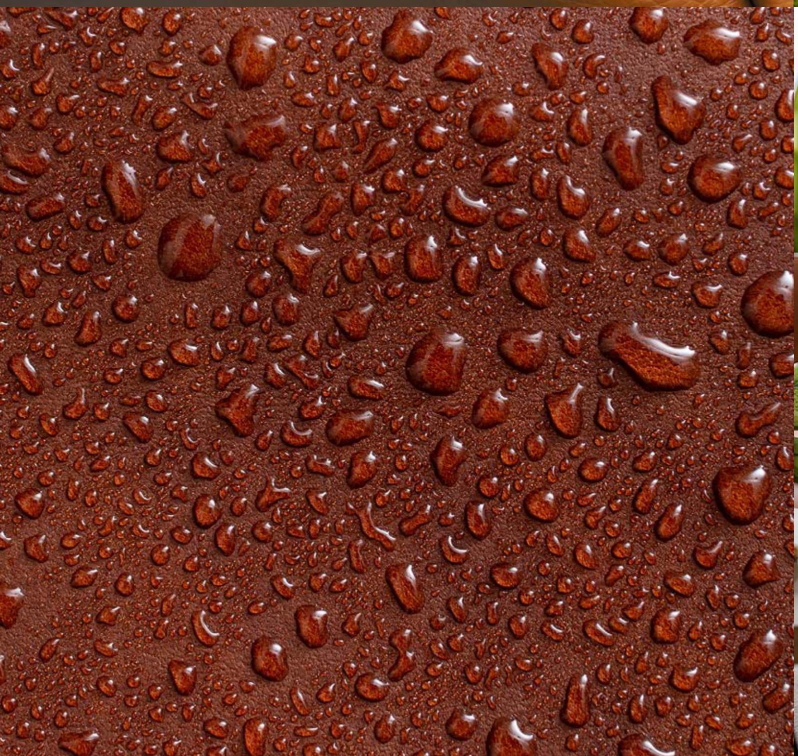
A GUIDE TO

LIFE CYCLE ASSESSMENTS (LCAS)

IN THE LEATHER INDUSTRY






1 OBJECTIVES

Welcome to this comprehensive guide on Life Cycle Assessments (LCAs) in the leather industry.

The aim of this document is to empower stakeholders across the leather industry with the knowledge and tools needed to effectively understand, interpret, and collaborate on LCAs across the value chain.

By providing clear insights into general concepts and practical tips, we hope to inspire a collective approach to assessing the environmental impact of leather production. With a special focus on cow leather, this guide also draws from a study conducted by Leather Naturally, offering accurate and actionable information to drive more informed decision-making. Let's work together on a sustainable future for leather!

2 LIFE CYCLE PERSPECTIVE

To make effective decisions and properly assess and manage the environmental impacts of a product, process, or service throughout its supply chain, it is crucial to adopt a holistic view.

A Life Cycle Perspective (LCP) provides a holistic view by considering impacts, inputs and outputs of a product, process or service beyond the Companies' own fences, including externalities caused by other stakeholders in the supply chain and covering all life cycle stages. This comprehensive perspective helps in understanding and avoiding the unintended transfer of impacts from one stage of the supply chain to another.

However, it is important to approach Life Cycle Assessments (LCAs) with caution. When not used responsibly, LCAs can contribute to greenwashing - misleading claims about environmental impacts or benefits. To avoid this, it is essential to adhere to best-in-class industry standards and methodologies, ensuring that the results are accurate, consistently transparent, and reflective of true environmental impacts.

To derive meaningful insights, LCAs must be properly interpreted. It is essential to understand the scope, unit of measurement, standards used, and various characterization factors before comparing LCA results, as the underlying assumptions can differ significantly.

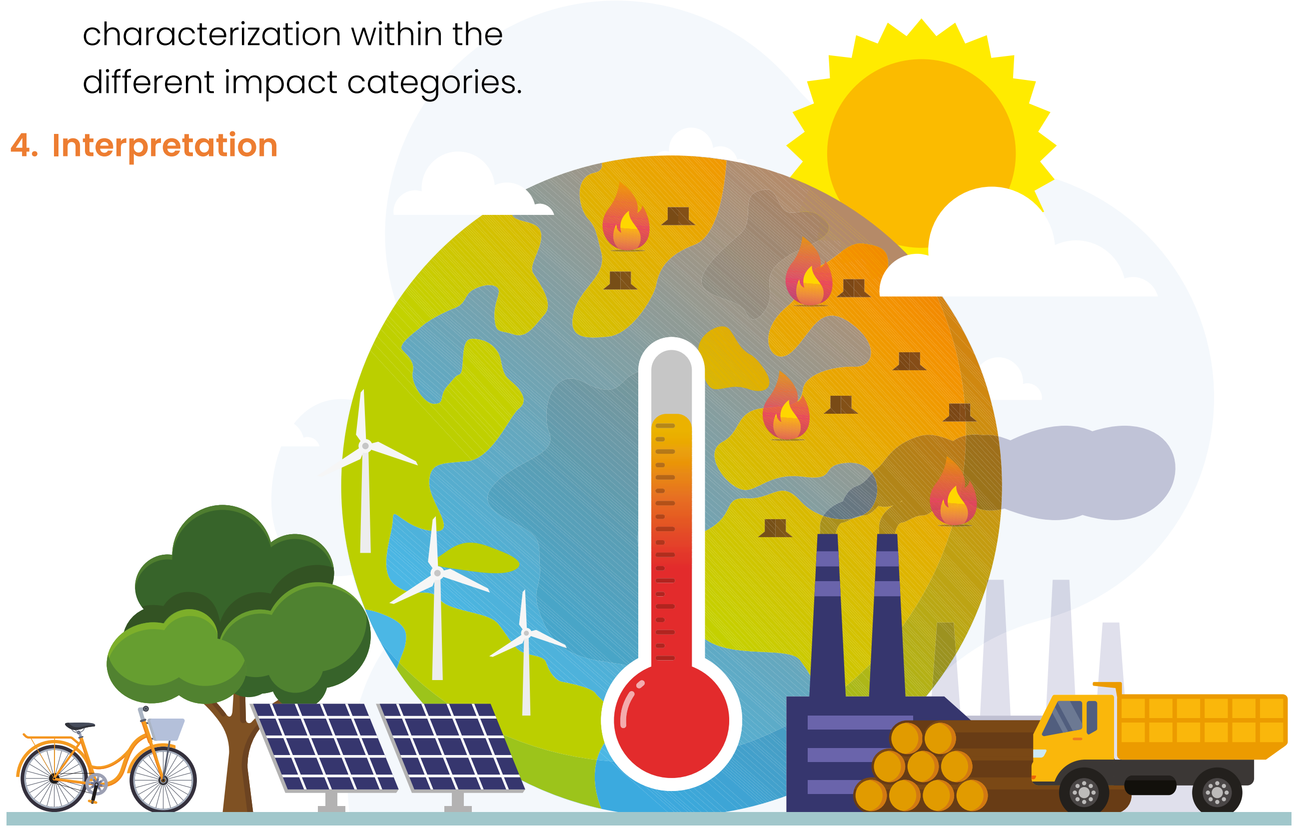
3 WHAT ARE LCAS?

LCAs are quantitative analyses to assess a broad range of environmental impacts associated with all the stages of the life cycle of a product, process, or service.

Based primarily on two International Organization for Standardization (ISO) standards (ISO 14040:2006 and ISO 14044:2006), there are well defined requirements, guidelines, and principles that allow LCAs to be used in a myriad of supply chains while providing both versality and comparability. These standards set and standardize important stages for all LCAs:

1. **Goal and Scope Definition**
2. **Life Cycle Inventory (LCI) Analysis**
    - Comprises data collection and calculation for each process in the life cycle.
3. **Life Cycle Impact Assessment (LCIA)**
    - Includes classification and characterization within the different impact categories.
4. **Interpretation**

The methodology is agnostic regarding the different environmental impacts, expressing the results independently: no impact category is more or less important than the other. Some examples of environmental impact categories are Climate Change (Global Warming Potential), Ozone Depletion, Water Use, and Freshwater Ecotoxicity.

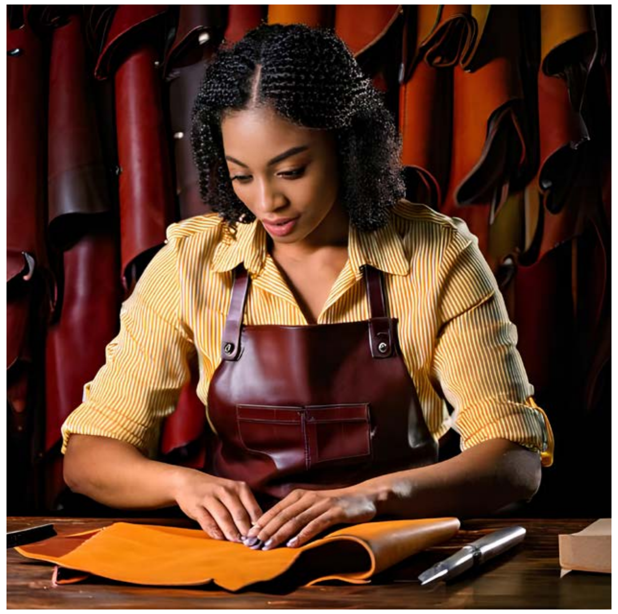


4 WHY ARE LCAS IMPORTANT?

Value chain approach

LCAs provide a holistic view of the environmental impacts associated with a product or service, considering not only the direct emissions and resource use but also indirect impacts such as transportation, energy consumption, and waste generation. By using an LCA, you can quantify and assess the environmental impacts of each stage and activity of the value chain of the respective product or service. This comprehensive analysis can help to identify where the most significant environmental impacts occur, how they are influenced by decisions and actions, and what are the potential trade-offs or synergies between different stages and activities. LCAs can also help to evaluate the environmental benefits of alternative scenarios such as changing suppliers, materials, processes, or technologies; identifying opportunities for improvement; optimizing resource use; minimizing waste; and reducing overall environmental impact throughout the entire value chain for a specific product, process or service.

In summary, LCAs provide for a value chain approach because they consider and evaluate the environmental impacts associated with all stages of a product's life cycle, from raw material extraction to disposal, enabling companies to make informed decisions and improve sustainability across the entire value chain. LCAs provide for data-driven transparency and can support in compliance and increasing regulatory demands. For example, some such regulations are the Sustainable Products Regulation (ESPR), the Digital Product Passport (DPP), the Corporate Sustainability Reporting Directive (CSRD), the Norwegian Market Control Act (MCA) in the EU, and the FTC Green Guides in the US. Please note that this is not an exhaustive list, and the regulatory environment is constantly evolving.



Why do it – as brand, but also as an upstream partner *(tannery, chemical company etc)*

Brands and upstream partners can use LCAs as a tool to show their impact to their key stakeholders and to make decisions internally about their sustainability strategy. With increased customer scrutiny on sustainability claims and increasing regulatory pressure, having evidence to back up leather's environmental impact potential can help to dispel misinformation on the impact of leather and provide primary data for your value chain. Lastly the data can help to support internal decision making on choosing lower impact materials and identifying hot spots for reducing impact at the operational level.

5 HOW LCAS ARE DONE

There are three different system boundaries to define the scope of analysis in an LCA. Each boundary outlines the extent of the life cycle stages considered in the assessment:

- **Cradle-to-gate** considers the environmental impacts from the raw material extraction (cradle) to the point where it leaves the factory gate as finished product. The use phase and disposal phase of the product are omitted in this case. When a value chain (such as leather) involves multiple parties in a sequential manner, each downstream factory gate can be assigned as the "gate" associated with the specified study.
- **Cradle-to-grave** considers the impacts from the raw material extraction (cradle) to the end of the product's life (grave). It is more comprehensive than the cradle-to-gate approach as it includes the use/ maintenance and the disposal phase of the product.
- **Cradle-to-cradle** considers the entire lifecycle of a product, including its use, disposal, and potential for recycling or reuse. It considers impacts from the raw material extraction (cradle) to when the product is recycled or reused and starts a new life cycle (cradle). It is considered the most comprehensive assessment by including of all the stages of a product's life cycle, promoting the concepts of circularity, recyclability, and reuse.

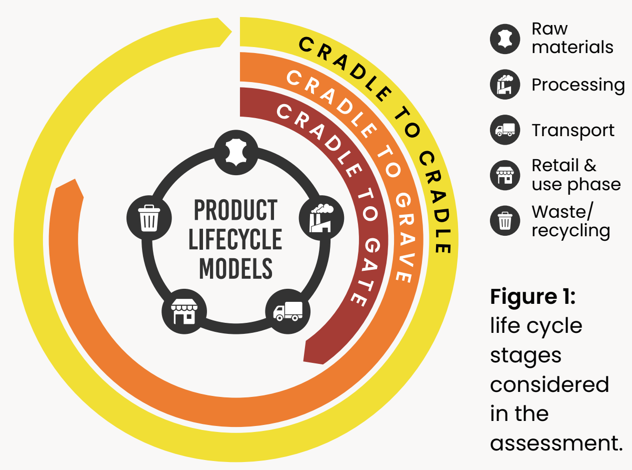


Figure 1: life cycle stages considered in the assessment.

Methodologies used:

When doing an LCA, ISO standards must be applied to assure proper calculations:

ISO 14040: 2006 Environmental management - Principles and framework.

ISO 14040 describes the key features of the LCA and outlines the phases of the analysis including: what areas of the environment should be covered, in what timeframe, the methodologies followed, and outlining parameters for transparency and public disclosure.

ISO 14044: 2006 Environmental management - Requirements and guidelines.

ISO 14044 is used in conjunction with ISO 14040 as a supplementary standard. It expands and explains the elements and approach in ISO 14040 and requires the modelling of a product or service life cycle as a system to determine environmental impacts.

Some sectorial guidance documents such as the European Commission's PEFCR (Product Environmental Footprint Category Rules) and the EPD's (Environmental Product Declaration) Product Category Rules for finished leather are also important guidance documents for leather LCAs.

Following these standards allows organizations to set the goals and scope of the LCA, model the system to be analyzed, collect the data, and report on the results. These ISO standards include the definition of the LCA, the inventory and impact phase and how to report and review the LCA results. They also have guidelines on the limitations of the LCA, the management of relationship between the phases, and options for value choices.

6 DATA TO USE

One key aspect of LCAs is recognizing that perfect data is rarely available, making it necessary to balance the use of both primary and secondary data.

Primary data refers to specific, original data that is directly collected from processes, operations, or activities within the life cycle of the product, service, or process assessed. This data is usually gathered from the company or organization involved and represents the most accurate and detailed information about the environmentally relevant inputs and outputs associated with their operations.

Secondary data refers to data that has not been directly collected from the specific processes, operations, or activities being assessed but is instead obtained from other available sources. This data is typically gathered from databases, literature, industry reports, or other studies and is used when primary data is unavailable, difficult to collect, or when assessing general trends rather than specific operations.

Choosing the right databases for specific sectors, technologies, and geographies—and ensuring they are reliable—is crucial to obtaining representative results. Some examples of commonly used databases for LCAs include:

- Ecoinvent
- Sphera (Managed LCA Content)
- Agri-footprint
- Agribalyse

ecoinvent | sphera | Agri-footprint | AGRIBALYSE

To accurately interpret LCA results, it's essential to understand the data sources, distinguishing between primary and secondary data, and knowing the specific databases used.

Another important consideration in working with LCAs is to not focus solely on the farm level when assessing the environmental impact of leather. To drive meaningful change, it's essential to leverage relationships throughout the entire value chain. Connections must be established and nurtured across all stages—from raw materials to finished products—to ensure that impacts are understood and addressed holistically.

Engaging with suppliers at different stages of the supply chain allows for a broader, more effective approach to sustainable development. By collaborating with upstream partners, brands can gather crucial resources and information and ask the right questions to make informed decisions. This ensures that efforts to reduce environmental impact are not concentrated only at the farm level, but are integrated across the entire leather making process, leading to more substantial improvements at the final product level.

Ultimately, creating this chain of engagement is key to making the LCA results actionable and ensuring all efforts contribute to a sustainable leather industry.

7 OUTPUT

LCA studies can be commissioned by different institutions with distinct goals. Commissioners can be students, companies, associations, etc. In the leather sector, multiple scientific papers were already published with an LCA approach to try to answer questions related to leather supply chain's environmental impacts. Several companies have also carried out LCA studies with different goals in mind, from understanding the sources of impact and hot spots to evidence-based reporting. Associations have also done some work: Leather Naturally has carried out an aggregated LCA based on data from a diverse set of tanneries worldwide. The Leather Working Group (LWG) has also run an aggregated LCA on the results of its members, with the goal of describing their certified tanneries. Available to LWG stakeholders only, LWG published a full report on their LCA study in December 2024. Both studies offer a comprehensive evaluation of the environmental impacts of leather production across a diverse set of products.The two associations have decided to merge their datasets to submit the resulting aggregated LCA to the Higg Index, which has now been submitted and approved.

Leather Naturally Average Industry LCA

To provide more accurate data on the average impacts of cow leather, Leather Naturally carried out an LCA composed of 56 different LCA studies from 6 large tanning companies across 11 different countries. The comprehensive scientific paper from the Leather Naturally Study has been published in the Discover Sustainability Journal on 10th February 2025 and can be found here. The Leather Naturally Average Industry LCA considered results from Beamhouse, Tanning, Post-tanning and, Finishing facilities from Argentina, Australia, Brazil, China, Italy, Sweden, Thailand, UK, Uruguay, USA, and Vietnam.

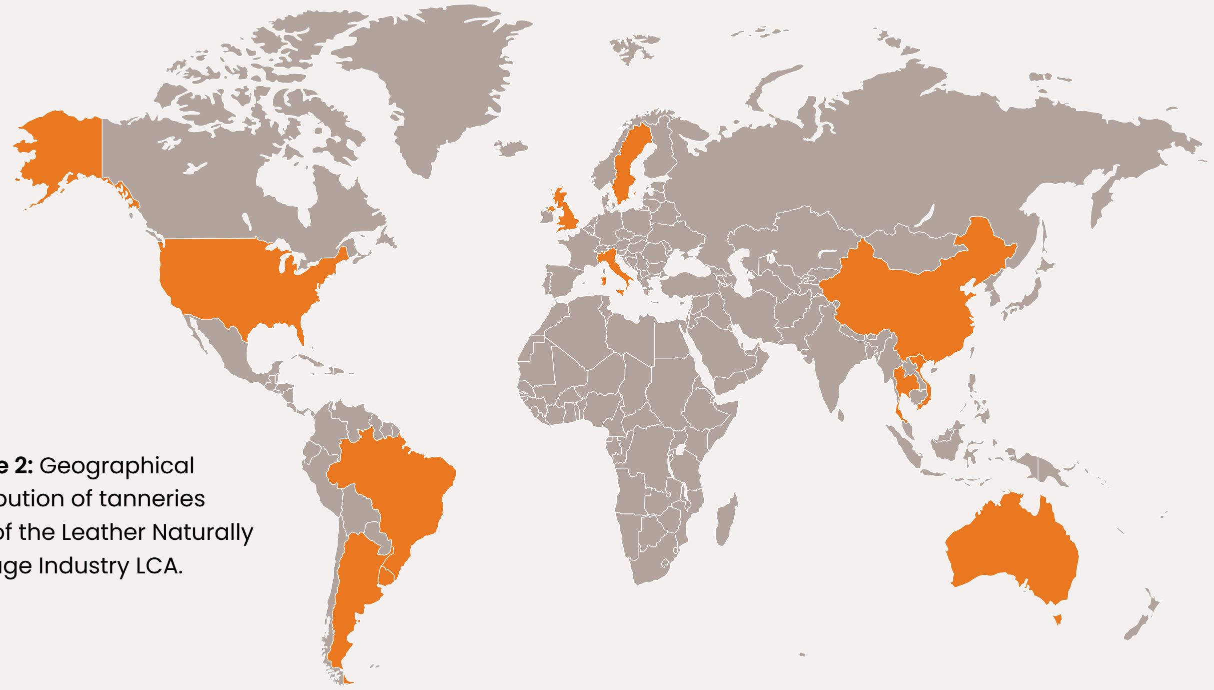


Figure 2: Geographical distribution of tanneries part of the Leather Naturally Average Industry LCA.

56 DIFFERENT LCA STUDIES | **6** LARGE TANNING COMPANIES | **11** DIFFERENT COUNTRIES

The study expressed the results from cradle-to-gate (from the sourcing of raw materials to finished leather) in 8 different impact categories:

Global Warming Potential
Measures the contribution of greenhouse gas emissions to climate change, expressed in kilograms of CO_2 equivalent.

Eutrophication
Evaluates the release of nutrients (like nitrogen and phosphorus) into water bodies, which can lead to algal blooms and oxygen depletion, harming aquatic ecosystems.

Abiotic Depletion, fossil fuels
Assesses the depletion of non-renewable fossil fuel resources, expressed in terms of their energy potential.

Water Use
Quantifies the total amount of water extracted from natural sources for a process or product, regardless of whether the water is being reused or returned.

Human Toxicity, cancer
Estimates the potential for substances to cause cancer in humans, typically expressed in comparative toxic units (CTU).

Human Toxicity, non-cancer
Measures the potential harm of substances to human health excluding cancer, expressed in comparative toxic units (CTU).

Freshwater Ecotoxicity
Evaluates the impact of chemicals on freshwater ecosystems, expressed in terms of toxic units per cubic meter (TU/m³).

Water Consumption
Quantifies the water withdrawn from its original water source due to evaporation, incorporation into products, or transfer to other watersheds, that is not being returned and no longer available for reuse.

The results of the study can be seen in Table 1.

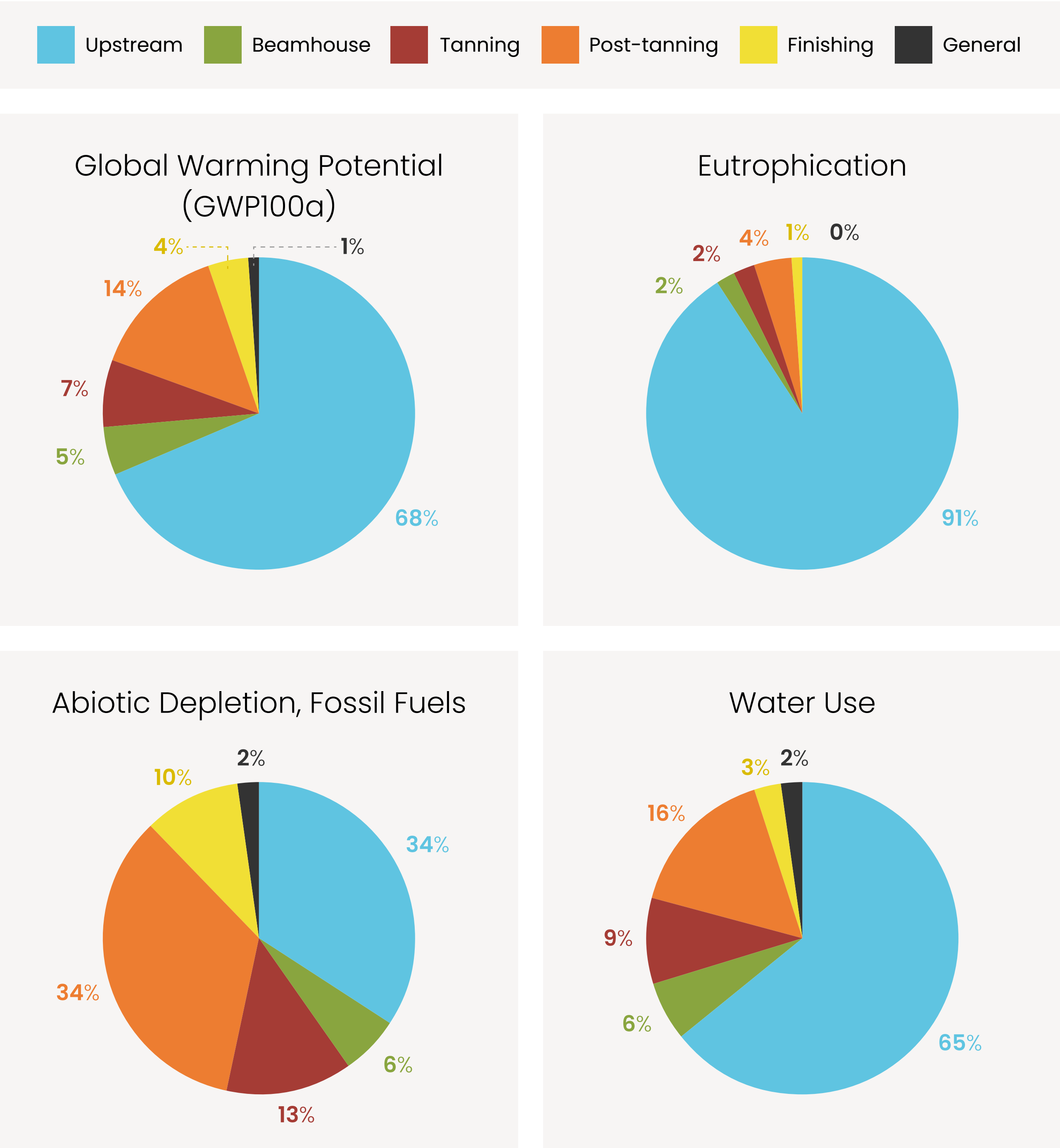
Impact Category	Measurement Unit	Upstream	Beamhouse	Tanning	Post-tanning	Finishing	General	Total
Global Warming Potential	kg CO_2 eq/kg	1.50×10^{1}	1.18×10^{0}	1.45×10^{0}	3.12×10^{0}	9.60×10^{-1}	2.39×10^{-1}	2.19×10^{1}
Eutrophication	kg PO_4--eq/kg	1.39×10^{-1}	2.83×10^{-3}	2.67×10^{-3}	5.97×10^{-3}	1.17×10^{-3}	3.52×10^{-4}	1.52×10^{-1}
Abiotic Depletion, fossil fuels	MJ/kg	4.78×10^{1}	8.59×10^{0}	1.88×10^{1}	4.78×10^{1}	1.45×10^{1}	2.28×10^{0}	1.40×10^{2}
Water use	m³/kg	7.35×10^{0}	6.70×10^{-1}	9.99×10^{-1}	1.83×10^{0}	2.87×10^{-1}	1.92×10^{-1}	1.13×10^{1}
Human Toxicity, cancer	CTUh/kg	1.50×10^{-8}	5.53×10^{-8}	1.35×10^{-7}	7.82×10^{-7}	3.88×10^{-8}	1.11×10^{-8}	1.04×10^{-6}
Human Toxicity, non-cancer	CTUh/kg	2.08×10^{-5}	1.25×10^{-6}	6.13×10^{-7}	1.61×10^{-6}	2.19×10^{-7}	1.33×10^{-7}	2.46×10^{-5}
Freshwater Ecotoxicity	CTUh/kg	3.60×10^{1}	8.72×10^{1}	3.92×10^{1}	7.77×10^{1}	8.95×10^{0}	6.71×10^{0}	2.56×10^{2}
Water Consumption	m³/kg	2.03×10^{-1}	2.23×10^{-2}	3.11×10^{-2}	6.82×10^{-2}	8.49×10^{-3}	1.05×10^{-2}	3.44×10^{-1}

Table 1: Results of the Leather Naturally Average Industry LCA per production stage.

Note: Values in the table are expressed in scientific notation (e.g., 1.20×10^{3} represents 1,200). The number preceding '×10' is multiplied by 10 raised to the specified power, indicating the magnitude of the value.

7 OUTPUT

The relative impact of each production stage per impact category can be analysed in Figure 3.



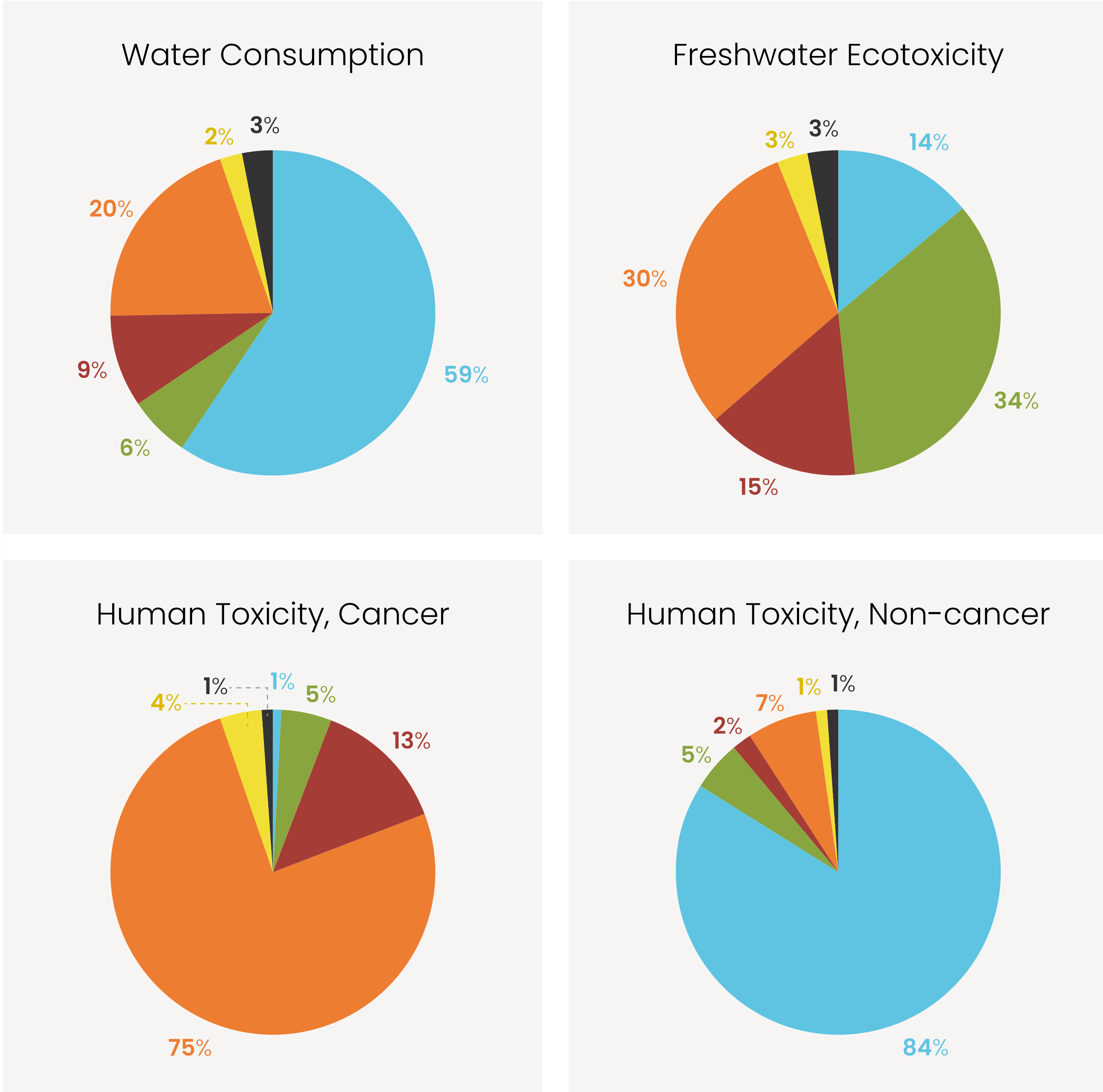


Figure 3: Relative impact of each production stage in the different impact categories

One can see that the Upstream stage, primarily involving animal farming and slaughterhouses, is a significant stage to all impact categories except for Human Toxicity, Cancer. The impacts of the Post-tanning stage are also significant, primarily due to the use of chemicals during the Retanning process.

More information on the Leather Naturally Average Industry LCA can be found at **www.leathernaturally.org**

8 HIGG SUBMISSION

Another outcome of this work was the collaboration between Leather Naturally and Leather Working Group (LWG) on a joint submission of a combined LCA dataset to the Higg Index.

Dispelling misinformation on the impact of leather includes carbon footprint figures published in the past on platforms such as Cascale's (formerly the Sustainable Apparel Coalition) Higg Material Sustainability Index (MSI). The industry data in this tool did not accurately represent the industry, since the dataset was outdated, and the data set parameters focused on farms that were not representative of your average leather product. Although they were using the best available data at the time, this resulted in a misconception that the carbon footprint for leather is quite high. For leather manufacturers that have conducted their own LCAs, it was common to see a 70% reduction in carbon footprint from the numbers on the Higg MSI platform.

After combining their two datasets, Leather Naturally and LWG therefore jointly submitted their combined LCA data to the Higg Index.

In October 2024, the Higg MSI adopted this combined data submission as a new average for bovine leather and the updated results have replaced the previously used values for bovine leather. The new dataset results in the environmental impacts of bovine leather being between 55% and 67% lower than the previous MSI value of leather. The Global Warming Potential, which previously showed an impact of of 36.8 points on the Higg MSI scale, is reduced by 60% to 14.6 points. This significant shift advances real change, promoting a more nuanced understanding of bovine leather as a sustainable material choice.

The barchart below (figure 4) 2 compares the previous results available for leather in the Higg Index with the new ones after the LN+LWG joint LCA effort.

Please be aware that the results in the barchart are expressed in Higg Index points per kilogram of material, not in the more standard units such as kg CO2 eq / m2.

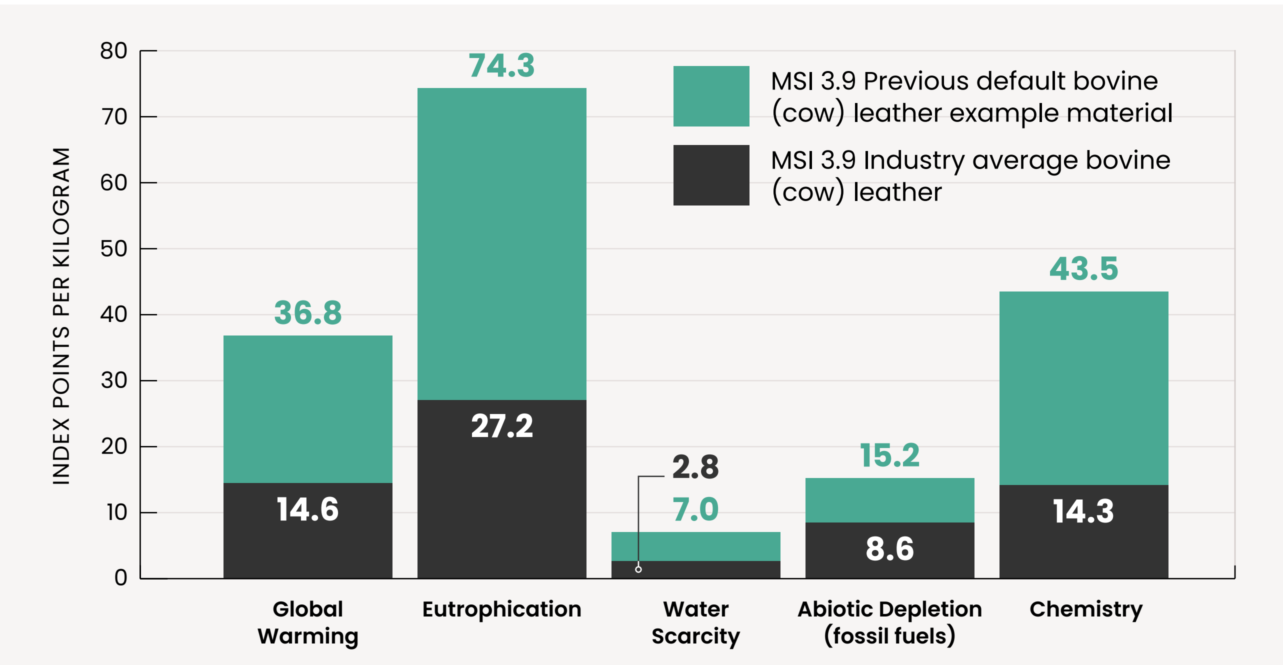


Figure 4: comparison between previous results available.

9 LIMITATIONS & CHALLENGES

While LCAs offer significant benefits for supporting transparent communication on product sustainability and guiding internal decision-making, they come with important considerations and limitations:

Imperfect Data Sources:

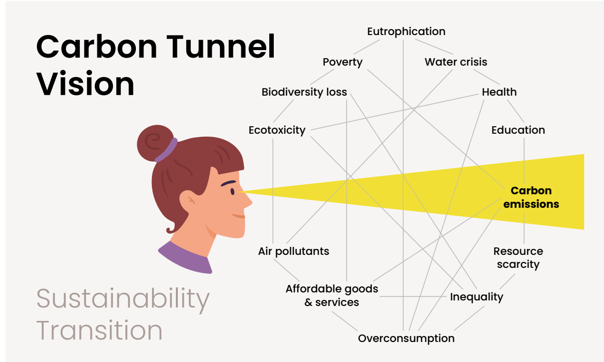
As mentioned earlier, obtaining 100% primary data for LCA studies can be challenging. These difficulties vary depending on several factors including the region from which hides and raw materials (from e.g. chemicals used) are sourced and the availability of detailed data down to the farm level. Although there are recommended databases that currently best represent the leather supply chain, they are not flawless. Gathering data directly from your own supply chain requires time, effort, and a strong supply chain engagement strategy to ensure accuracy and relevance.

Varying Methodologies:

Currently, numerous methodologies exist for conducting LCAs across different industries and for calculating land use impacts within supply chains. These variations in methodology—particularly when determining the most appropriate conversion and allocation rates—can lead to inconsistencies. This has not yet been fully realized, while there are ongoing promising efforts, such as the one commissioned by UNIDO to create a standardized approach for LCAs in the leather industry. Without an industry-aligned methodology, companies may choose the methods that present their data in the most favorable light, which can undermine transparency and make it difficult to compare results across the industry or against benchmarks such as the Leather Naturally LCA. This lack of consistency hinders the ability to create a fair, level playing field for evaluating environmental impacts.

Limited Scope of Impact and carbon tunnel vision:

While global warming potential is crucial for measuring progress towards climate action targets like GHG emissions reduction, focusing solely on this metric can limit a company's approach to sustainability.



To develop well-rounded strategies, it's important to take a holistic view and address a broader range of environmental impact areas. LCAs offer a maximum of fifteen impact categories to choose from—such as water use, resource depletion, and biodiversity loss—that provide a more comprehensive understanding of a product's wider environmental footprint. Although global warming potential remains the most commonly used metric, as companies prioritize tackling climate change, it's essential to consider the full spectrum of environmental impacts to advance sustainable development.

Considering longevity of leather:

The longevity of leather is unfortunately often overlooked when measuring its environmental impact. Leather, when properly maintained, is an exceptionally durable material that can outlast many other alternatives, significantly lowering its environmental impacts by spreading impacts over many years. Additionally, extending the life of leather products, reduces the frequency for new production cycles making it a more sustainable option compared to short-lived, fast-fashion alternatives. Leather goods align with the key principles of a circular economy as leather goods can be repaired, resold, or repurposed, reinforcing leather's role as a durable, eco-friendly material when viewed through a long-term perspective.

10 NEXT STEPS

The true value of a Life Cycle Assessment (LCA) lies in its power to illuminate the full spectrum of environmental impacts associated with a product, process, or service throughout its entire life cycle.

By providing a comprehensive, data-driven evaluation, LCAs empower every stakeholder in the value chain to make more sustainable, informed, and transparent decisions—decisions that not only safeguard the environment but also drive business success. However, the real impact of an LCA comes from understanding its findings.

Accurate interpretation is essential to grasp the true environmental footprint of what is being analyzed. Comparisons must be made with this deeper insight to ensure they lead to meaningful change. Ultimately, creating a more sustainable leather sector—or any industry—requires collaboration. It's through collective effort, supported by robust LCA data, that we can achieve a truly sustainable future.


LEATHER
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