of the Brazilian-Italian bovine leather trade. Forests. 2020; 11: <https://dx.doi.org/10.3390/f11040472>
- 7 Skidmore M, Mofette F, Rausch L, et al. Cattle ranchers and deforestation in the Brazilian Amazon: production, location and policies. Global Environmental Change. 2021; 68: <https://doi.org/10.1016/j.gloenvcha.2021.102280>
- 8 Leather supply chain mapping and traceability guidelines. [Internet]. Lamesa (US): Textile Exchange; 2021 [cited 2022]. Available from: <https://textileexchange.org/wp-content/uploads/2021/02/LIA-261-V0.1-Leather-Supply-Chain-Mapping-and-Traceability-Guidelines.pdf>

Introduction to a just transition beyond leather

- 1 Hakansson E, Carter N, Halliday C, et al. Under their skin. [Internet]. Melbourne: Collective Fashion Justice; 2022 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/under-their-skin>
- 2 Verkuil C, Strambo C, Hocquet R, et al. A just transition in the meat sector: why, who and how?. [Internet]. Stockholm: Stockholm Environment Institute; 2022 [cited 2023]. Available from: <https://www.sei.org/wp-content/uploads/2022/11/just-transition-meat-sector.pdf>
- 3 Morris C, Kaljonen M, Aavik K, et al. Priorities for social science and humanities research on the challenges of moving beyond animal-based food systems. Nature. 2021; 38. <https://doi.org/10.1057/s41599-021-00714-z>
- 4 Gass P. In search of just transition: examples from around the world. [Internet]. Winnipeg: IISD; 2019 [cited 2023]. Available from: <https://www.iisd.org/articles/just-transition-examples>

- 5 Hakansson E. Total ethics fashion: bringing the planet, people and animals together. [Internet]. Melbourne: Collective Fashion Justice; 2022 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/articles/total-ethics-fashion>
- 6 Global Trade Analysis Project data used in Nature Communications published article, provided by the co-author, Freund F (personal communication, uploaded following private document sharing, February 2023): <https://www.collectivefashionjustice.org/s/Subsidy-data-provided-by-Freund-F.xlsx>
- 1 Milton K. Loving nature: towards an ecology of emotion. London: Routledge. 2002.
- 2 Lee M, Karpova E, Baytar F. The effects of information on young consumers' attitudes and purchase intentions of fashion products made of fur, leather, and wool. Journal of Global Fashion Marketing. 2019; 10 (2): 177–193. <https://dx.doi.org/10.1080/20932685.2019.1577160>
- 3 Design for longevity. [Internet]. Sham Shui Po (HK): Redress; c2023 [cited 2023]. Available from: <https://www.redressdesignaward.com/academy/resources/guide/design-for-longevity>
- 4 Orzechowski K. International survey: the future is animal free. [Internet]. San Diego: Faunalytics; 2015 [cited 2023]. Available from: <https://faunalytics.org/international-survey-the-future-is-animal-free/>
- 5 New study: pandemic leads to increased demand for compassion in fashion. [Internet]. Vienna: FOUR PAWS; 2021 [cited 2023]. Available from: <https://www.four-paws.org.au/our-stories/press-releases/2021/new-study-pandemic-leads-to-increased-demand-for-compassion-in-fashion>
- 6 Brand engagement with next-gen materials: 2022 landscape. (Internet). San Francisco: Material Innovation Initiative; 2022 [cited 2023]. Available from: https://materialinnovation.org/wp-content/uploads/Next-Gen-Materials_Brand-Engagement-Report_FINAL_2-1-2022.pdf
- 7 PurePoll consumer polling commissioned by CFJ. [Internet]. Melbourne: Collective Fashion Justice; 2023 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/s/UK-polling-summary-leather.pdf>
- 8 PurePoll consumer polling commissioned by CFJ. [Internet]. Melbourne: Collective Fashion Justice; 2023 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/s/AUS-polling-summary-leather.pdf>
- 9 Next-gen leather: Chinese consumer perceptions. (Internet). San Francisco: Material Innovation Initiative; 2021 [cited 2023]. Available from: <https://materialinnovation.org/reports/next-gen-leather-chinese-consumer-perceptions/>
- 10 Leather and the consumer. [Internet]. Northampton (UK): Leather UK; 2022 [cited 2023]. Available from: https://leatheruk.org/wp-content/uploads/2022/09/leather-survey-concept_final-WEB.pdf
- 11 Hakansson E, Carter N, Coen L, et al. Under their skin: leather's impact on the planet. [Internet]. Melbourne: Collective Fashion Justice; 2022 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/under-their-skin>
- 12 New consumer research shows broad US demand for next-gen materials. (Internet). San Francisco: Material Innovation Initiative; 2021 [cited 2023]. Available from: <https://materialinnovation.org/wp-content/uploads/US-Consumer-Preference-Press-Release-September-2021.pdf>

Shifting perceptions on leather

Fashion industry transition and the future of leather

- 1 Hakansson E, Carter N, Coen L, et al. Under their skin: leather's impact on the planet. [Internet]. Melbourne: Collective Fashion Justice; 2022 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/under-their-skin>
- 2 Synthetics. [Internet]. Melbourne: Collective Fashion Justice; 2022 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/synthetics>
- 3 Assessing our impact: the carbon footprint of MIRUM. [Internet]. Illinois: Natural Fiber Welding; 2022 [cited 2023]. Available from: <https://blog.naturalfiberwelding.com/mirum-lca-carbon-footprint>
- 4 Leather carbon footprint. Vienna: UNIDO Leather Panel; 2021 [cited 2022]. Available from: https://leatherpanel.org/sites/default/files/publications-attachments/leather_carbon_footprint_p.pdf
- 5 2021 state of the industry report: next-gen materials. (Internet). San Francisco: Material Innovation Initiative; 2022 [cited 2023]. Available from: <https://materialinnovation.org/reports/state-of-the-industry-report-next-gen-materials/>
- 6 2022 state of the industry report: next-gen materials. (Internet). San Francisco: Material Innovation Initiative; 2023 [cited 2023]. Available from: <https://materialinnovation.org/reports/2022-state-of-the-industry-report-next-gen-materials/>
- 7 Innovator database. (Internet). San Francisco: Material Innovation Initiative; c2023 [cited 2023]. Available from: <https://materialinnovation.org/next-gen-innovation-databases/innovators-database/>
- 8 2022 state of the industry report: next-gen materials. (Internet). San Francisco: Material Innovation Initiative; 2023 [cited 2023]. Available from: <https://materialinnovation.org/reports/2022-state-of-the-industry-report-next-gen-materials/>

What makes leather 'leather'?

- 1 Hakansson E, Carter N, Coen L, et al. Under their skin: leather's impact on the planet. [Internet]. Melbourne: Collective Fashion Justice; 2022 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/under-their-skin>
- 2 Mohamed N, Hassan N, et al. An investigation into the physical and functional properties and sew ability of faux leather. International Design Journal. 2015; 5: 2. 517–524. Available from: https://journals.ekb.eg/article_101807_f236883653adf3e2b9e46bc5ce13f786.pdf
- 3 Král I, Schméi F, Buljan J. The future of leather. Vienna: UNIDO Leather Panel; 2014 [cited 2022]. Available from: https://leatherpanel.org/sites/default/files/publications-attachments/future_for_leather_final.pdf
- 4 Paton E. Why does fashion love this radical anticapitalist concept?. [Internet]. New York: The New York Times; 2022 [cited 2023]. Available from: <https://www.nytimes.com/2022/11/17/fashion/degrowth.html>
- 5 Nicholas Kirkwood. [Internet]. London: Nicholas Kirkwood; 2023 [cited 2023]. Available from: <https://www.nicholaskirkwood.com/>
- 6 Nicholas Kirkwood direct quote (personal communication, February, 2023).
- 7 Bai C, Dallasega P, Orzes G, et al. Industry 4.0 technologies assessment: a sustainability perspective. International Journal of Production Economics. 2020; 229: 107776. Available from: <https://www.sciencedirect.com/science/article/pii/S0925527320301559?via%3Dihub>

Currently available and scaling leather alternatives

- 1 Innovator database. (Internet). San Francisco: Material Innovation Initiative; c2023 [cited 2023]. Available from: <https://materialinnovation.org/next-gen-innovation-databases/innovators-database/>
- 2 Mangalmurti D. Made with soul: Atma Leather solves problems at the intersection of South Asia and sustainability with banana fiber 'leather'. [Internet]. New Haven (US): Yale Macmillan Center; 2022 [cited 2023]. Available from: <https://southasia.macmillan.yale.edu/news/made-soul-atma-leather-solves-problems-intersection-south-asia-and-sustainability-banana-fiber>
- 3 Bain M, Kennedy J. Why bio-fabricated leather is always just around the corner. [Internet]. London: Business of Fashion; 2022 [cited 2023]. Available from: <https://www.businessoffashion.com/articles/technology/why-bio-fabricated-leather-is-always-just-around-the-corner/>
- 4 AppleSkin and other sustainable materials. [Internet]. Niedersachsen (DE): Nuuwai; c2023 [cited 2023]. Available from: <https://www.nuuwai.com/pages/materials>
- 5 LuckyNelly. [Internet]. Amsterdam: Material District; c2023 [cited 2023]. Available from: <https://materialdistrict.com/brand/luckynelly-berlin/>
- 6 Kent S. The truth about 'vegan leather'. [Internet]. London: Business of Fashion; 2022 [cited 2023]. Available from: <https://www.businessoffashion.com/articles/sustainability/vegan-leather-plastic-mycelium-mushroom-innovation-material-sustainability/>

Brand benefits of a transition beyond leather

- 1 Brand engagement report: 100+ brands adopting next-gen materials. (Internet). San Francisco: Material Innovation Initiative; 2022 [cited 2023]. Available from: <https://materialinnovation.org/brand-engagement-report/>
- 2 Anderson J. Impact of corporate commitments on public attitudes. [Internet]. San Diego: Faunalytics; 2019 [cited 2023]. Available from: <https://faunalytics.org/impact-of-corporate-commitments-on-public-attitudes/>
- 3 Webb B. Brutal honesty: the new look sustainable marketing. [Internet]. London: Vogue Business; 2021 [cited 2023]. Available from: <https://www.voguebusiness.com/sustainability/brutal-honesty-the-new-look-sustainable-marketing-ace-and-tate>
- 4 PR reporting tool with automated metrics. [Internet]. Brighton (UK): CoverageBook; 2023 [tool used and data retrieved on March 17, 2023]. Available from: <https://coveragebook.com/>
- 5 Abdulla H. Bolt Threads Greener Pastures Initiative rewards shift from animal leathers. [Internet]. London: Just Style; 2022 [cited 2023]. Available from: <https://www.just-style.com/news/bolt-threads-greener-pastures-initiative-rewards-shift-from-animal-leathers/>
- 6 Who we are. [Internet]. Guangzhou (CH): Veshin; c2023 [cited 2023]. Available from: <https://veshinfactory.com/about-us-our-story/>
- 7 Mohamed N, Hassan N, et al. An investigation into the physical and functional properties and sew ability of faux leather. International Design Journal. 2015; 5: 2. 517-524. Available from: https://journals.ekb.eg/article_101807_f236883653adf3e2b9e46bc5ce13f786.pdf
- 8 Král I, Schmél F, Buljan J. The future of leather. Vienna: UNIDO Leather Panel; 2014 [cited 2022]. Available from: https://leatherpanel.org/sites/default/files/publications-attachments/future_for_leather_final.pdf
- 9 Hakansson E, Carter N, Coen L, et al. Under their skin: leather's impact on the planet. [Internet]. Melbourne: Collective Fashion Justice; 2022 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/under-their-skin>

Leather supply chain just transition possibilities

- 10 Casey Dworkin interview (personal communication, February 3, 2023).
- 1 Carrington D. Nearly all global farm subsidies harm people and planet – UN. [Internet]. London: Guardian; 2021 [cited 2023]. Available from: <https://www.theguardian.com/environment/2021/sep/14/global-farm-subsidies-damage-people-planet-un-climate-crisis-nature-inequality>
- 2 A multi-billion-dollar opportunity – repurposing agricultural support to transform food systems. Rome: FAO, UNDP, UNEP; 2021. <https://doi.org/10.4060/cb6562en>
- 3 The economics of biodiversity: the Dasgupta review. [Internet]. London: Gov.uk; 2021 [cited 2023]. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/957629/Dasgupta_Review_-_Headline_Messages.pdf
- 4 Springmann M. Meat and dairy gobble up farming subsidies worldwide, which is bad for your health and the planet. [Internet]. Melbourne: The Conversation; 2022 [cited 2023]. Available from: <https://theconversation.com/meat-and-dairy-gobble-up-farming-subsidies-worldwide-which-is-bad-for-your-health-and-the-planet-174644>
- 5 Springmann M, Freund F. Options for reforming agricultural subsidies from health, climate, and economic perspectives. Nature Communications. 2022; 13: 82. <https://doi.org/10.1038/s41467-021-27645-2>
- 6 Hot money. [Internet]. New York: Changing Markets Foundation; 2023 [cited 2023]. Available from: <http://changingmarkets.org/wp-content/uploads/2023/01/Hot-Money-Report-1.pdf>
- 7 Global Trade Analysis Project data used in Nature Communications published article, provided by the co-author, Freund F (personal communication, uploaded following private document sharing, February 2023): <https://www.collectivefashionjustice.org/s/Subsidy-data-provided-by-Freund-F.xlsx>
- 8 Statistics and sources of information. [Internet]. Northampton (UK): Leather Council; c2022 [cited 2022]. Available from: <https://leather-council.org/information/statistics-sources-of-information/>
- 9 World statistical compendium for raw hides and skins, leather and leather footwear 1998-2014. [Internet]. Rome: FAO; 2015 [cited 2023]. Available from: <https://www.fao.org/publications/card/en/c/b1ab57c1-d0c9-40de-9555-/>
- 10 About. [Internet]. Sydney: LiveCorp; c2023 [cited 2023]. Available from: <https://livecorp.com.au/about>
- 11 Sharma M. Modi slammed UPA for subsidising slaughterhouses, but his govt gave them 33% more money. [Internet]. New Delhi: The Print; 2019 [cited 2023]. Available from: <https://theprint.in/india/governance/modi-slammed-upa-for-subsidising-slaughterhouses-but-his-govt-gave-them-33-more-money/329800/>
- 12 Soy. [Internet]. Washington: Agricultural Fairness Alliance; 2020 [cited 2023]. Available from: <https://agriculturefairnessalliance.org/news/soy/>
- 13 Feeding the problem. [Internet]. Brussels: Greenpeace; 2019 [cited 2023]. Available from: <https://www.greenpeace.org/static/planet4-eu-unit-stateless/2019/02/83254ee1-190212-feeding-the-problem-dangerous-intensification-of-animal-farming-in-europe.pdf>

- 14 Verkuil C, Strambo C, Hocquet R, et al. A just transition in the meat sector: why, who and how? [Internet]. Stockholm: Stockholm Environment Institute; 2022 [cited 2023]. Available from: <https://www.sei.org/wp-content/uploads/2022/11/just-transition-meat-sector.pdf>
- 15 British carbon tax leads to 93% drop in coal-fired electricity. [Internet]. Washington: Phys.org; 2020 [cited 2023]. Available from: <https://phys.org/news/2020-01-british-carbon-tax-coal-fired-electricity.html>
- 16 Hepburn C, Funke F. A meat tax is probably inevitable – here's how it could work. [Internet]. Melbourne: The Conversation; 2022 [cited 2023]. Available from: <https://theconversation.com/a-meat-tax-is-probably-inevitable-heres-how-it-could-work-188023>
- 17 Solomon M. Inflation Reduction Act benefits: billions in just transition funding for coal communities. [Internet]. Jersey City: Forbes; 2022 [cited 2023]. Available from: <https://www.forbes.com/sites/energyinnovation/2022/08/24/inflation-reduction-act-benefits-billions-in-just-transition-funding-for-coal-communities/?sh=74a666916ebd>
- 18 Moore K. Report shows customers want responsible fashion, but don't want to pay for it. What should brands do?. [Internet]. Jersey City: Forbes; 2019 [cited 2023]. Available from: <https://www.forbes.com/sites/kaleighmoore/2019/06/05/report-shows-customers-want-responsible-fashion-but-dont-want-to-pay-for-it/?sh=7027e30f1782>
- 1 Tubb C, Seba T. Rethinking food and agriculture 2020-2030. [Internet]. London: RethinkX; 2019 [cited 2023]. Available from: <https://static1.squarespace.com/static/585c3439be65942f022bbf9b/t/5d7fe0e83d119516bfc0017e/1568661791363/RethinkX+Food+and+Agriculture+Report.pdf>
- 2 Tubb C. Animal agriculture doesn't stand a chance. [Internet]. Cheshire: Innovation Textiles; 2022 [cited 2023]. Available from: <https://www.innovationintextiles.com/interviews/animal-agriculture-doesnt-stand-a-chance/>
- 3 Morse A. Early review of the new farming programme. [Internet]. London: National Audit Office; 2019 [cited 2023]. Available from: <https://www.nao.org.uk/wp-content/uploads/2019/06/Early-review-of-the-new-farming-programme.pdf>
- 4 Farm support, the new environmental land management system and the funding gap – Reports 1 and 2. [Internet]. London: Strutt and Parker; 2019 [cited 2023]. Available from: https://2391de4ba78ae59a71f3-fe3f5161196526a8a7b5af72d4961ee5.ssi.cf3.rackcdn.com/9515/6076/7972/Info_2019___farming___Farm_support_the_new_Environmental_Land_Management_Scheme_and_the_funding_Final.pdf
- 5 Verkuil C, Strambo C, Hocquet R, et al. A just transition in the meat sector: why, who and how? [Internet]. Stockholm: Stockholm Environment Institute; 2022 [cited 2023]. Available from: <https://www.sei.org/wp-content/uploads/2022/11/just-transition-meat-sector.pdf>
- 6 Thriving beyond the protein transition. [Internet]. Aberdeenshire (SCT): Stockfree Farming; 2022 [cited 2023]. Available from: https://s3-ap-southeast-2.amazonaws.com/os-data-2/farmta/documents/thriving_beyond_the_protein_transition.pdf
- 7 Brexit, beef and beans: transforming Britain's food-system. [Internet]. London: The Vegan Society; 2019 [cited 2023]. Available from: <https://www.vegansociety.com/about-us/research/research-news/brexit-beef-and-beans-transforming-britain's-food-system>

Transitioning farmlands and workers

- 8 EU must help animal farmers transition to plant-crop farming to benefit from plant-based boom, experts tell MEPs. [Internet]. Brussels: Humane Society International; 2019 [cited 2023]. Available from: <https://www.hsi.org/news-media/eu-plant-crop-farming-031119/>
- 9 Streeter S. Farmers may care for animals, but they can't say so. [Internet]. San Diego: Faunalytics; 2021 [cited 2023]. Available from: <https://faunalytics.org/farmers-may-care-for-animals-but-they-cant-say-so/>
- 10 Transfarmation. [Internet]. Los Angeles; c2023 [cited 2023]. Available from: <https://thetransformationproject.org>
- 11 Farm Transitions Australia [Internet]. (Hobart) (AU); c2023 [cited 2023]. Available from: <https://www.farmtransitionsaustralia.org/>
- 12 Successful transitions. [Internet]. Los Angeles; c2023 [cited 2023]. Available from: <https://thetransformationproject.org/our-farmers/halley-farms-successful-chicken-to-hemp-transformation/>
- 13 New report from The Vegan Society shows plant-based food system is needed now to save lives and hit climate targets. [Internet]. London: The Vegan Society; 2021 [cited 2023]. Available from: <https://www.vegansociety.com/news/news/new-report-vegan-society-shows-plant-based-food-system-needed-now-save-lives-and-hit-climate-targets>
- 14 Krystal Camilleri interview (personal communication, February 12, 2023).
- 15 Newton P, Blaustein-Rejto D. Social and economic opportunities and challenges of plant-based and cultured meat for rural producers in the US. *Frontiers in Sustainable Food Systems*. 2021; 5. <https://doi.org/10.3389/fsufs.2021.624270>
- 16 Mike Lanigan and Edith Barabash transformed a cattle ranch into a vegetable farm. [Internet]. Los Angeles; c2023 [cited 2023]. Available from: <https://thetransformationproject.org/other-farmers/mike-lanigan-and-edith-barabash-transformed-a-cattle-ranch-into-a-vegetable-farm/#farmer-heading>
- 17 How the Faaborg family is changing the future of farming in Iowa. [Internet]. Los Angeles; c2023 [cited 2023]. Available from: <https://thetransformationproject.org/our-farmers/how-the-faaborg-family-is-changing-the-future-of-farming-in-iowa/#farmer-heading>
- 18 Craig Watts is transforming his former poultry farm. [Internet]. Los Angeles; c2023 [cited 2023]. Available from: <https://thetransformationproject.org/our-farmers/craig-watts-is-transforming-his-former-poultry-farm/#farmer-heading>
- 19 Videle J. Deconstructing animal exploitation in the US, one study at a time. [Internet]. San Diego: Faunalytics; 2018 [cited 2023]. Available from: <https://faunalytics.org/farmers-may-care-for-animals-but-they-cant-say-so/>
- 20 Hakansson E, Carter N, Coen L, et al. Under their skin: leather's impact on the planet. [Internet]. Melbourne: Collective Fashion Justice; 2022 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/under-their-skin>
- 21 Leather alternatives. [Internet]. Melbourne: Collective Fashion Justice; c2023 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/leather-alternatives>
- 22 Wilson C. Demand increases for produce solution for imperfect fruit seconds. [Internet]. Sydney: Stockfree Farming; 2023 [cited 2023]. Available from: <https://www.abc.net.au/news/rural/2023-02-19/imperfect-produce-solution-for-fruit-seconds/101985508>

- 23 Economy and just work. [Internet]. London: The Vegan Society; c2021 [cited 2023]. Available from: <https://www.plantingvalueinfood.org/#fnote7>
- 24 Farming. [Internet]. Sydney: Animal Justice Party; c2023 [cited 2023]. Available from: <https://www.animaljusticeparty.org/farming>
- 25 Hakansson E, Vance U. Under their skin: leather's impact on people. [Internet]. Melbourne: Collective Fashion Justice; 2022 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/under-their-skin>
- 26 Jorge Cajacuri shared Amazkin documents (personal communication, February 2, 2023).
- 27 Morais-da-Silva R, Villar E, Reis G, et al. The expected impact of cultivated and plant-based meats on jobs: the views of experts from Brazil, the United States and Europe. 2022; 9: 297. <https://doi.org/10.1057/s41599-022-01316-z>
- 28 Decent work in nature-based solutions 2022. [Internet]. Geneva: ILO, UNEP, IUCN; 2022 [cited 2023]. Available from: https://www.ilo.org/wcmsp5/groups/public/--ed_emp/documents/publication/wcms_863035.pdf
- 29 Respecting our culture certification. [Internet]. Brisbane: Ecotourism Australia; c2023 [cited 2023]. Available from: <https://www.ecotourism.org.au/our-certification-programs/eco-certification-3>
- 30 Souza H, Garcia E. Indigenous Peoples are essential to forest conservation and the bioeconomy. [Internet]. Arlington: The Nature Conservancy; 2021 [cited 2023]. Available from: <https://www.nature.org/en-us/about-us/where-we-work/latin-america/brazil/stories-in-brazil/indigenous-are-essential-to-forest-conservation/>
- 31 Zeppel H. Indigenous ecotourism: sustainable development and management. Wallingford (UK); CABI Publishing. 2006.
- 32 Carrington D. Environment to benefit from 'biggest farming shake-up in 50 years'. [Internet]. London: The Guardian; 2020 [cited 2023]. Available from: <https://www.theguardian.com/environment/2020/nov/30/environment-to-benefit-from-biggest-farming-shake-up-in-50-years>
- 33 US study shows widening disconnect with nature, and potential solution. [Internet]. New Haven (US): Yale Environment; 2017 [cited 2023]. Available from: <https://e360.yale.edu/digest/u-s-study-shows-widening-disconnect-with-nature-and-potential-solutions>
- 34 Graham D. City-dwellers increasingly disconnected with nature, reveals poll. [Internet]. Bristol: Countryfile; 2017 [cited 2023]. Available from: <https://www.countryfile.com/go-outdoors/city-dwellers-increasingly-disconnected-with-nature-reveals-poll/>
- 35 Gelsthorpe J. Disconnect from nature and its effect on health and well-being. [Internet]. London: Natural History Museum; 2017 [cited 2023]. Available from: <https://application.synthesys.info/content/dam/nhmwww/about-us/visitor-research/Disconnect%20with%20nature%20Lit%20review.pdf>
- 36 Kesebir S, Kesebir P. How modern life became disconnected from nature. [Internet]. Berkeley: Greater Good Magazine; 2017 [cited 2023]. Available from: https://greatergood.berkeley.edu/article/item/how_modern_life_became_disconnected_from_nature
- 37 Kesebir S, Kesebir P. A growing disconnection from nature is evident in cultural products. Perspectives on Psychological Science. 2017; 12: 2. 258–269. <http://doi.org/10.1177/1745691616662473>

- 38 Robbins J. Ecopsychology: how immersion in nature benefits your health. [Internet]. New Haven (US): Yale Environment; 2020 [cited 2023]. Available from: <https://e360.yale.edu/features/ecopsychology-how-immersion-in-nature-benefits-your-health>
- 39 Weir K. Nurtured by nature. [Internet]. Washington: American Psychological Association; 2020 [cited 2023]. Available from: <https://www.apa.org/monitor/2020/04/nurtured-nature>
- 40 Levitt T. Netherlands announces €25bn plan to radically reduce livestock numbers. [Internet]. London: The Guardian; 2021 [cited 2023]. Available from: <https://www.theguardian.com/environment/2021/dec/15/netherlands-announces-25bn-plan-to-radically-reduce-livestock-numbers>
- 41 Land rights. [Internet]. Canberra: AIATSIS; c2023 [cited 2023]. Available from: <https://aiatsis.gov.au/explore/land-rights>
- 42 Smeed B. Indigenous traditional owners win back Daintree rainforest in historic deal. [Internet]. London: The Guardian; 2021 [cited 2023]. Available from: <https://www.theguardian.com/australia-news/2021/sep/29/indigenous-traditional-owners-win-back-daintree-rainforest-in-historic-deal>
- 43 Jones L. Over 200 hectares of California redwood forest returned to Indigenous owners. [Internet]. Ultimo (AU): Planet Ark; 2022 [cited 2023]. Available from: <https://planetark.org/newsroom/news/over-200-hectares-of-california-redwood-forest-returned-to-indigenous-owners>
- 44 Elisabeth A, Jong H. In first for Indonesia, government recognizes Indigenous Papuans' ancestral forests. [Internet]. Menlo Park (US): Mongabay; 2022 [cited 2023]. Available from: <https://news.mongabay.com/2022/12/in-first-for-indonesia-government-recognizes-indigenous-papuans-ancestral-forests/>
- 45 Brown K. 'We go in and take Indigenous lands back from cattle ranchers': Q&A with activist Pablo Sibar. [Internet]. Menlo Park (US): Mongabay; 2022 [cited 2023]. Available from: <https://news.mongabay.com/2022/11/we-go-in-and-take-indigenous-land-back-from-cattle-ranchers-qa-with-activist-pablo-sibar/>
- 46 Livingstone A, Wilson C, Vince A, et al. An investment in nature is an investment in our future. [Internet]. Melbourne: Defend the Wild; 2023 [cited 2023]. Available from: defendthewild.org/invest-in-our-future
- 47 Barker E. Concerns raised over Plibersek's plan to "lock up" land. [Internet]. Bulimba (AU): Beef Central; 2022 [cited 2023]. Available from: <https://www.beefcentral.com/news/concerns-raised-over-pliberseks-plan-to-lock-up-land/>
- 48 Sustainable farms mental health research report. [Internet]. Canberra (AU): Australian National University; 2022 [cited 2023]. Available from: https://www.sustainablefarms.org.au/wp-content/uploads/2022/10/Mental-Health-Report-2022_Summary.pdf
- 49 How climate change affects mental health in Australia. [Internet]. Melbourne: Doctors for the Environment; 2021 [cited 2023]. Available from: <https://www.dea.org.au/wp-content/uploads/2021/10/Report-How-Climate-Change-Affects-Mental-Health-in-Australia-v3-1.pdf>
- 50 First national study of farmer suicide rates using coronial data. [Internet]. Deakin (AU): National Rural Health Alliance; 2021 [cited 2023]. Available from: <https://www.ruralhealth.org.au/news/first-national-study-farmer-suicide-rates-using-coronial-data>
- 51 Shourthouse M, Stone L. Inequity amplified: climate change, the Australian farmer, and mental health. Medical Journal of Australia; 2018. 209: 4. Available from: https://www.mja.com.au/system/files/issues/209_04/10.5694/mja18.00624.pdf

- 52 Lombardo C, Negus C, Troy D, et al. Nature: how connecting with nature benefits our mental health. [Internet]. London: Mental Health Foundation; 2022 [cited 2023]. Available from: <https://www.mentalhealth.org.uk/sites/default/files/2022-06/MHAW21-Nature-research-report.pdf>
- 53 Creating shared value: the business imperative to improve mental health in Australia. [Internet]. Melbourne: Shared Value Project; 2019 [cited 2023]. Available from: <https://sharedvalue.org.au/wp-content/uploads/2019/10/CSV-The-business-imperative-to-improve-mental-health-in-Australia.pdf>
- 1 State of the industry report: the Australian red meat and livestock industry 2022. [Internet]. Sydney: Meat and Livestock Australia; 2022 [cited 2023]. Available from: https://www.mla.com.au/globalassets/mla-corporate/prices-markets/documents/trends-analysis/soti-report/2879-mla-state-of-industry-report-2022_d6_low-res_spreads.pdf
- 2 Walljasper C. Slaughterhouses offer rural communities employment but low wages. [Internet]. Chicago: In These Times; 2018 [cited 2023]. Available from: <https://inthesetimes.com/article/slaughterhouses-employment-wages-rural-meat-maps-work>
- 3 Zhang Q, Zhanping H. Rural China under the COVID-19 pandemic: differentiated impacts, rural-urban inequality and agro-industrialization. Journal of Agrarian Change. 2020. Available from: https://ink.library.smu.edu.sg/cgi/viewcontent.cgi?article=4690&context=soas_research
- 4 Singh R. Recent status of Indian meat industry – an overview. [Internet]. Jamshedpur (IN): Pashudhan Praharee; 2022 [cited 2023]. Available from: <http://www.pashudhanpraharee.com/recent-status-of-indian-meat-industry-an-overview>
- 5 Morais-da-Silva R, Villar E, Reis G, et al. The expected impact of cultivated and plant-based meats on jobs: the views of experts from Brazil, the United States and Europe. 2022; 9: 297. <https://doi.org/10.1057/s41599-022-01316-z>
- 6 Wu J-R, Holmes G, DeWalt D, et al. Low literacy is associated with increased risk of hospitalization and death among individuals with heart failure. Journal of General Internal Medicine. 2013; 28 (9): 1174–1180. <https://doi.org/10.1007%2F11606-013-2394-4>
- 7 DeWalt D, Berkman N, Sheridan S, et al. Literacy and health outcomes: a systematic review of the literature. Journal of General Internal Medicine. 2005; 19 (12): 1228–1239. <http://dx.doi.org/10.1111/j.1525%E2%80%93931497.2004.40153.x>
- 8 Decent work in nature-based solutions 2022. [Internet]. Geneva: ILO, UNEP, IUCN; 2022 [cited 2023]. Available from: https://www.ilo.org/wcmsp5/groups/public/-/ed_emp/documents/publication/wcms_863035.pdf
- 9 Brave New Life Project. [Internet]. (US): Brave New Life Project; c2023 [cited 2023]. Available from: <https://www.bravenewlife.org>
- 10 Brave New Life Project: Our first client has been a joy to work with. [Internet]. (US): Instagram; 2022 [cited 2023]. Available from: <https://www.instagram.com/p/CiREpogsXr2/>
- 11 Tubb C, Seba T. Rethinking food and agriculture 2020-2030. [Internet]. London: RethinkX; 2019 [cited 2022]. Available from: <https://static1.squarespace.com/static/585c3439be65942f022bbf9b/t/5d7fe0e83d19516bfc0017e/1568661791363/RethinkX+Food+and+Agriculture+Report.pdf>
- 12 Employment. [Internet]. Melbourne: Animal Justice Party Victoria; c2023 [cited 2023]. Available from: <https://vic.animaljusticeparty.org/employment>

Shifting beyond slaughterhouse work

- 13 Hakansson E, Vance U. Under their skin: leather's impact on people. [Internet]. Melbourne: Collective Fashion Justice; 2022 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/under-their-skin>
- 14 Taete J. How do you sleep at night? An interview with a slaughterhouse worker. [Internet]. New York: Mic; 2022 [cited 2023]. Available from: <https://www.mic.com/impact/how-do-you-sleep-at-night-interview-with-a-slaughterhouse-worker>
- 15 Lastrucci G. The shocking statements of a former slaughterhouse worker. [Internet]. London: Animal Equality UK; 2021 [cited 2023]. Available from: <https://animalequality.org.uk/blog/2021/12/14/the-shocking-statements-of-a-former-slaughterhouse-worker/>
- 16 Slaughterhouse workers. [Internet]. Melbourne: Collective Fashion Justice; c2023 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/slaughterhouse-workers>
- 17 Interview with Craig Whitney (personal communication, September, 2020).
- 18 Economic cost of violence against women and their children. [Internet]. Canberra: Australian Government Department of Social Services; 2009 [cited 2023]. Available from: <https://www.dss.gov.au/our-responsibilities/women/publications-articles/reducing-violence/national-plan-to-reduce-violence-against-women-and-their-children/economic-cost-of-violence-against-women-and-their-children?HTML>
- 19 Condon J. JBS invests A\$138m in lab-based cultured animal protein venture. [Internet]. Bulimba (AU): Beef Central; 2021 [cited 2023]. Available from: <https://www.beefcentral.com/news/jbs-invests-a138m-in-lab-based-cultured-animal-protein-venture/>
- 20 Hakansson E, Carter N, Coen L, et al. Under their skin: leather's impact on the planet. [Internet]. Melbourne: Collective Fashion Justice; 2022 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/under-their-skin>
- 21 Carbon tax basics. [Internet]. Arlington: Center for Climate and Energy Solutions; c2023 [cited 2023]. Available from: <https://www.c2es.org/content/carbon-tax-basics/>
- 1 Leather tanning and finishing in the US - employment statistics 2003–2028. [Internet]. Los Angeles: IBIS World; 2022 [cited 2023]. Available from: <https://www.ibisworld.com/industry-statistics/employment/leather-tanning-finishing-united-states/>
- 2 Number of employees of the leather tanning industry in Italy from 2015 to 2018. [Internet]. Hamburg: Statista; 2019 [cited 2023]. Available from: <https://www.statista.com/statistics/737406/number-of-employees-of-the-leather-tanning-industry-in-italy/>
- 3 Leather sourcing delegation to Brazil and Argentina. [Internet]. Chennai (IN): Leather India; 2014 [cited 2023]. Available from: <https://leatherindia.org/wp-content/uploads/2015/07/spe-feature.pdf>
- 4 Why should you admire Brazilian leather?. [Internet]. Wanchai (HK): APLF; 2022 [cited 2023]. Available from: <https://www.aplf.com/2022/08/24/why-should-you-admire-brazilian-leather/#:~:text=Brazilian%20tanneries%20work%20with%20high,on%20tanning%20hides%20in%20Brazil>
- 5 China leather tanning processing: number of employee: average. [Internet]. New York: CEIC; c2023 [cited 2023]. Available from: <https://www.ceicdata.com/en/china/leather-fur-feather-and-its-product-and-shoes-leather-tanning-processing/cn-leather-tanning-processing-no-of-employee-average>

Reimagining and moving beyond tannery work

- 6 Textile, clothing, footwear and leather sectors in Russia and north-west region. [Internet]. St Petersburg: Flanders Investment and Trade; 2017 [cited 2023]. Available from: https://www.flandersinvestmentandtrade.com/export/sites/trade/files/market_studies/2017-Russia-Clothing-textile-sector_1.pdf
- 7 Korea number of workers: mfg: tanning and dressing of leather, luggage. [Internet]. New York: CEIC; c2023 [cited 2023]. Available from: <https://www.ceicdata.com/en/korea/no-of-workers-ksic-9th-revision-annual/no-of-workers-mfg-tanning-dressing-of-leather-luggage>
- 8 Hoefe R. Do leather workers matter?. [Internet]. Utrecht (NL): India Committee of the Netherlands; 2017 [cited 2023]. Available from: <http://www.indianet.nl/pdf/DoLeatherWorkersMatter.pdf>
- 9 Tanning and finishing of leather and leather in Mexico. [Internet]. Mexico City: Market Data Mexico; c2023 [cited 2023]. Available from: <https://www.marketdatamexico.com/en/article/Tanning-and-finishing-of-leather-and-leather-in-Mexico>
- 10 Schröder A. Giving labour rights the boot. [Internet]. Berlin: INKOTA; 2017 [cited 2023]. Available from: http://labourbehindthelabel.net/wp-content/uploads/2017/08/Change_Your_Shoes_Report_Turkey_Giving_Labor_Rights_the_Boot.pdf
- 11 Skills for green jobs in Bangladesh. [Internet]. Geneva: ILO; 2018 [cited 2023]. Available from: https://www.ilo.org/wcmsp5/groups/public/--asia/--ro-bangkok/--ilo-dhaka/documents/publication/wcms_694947.pdf
- 12 Hakansson E, Carter N, Coen L, et al. Under their skin: leather's impact on the planet. [Internet]. Melbourne: Collective Fashion Justice; 2022 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/under-their-skin>
- 13 Mycoworks. [Internet]. Emeryville (US): MycoWorks; c2023 [cited 2023]. Available from: <https://www.mycoworks.com/our-products>
- 14 James D. Leather tannery Ecco partners with mycelium material brand Ecovative. [Internet]. Washington: RetailDive; 2022 [cited 2023]. Available from: <https://www.retaildive.com/news/leather-tannery-ecco-partners-with-mycelium-material-brand-ecovative/636340/>
- 15 Westall M. Balenciaga presents first time EPHEA™ has ever been applied to fashion. [Internet]. London: Fad Magazine; 2022 [cited 2023]. Available from: <https://fadmagazine.com/2022/10/27/balenciaga-presents-first-time-ephea-has-ever-been-applied-to-fashion/>
- 16 Next-generation mycelium materials meet traditional leather craft. [Internet]. Green Island (US): Ecovative; c2023 [cited 2023]. Available from: <https://shop.ecovative.com/blogs/blog/traditional-leather-craft-meets-next-generation-mycelium-materials>
- 17 World leading leather tannery's partnership with Bolt Threads marks its first foray into alt leather in 100 years. [Internet]. Dinklage (DE): Vegconomist; 2021 [cited 2023]. Available from: <https://vegconomist.com/fashion-design-and-beauty/leather-alternatives/world-leading-leather-tannerys-partnership-with-bolt-threads-marks-its-first-foray-into-alt-leather-in-100-years/>
- 18 Roberts J. Ecco leather partners with Ecovative to produce mycelium products at scale. [Internet]. New York: Futurevorld; 2022 [cited 2023]. Available from: <https://futurevorld.com/design/ecco-leather-ecovative-mycelium-leather-alternatives-vegan-partnership/>
- 19 Pradeep S, Sundaramoorthy S, Sathish M, et al. Chromium-free and waterless vegetable-aluminium tanning system for sustainable leather manufacture. Chemical Engineering Journal Advances. 2021; 7. <https://doi.org/10.1016/j.cej.2021.100108>

- 20 Get the facts. [Internet]. Cleveland: Leather Naturally; c2023 [cited 2023]. Available from: <https://www.leathernaturally.org/Education/Fact-Sheets/Manufacturing/Summary-of-the-different-types-of-tanning>
- 21 Ward C. Tanning waste minimisation processes. [Internet]. Canberra: CSIRO; 2011 [cited 2023]. Available from: <https://csiropedia.csiro.au/tanning-waste-minimisation-processes/>
- 22 Chrome free leather. [Internet]. Weesp: Nera tanning; c2023 [cited 2023]. Available from: <https://www.neratanning.com/chrome-free-leather/>
- 23 How vegan leather is made from mangoes. [Internet]. Rotterdam: Fruit Leather Rotterdam; c2023 [cited 2023]. Available from: <https://fruitleather.nl/introduction-2/>
- 24 Cernansky R. The race for fashion's leather alternatives heats up. [Internet]. London: Vogue Business; 2021 [cited 2023]. Available from: <https://www.voguebusiness.com/sustainability/the-race-for-fashion-leather-alternatives-heats-up>
- 25 Sandeman C. Balenciaga's first plant-based leather piece looks straight out of the Matrix. [Internet]. New York: Futurevorld; 2022 [cited 2023]. Available from: <https://futurevorld.com/fashion/balenciaga-mushroom-leather-jacket-hooded-wrap-coat-ephea-mycelium/>
- 26 Better together?. [Internet]. London: Leather Mag; 2022 [cited 2023]. Available from: <https://www.leathermag.com/features/featurebetter-together-250822-9954986/>
- 27 Hakansson E, Vance U. Under their skin: leather's impact on people. [Internet]. Melbourne: Collective Fashion Justice; 2022 [cited 2023]. Available from: <https://www.collectivefashionjustice.org/under-their-skin>
- 28 Hide and skin processing workers. [Internet]. Canberra: Australian Government Labour Market Insights; 2021 [cited 2023]. Available from: <https://labourmarketinsights.gov.au/occupation-profile/hide-and-skin-processing-workers?occupationCode=839917>
- 29 Decent work in nature-based solutions 2022. [Internet]. Geneva: ILO, UNEP, IUCN; 2022 [cited 2023]. Available from: https://www.ilo.org/wcmsp5/groups/public/--ed_emp/documents/publication/wcms_863035.pdf
- 30 Mangalmurti D. Made with soul: Atma Leather solves problems at the intersection of South Asia and sustainability with banana fiber 'leather'. [Internet]. New Haven (US): Yale Macmillan Center; 2022 [cited 2023]. Available from: <https://southasia.macmillan.yale.edu/news/made-soul-atma-leather-solves-problems-intersection-south-asia-and-sustainability-banana-fiber>

Conclusion

- 1 VERY RARE Hermes vintage shoulder bag in white Beluga leather and gold hardware. [Internet]. New York: 1st Dibs; c2023 [cited 2023]. Available from: https://www.1stdibs.com/fashion/handbags-purses-bags/shoulder-bags/very-rare-hermes-vintage-shoulder-bag-white-beluga-leather-gold-hardware/id-v_12286012/
- 2 41 jobs that don't exist anymore. [Internet]. Austin: Indeed; 2022 [cited 2023]. Available from: <https://www.indeed.com/career-advice/career-development/jobs-that-dont-exist-anymore>
- 3 About RethinkX. [Internet]. London: RethinkX; c2022 [cited 2022]. Available from: <https://www.rethinkx.com/about>
- 4 According to Arbib J (personal communication, July 7, 2022), it can take about 15 years for a new product to effectively disrupt a market.

- 5 Arbib J, Dorr A, et al. Rethinking climate change. [Internet]. London: RethinkX; 2021 [cited 2022]. Available from: <https://www.rethinkx.com/climate-implications#climate-download>
- 6 According to Rawlings N (personal communication, May 27, 2022), broad disruption will likely occur around 2040.
- 7 Tubb C, Seba T. Rethinking food and agriculture 2020-2030. [Internet]. London: RethinkX; 2019 [cited 2022]. Available from: <https://static1.squarespace.com/static/585c3439be65942f022bbf9b/t/5d7fe0e83d119516bfc0017e/1568661791363/RethinkX+Food+and+Agriculture+Report.pdf>
- 8 The evidence is clear: the time for action is now. We can halve emissions by 2030. [Internet]. Geneva: IPCC; 2022 [cited 2022]. Available from: <https://www.ipcc.ch/2022/04/04/ipcc-ar6-wgiii-pressrelease/>
- 9 Webb B. Degrowth: the future that fashion has been looking for?. [Internet]. London: Vogue Business; 2022 [cited 2022]. Available from: <https://www.voguebusiness.com/sustainability/degrowth-the-future-that-fashion-has-been-looking-for>

Full leather report

Under their skin:

A just transition beyond leather

Other reports in the series:

Leather's impact on people

Leather's impact on the planet

Leather's impact on animals

April 2023