



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION



GUIDELINES FOR ASSESSING THE ENVIRONMENTAL FOOTPRINT OF LEATHER

RECOMMENDATIONS FOR HARMONIZATION

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1. INTRODUCTION

Aim of the Guidelines for Assessing the Environmental Footprint of Leather is to provide scientifically grounded recommendations for policymakers and industry stakeholders, offering a harmonized approach for calculating the environmental footprint of leather. This will ensure transparency along the leather value chain.

Specifically, the guidelines aim to assess existing knowledge and provide recommendations for environmental and carbon footprint allocation rules and system boundaries in leather production. This includes guidance of the allocation of upstream processes, such as livestock rearing.

Interest in the leather value chain has grown in recent years, particularly concerning the development of Product Environmental Footprint (PEF) calculations based on Life Cycle Assessment (LCA).

Among the various indicators used to measure environmental footprints, the international market is showing particular interest in the Product Carbon Footprint (CFP).

To be verifiable and certifiable - and therefore recognized in international markets - PEF calculations must comply with specific methodological requirements. Common and harmonized calculation rules are essential to ensure consistency across PEF assessments. These methodological rules are known as Product Category Rules (PCRs).

The development of Leather PCRs began in 2011, within the Environmental Product Declaration (EPD) framework and with a specific focus on finished bovine leather (PCR 2011-13), followed by a broader technical report prepared for UNIDO¹. This technical report identified key parameters and data requirements needed to harmonize the calculation of leather CFPs.

Further guidelines and relevant PCRs were later developed by the European standardization body CEN, under the European Commission's Product Environmental Footprint pilot phase and within the Environmental Product Declaration framework.

These documents represent the most relevant existing frameworks for assessing the environmental performance of leather supply chains from a life cycle perspective. However, additional data and insights continue to emerge from both the market and academic literature.

The existing PCRs on leather still lack a comprehensive and standardized methodological approach.

¹ Brugnoli, F., Král, I. (editor) (2012). Life Cycle Assessment, Carbon footprint in Leather Processing (Review of methodologies and recommendations for harmonization). In: Eighteen Session of the Leather and Leather Products Industry Panel, Shanghai, PRC, 01-05 Sept.

As a result, Leather LCA calculations may be difficult for third parties to assess and may not be easily comparable across products.

The complexity and inherent uncertainty in environmental footprint analysis contrast with the need to communicate results in a simple, clear, and unambiguous way along the value chain, and ultimately to consumers.

Harmonizing this growing body of knowledge is therefore both necessary and urgent.

The structure of the document is designed to support these objectives, while also offering an in-depth analysis of the context in which the guidelines are published.

Chapter 3 defines the scope of the guidelines and provides a common definition of leather.

Chapter 4 presents recent developments and trends from four angles:

- Scientific knowledge on the evolution of planetary environmental pressures
- The most important legislation on sustainability at a global scale
- International standards that refer to the environmental footprint methodologies, with particular reference to climate and carbon
- Commitments of key market players involved in leather-related value chains

Chapter 5 provides an updated overview of global leather trade, including the availability and use of raw materials, types of leather produced globally, geographic distribution, market flows, and final applications (wet blue, crust, finished leather).

Chapter 6 forms the core of the document. It outlines and analyses the essential requirements for calculating the environmental footprint of leather and provides corresponding recommendations, which are described and justified in detail. Key elements are identified as fundamental to international harmonization: (i) PRODUCT SYSTEM, (ii) FUNCTIONAL UNIT AND REFERENCE FLOW, (iii) SYSTEM BOUNDARIES, (iv) ALLOCATION RULES, (v) IMPACT METHODS, (vi) CUT-OFF RULES, (vii) DATA QUALITY RULES, AND DATA RATING, (viii) REPORTING CRITERIA.

For each of these elements, the guidelines begin with a review and analysis of existing standards and Product Category Rules, followed by justification for the recommendations made. Where relevant, additional insights and “hints for innovation” are also included in the specific paragraph.

Chapter 7 explores potential future developments and broader applications, considering how the approaches outlined in these guidelines may also apply, identifying key aspects considered in these guidelines for leather, which by extension could also be applicable to other biobased design materials with similar or shared characteristics.

Finally, **Chapter 8** concluded the document with key findings and overall recommendations for future activities.

2. EXECUTIVE SUMMARY

These guidelines represent an important milestone in the development of a harmonized methodological framework for assessing the environmental performance of leather. Some of the most important achievements linked with the publication of the guidelines can be described as follows:

Hides and skins from animals slaughtered for human food consumption purposes have been defined as “Non-Determining Animal By-Products” as they result from a multifunctional process which do not affect the production volume.” The important related conclusion is that: Non-Determining Animal By-Products are by definition not drivers of environmental change.

An additional step towards the integration of LCA with the Planetary Boundaries concept has been provided, also highlighting the need for further development of the LCA science-based methodologies towards impact categories that calculate specifically the impacts of microplastics.

The identification of very relevant methodological opportunities provided by the ISO 14067/68 and SBTi FLAG guidelines has been identified, both allowing reforestation and biogenic carbon removals to be considered as ways in which GHG removals can be achieved and therefore potentially reflect such removals in the carbon footprint of hides and skins.

A detailed picture of the most important leather-related market data has been provided, starting from the livestock growth trend at global and regional scale, to the availability of raw materials, to tanning production, highlighting the need for a proper data update, with particular reference to the difference between the raw hides and skins that are globally available and those valorised through the international tanning industry.

A methodologically sound identification of 8 key elements for developing Life Cycle Assessment studies of Leather, for which a harmonization of requirements is necessary, and for each of them, specific recommendations have been issued, supported by explicit justifications of the choices made, and when needed, additional information to support the recommended methodological approach.

When relevant and potentially useful for the global value chain, specific information on innovative approaches has been described in detail and linked with possible environmental improvements along the value chain.

It is now possible for the international leather sector to count on a harmonized approach on the following key elements of the LCA methodologies:

1. Product System
2. Functional Unit and Reference Flow
3. System Boundaries
4. Allocation Rules and Procedures
5. LCIA Methodology and Types of Impact

6. Cut-Off Rules
7. Data Quality Requirements
8. Reporting Criteria

Additionally, some other key elements covered in the Guidelines:

It has been possible to define and introduce the concept of “Environmental Amortization” of a material, a broader and more comprehensive way of assessing the environmental footprint of a material such as leather, through the inclusion of its technical performance.

On the important topic of Products Durability, it has been possible to create the link between the environmental performance of a consumer product, the important definition of its “Duration of Service” (DoS), and with the environmental impacts, technical performances of leather and environmental amortization.

Regarding in particular Allocation, it has been possible to merge the requirements of the ISO 14040/44 with the relevant and reviewed “Allocation and cutoff by classification” approach, developing a simple methodology that allows classification of the different outputs of the various Life Cycle Stages linked with leather making between “Main products”, “Allocatable by-products”, “Recyclable materials” and “Wastes”.

Still on allocation, but on the important topic of global averages to allocate at the slaughterhouse in case of absence of primary data. Accordingly, the following information will be available to be adopted in case no primary data are available²:

Economic Allocation: 1,50 %

Mass Fraction: 7,33 %

The corresponding Allocation Ratio that derives from this value is 0,205.

$$EA 1,50 \% / MF 7,33 \% = AR 0,205$$

It has been possible to recommend a specific methodology to report on the Biogenic content of leather and the interconnected Biogenic Stored Carbon, according to the provisions of ISO 14067.

² Data from 299 studies prepared by SPIN360

Still on biogenic carbon and on the approaches of ISO 14067, the guidelines also provide indications on how to quantify the carbon footprint of leather, considering the GHG removals that can take place in some parts of its supply chain.

A full chapter has been dedicated to describing how the different LCA approaches recommended in the guidelines can be applied by extension to other “Biobased Design Materials” that share many commonalities with leather in their ORIGIN, the PRODUCTION PROCESSES they undergo, and their USES.

As sustainability expectations rise globally, there is a need for consistent, transparent, and verifiable environmental data. Yet, the lack of unified LCA guidance has led to fragmented practices, making it difficult to compare materials or products and undermining trust in environmental claims.

These guidelines propose the definition and application of common principles for a broader class of Biobased Design Materials—such as wool, cotton, silk, hemp, and cork—that share renewable origins, similar transformation processes, and overlapping end-use markets. By creating a uniform language and methodology across these materials, this work lays the foundation for a more coherent, comparable, and credible sustainability landscape.

2.1 A synthesis of the Key Recommendations

Product System

PRODUCTS IN SCOPE	“Leather”, intended as a semi-processed or finished product to either be further processed in the tanning sector or, after completion of all processing steps, in various consumer articles’ manufacturing sectors
GEOGRAPHY	Global
PRODUCT DEFINITION	Leather as defined by EN15987:2022: “hide or skin (of Animal Origin) with its original fibrous structure more or less intact, tanned to be imputrescible, where the hair or wool may or may not have been removed, whether or not the hide or skin has been split into layers or segmented either before or after tanning and where any surface coating or surface layer, however applied, is not thicker than 0.15 mm”
	Hides and Skins of animals slaughtered for human consumption purposes can be defined as “Non-Determining Animal By-Products”, as they are the result of a Multifunctional process of which they do not affect the production volume, or the change in the production volume.
EXCLUSIONS	All leathers produced from hides or skins of animals other than those slaughtered for human food consumption
CLASSIFICATION	UN CPC
CODES	Division: 29 - Leather and leather products; footwear Group: 291 - Tanned or dressed leather; composition leather Class: 2912 - Other leather, of bovine or equine animals, furless

Declared Unit and Reference Flow

DECLARED UNIT	The Declared Unit (DU) is a square meter (m ²) of leather, or a kilogram (kg) of sole leather, as routinely measured at the tannery according to ISO 11646 standard or EN ISO 19076.
FUNCTIONAL UNIT	What: Precise identification of the leather under study - See paragraph 6.5.2.1
	How Much: A square meter of leather (kg in case of sole leather), indicating mass intensity and unitary surface – See paragraph 6.5.2.2
	How Well: the declared unit should include technical performance of the leather under study – See paragraph 6.5.2.3
	How Long: Leather is an intermediate product and has no expiry date. Its life span depends on its final use but considering that use phase is beyond the system boundaries. “How long?” specification cannot be defined – See paragraph 6.5.2.4
REFERENCE FLOW	The reference flow is the amount of product needed to fulfil the defined function and should be measured in kg of raw hide or skin/DU. All quantitative input and output data collected in the study should be calculated in relation to this reference flow.

System Boundaries

<p>GENERAL SYSTEM BOUNDARIES</p>	<p>The product system of leather can be represented as divided into three different life cycle stages:</p> <ul style="list-style-type: none"> • UPSTREAM PROCESSES, (from cradle to entry gate of the tannery) • CORE PROCESSES, (from gate to gate of the tannery) • DOWNSTREAM PROCESSES, are the ones using/managing the outputs of the tannery <p>The following attributional UPSTREAM PROCESSES are to be included:</p> <ul style="list-style-type: none"> • Animal Farming • Slaughtering • Curing • Production Of Chemicals • Energy Production • Water Delivery • Packaging Manufacturing • Transportations <p>The following attributional CORE PROCESSES are to be included:</p> <ul style="list-style-type: none"> • PRODUCTION <ul style="list-style-type: none"> • Beamhouse • Tanning • Post-Tanning, • Finishing • All TRANSPORTS TO CORE PROCESSES • Waste Management • Water treatment <p>DOWNSTREAM processes (from gate-to-grave) are excluded</p>
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Allocation Rules and Procedures

<p>ANIMAL FARMING</p>	<p>ALL SPECIES</p> <p>Subdivision should be used for processes that can be directly attributed to certain outputs. When the processes cannot be subdivided the upstream burdens should be allocated to farm outputs using a biophysical allocation method. The impact should be allocated on the biophysical basis to the different outputs of the Farm, such as for example:</p> <ul style="list-style-type: none"> • Reproductive mammals at the end of career • Milk • Live animals exiting the farm (to another farm or to slaughter) • Wool • Any other Allocatable By-Product <p>Farm specific data should be preferred, including, if possible, calculations on Carbon Mineralization and fixation in soils. In case default or generic data are used, their choice should be duly justified and related data quality highlighted in the LCA Report. For non-reproducing mammals 100% of the impact should be allocated to the “live animal to slaughter”.</p>
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SLAUGHTERING	<p>ALL SPECIES</p> <p>The outputs of a Slaughterhouse can be identified as follows:</p> <ul style="list-style-type: none"> · Fresh meat and edible offal · Food grade fat · Food grade bones · Hides and skins · Cat. 3 slaughtering By-products · Cat 1/2 material & waste <p>The environmental impact for each output of the slaughterhouse should be evaluated using use the Allocation Ratio, calculated as follows:</p> $AR = \frac{EA (\%)}{MF (\%)}$ <p>Where:</p> <p>EA (%) is the Economic Allocation of meat and all the other outputs, expressed as the percentage of the value of the output on the total value of all the outputs of the slaughterhouse.</p> <p>MF (%) is the Mass Fraction of meat and all the other outputs, expressed as the percentage of the mass of the output on the total mass of all the outputs of the slaughterhouse.</p> <p>Both EA and MF should be calculated considering the rolling average economic of the past three years, with annual verification of updates; these values should be available in the LCA Report, along with a description of sources and main hypotheses done for the calculation. Supply Chain specific data should be preferred. In case default or generic data are used, their choice should be duly justified and related data quality highlighted in the LCA Report. Default data for Bovine leather are Mass Fraction 7.33 % Economic allocation 1.50 %, as described in Chapter 6.7.3.1.3</p>
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CORE PROCESSES	<p>Allocation factors to be applied in the different core processes should be calculated according to the following steps:</p> <ol style="list-style-type: none"> 1. Identification of all offcuts generated during the process and their destination 2. Verification of the definition of Allocatable By-products 3. Mass balance calculation 4. Allocation factors calculation <p>Tannery/Supply Chain specific data should be preferred. In case default or generic data are used, their choice should be duly justified and related data quality highlighted in the LCA Report.</p> <p>Potential Allocatable by-products to be considered:</p> <ul style="list-style-type: none"> • Recovered Hair • Green Fleshings • Green Splits • Lime Fleshings • Lime Trimmings • Lime Splits • Tanned Shavings • Tanned Splits • Tanned Trimmings • Crust Trimmings • Crust Buffing Dust • Finished Trimmings
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Life Cycle Impact Assessment (LCIA) Methodology and Types of Impact

METHOD	INDICATOR	UOM/m ² of leather
EF 3.1	CLIMATE CHANGE	kg CO ₂ eq
EF 3.1	BIOGENIC	kg CO ₂ eq
EF 3.1	FOSSIL	kg CO ₂ eq
EF 3.1	LAND USE/LAND USE CHANGE	kg CO ₂ eq
EF 3.1	OZONE DEPLETION	kg CFC-11 eq
EF 3.1	IONISING RADIATION	kBq U235 eq
EF 3.1	PHOTOCH. OZONE FORMATION	kg NMVOC eq
EF 3.1	PARTICULATE MATTER	disease incidence
EF 3.1	HUMAN TOXICITY, NON-CANCER	CTUh
EF 3.1	HUMAN TOXICITY, CANCER	CTUh
EF 3.1	ACIDIFICATION	mol H ⁺ eq
EF 3.1	EUTROPHICATION, FRESHWATER	kg P eq
EF 3.1	EUTROPHICATION, MARINE	kg N eq
EF 3.1	EUTROPHICATION, TERRESTRIAL	mol N eq
EF 3.1	ECOTOXICITY, FRESHWATER	CTUe
EF 3.1	LAND USE	Pt
EF 3.1	WATER USE	m ³ world eq
EF 3.1	RESOURCE USE, FOSSILS	MJ
EF 3.1	RESOURCE USE, MINERALS & METALS	kg Sb eq
CML1a BAS. 2013	EUTROPHICATION	kg PO ₄ ³⁻ eq
CML1a BAS. 2013	ABIOTIC DEPLETION, ELEMENTS	kg Sb eq
CML1a BAS. 2013	ABIOTIC DEPLETION, FOSSIL FUELS	MJ
AWARE	WATER DEPRIVATION POTENTIAL	m ³
USETOX	HUMAN TOXICITY	CTUh
USETOX	ECOTOXICITY	CTUh
SINGLE SCORE	MULTIPLE IMPACT CATEGORIES	Pt

Cut-Off Rules

CUT OFF RULES	<p>Life Cycle Inventory data for a minimum of 99% of total inflows to the core module should be included.</p> <p>All chemical products should be included in the inventory if the total weight of the product (as commercial presentation) is $\geq 0.002\%$ respect to the mass of all chemical product inputs.</p> <p>As the only exception to this rule, for the average leather production it is allowed a cut-off of 0.1% of the total weight of the product (as commercial presentation) respect to the mass of all chemical product inputs.</p>
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Data Quality Requirements

TYPE OF DATA AND DATA SOURCE	<p>Data are distinguished between Life Cycle Inventory data representing the input/output of modelled flows, focusing in particular on core processes; Characterization factors, that associate the different impact categories to the of the inventory through the selection of representative to be associated to LCI data.</p>
DATA QUALITY RATING CALCULATION	<p>Data quality for each flow in the LCA study (DQ_i) can be calculated as the average between the Data Quality of the Inventory (DQI_i) and the Data Quality of the Emission factor ($DQEF_i$).</p> $DQ_i = \frac{DQI_i + DQSi + DQEF_i}{3}$ <p>Rata Quality Rating of the LCA Study:</p> $DQR_{LCA} = \frac{\sum_{i=1}^n DQ_i \cdot EI_i}{\sum_{j=1}^n EI_j}$
MINIMUM DATA QUALITY RATING	<p>Rating is quantitatively assigned from</p> <ol style="list-style-type: none"> 1-Very good, 2-Good, 3-Average, 4-Poor, 5-Very poor/unknown/not evaluated

Reporting Criteria

REPORTING CRITERIA	<p>LCA results should be presented in a Report, written on the basis of what included in ISO 14040/44 to ensure transparency, consistency, and credibility of the study. With the same aim, the Upstream and Core environmental impact results should be reported separately. The following sections to the report should at least be included:</p> <ol style="list-style-type: none"> 1- General information <ol style="list-style-type: none"> a. LCA commissioner and practitioner b. Date of reporting c. Validity of the study d. Reference Standards 2- Goal of the study <ol style="list-style-type: none"> a. Reasons to carry out the study b. Intended audience c. Intended applications 3- Scope of the study <ol style="list-style-type: none"> a. System boundaries b. Source of LCI data c. Definition of functional unit d. Assumptions and limitations e. Cut-off criteria 4- Life cycle inventory analysis <ol style="list-style-type: none"> a. Data collection and aggregation methods b. Description of unit processes c. References for non-primary data d. Allocation principles with justification
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	<ul style="list-style-type: none"> e. Quantitative description of unit processes 5- Life cycle impact assessment a. LCIA procedures and methodologies b. References to characterization methods c. LCA Results (Reporting Upstream, Core and Downstream results separately) 6- Life cycle interpretation a. Results (Reporting Upstream and Core results separately) b. Data quality assessment c. Hotspot Analysis d. Additional Interpretations of results e. Additional environmental performance indicator 7- Critical review (if applicable) a. Name and affiliation of reviewers b. Critical review report c. Recommendations and responses d. Critical review statement
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3. SCOPE OF THE GUIDELINES

The most widely recognized definition of leather is provided by EN15987:2022:

“Hide or skin (of animal origin³) with its original fibrous structure more or less intact, tanned to be imputrescible, where the hair or wool may or may not have been removed, whether or not the hide or skin has been split into layers or segmented either before or after tanning and where any surface coating or surface layer, however applied, is not thicker than 0.15 mm”

Leather is a valuable, durable material used in a wide variety of applications. The raw materials used to produce leather are hides and skins of animals. As will be discussed in the following paragraphs, several key elements must be clarified regarding the nature of these materials and their significance in the activities and processes that generate them.

The Nature of Hides and Skins: The European Commission officially defines hides and skins of animals slaughtered for purposes other than leather production – specifically for human food consumption - are classified as “animal by-products” in Regulation (EC) No 1069/2009 of the European Parliament and of the Council of 21 October 2009⁴.

The Importance of Hides and Skins in Multi-Functional Processes: The role of hides and skins has been examined in scientific literature, both from an economic and environmental point of view. Notably, a United Nations⁵ reference distinguishes between two distinct categories of outputs from multi-functional production processes:

- The Determining Products
- The Dependent Co-Products or By-Products

A **Determining Product** is defined as a product for which a change in demand leads to a change in overall production volume of the activity.

A **Dependent Co-Product or a By-Product** is a product for which change in demand does not affect production volume of the multi-functional processes. The production volume of a dependent co-product or of a by-product is constrained by the demand for the Determining Product.

In the context of leather, a change in demand for hides and skins – when these originate from animals slaughtered mainly for human food - does not affect the production volume of animal farming and slaughter. Only Determining Products can cause a change in the production volume of an activity and therefore can be identified as drivers of important economic and environmental transformations, such as land use change.

² Add on from the author in response to a specific comment received from a TAG member

⁴ The European (Dir. 2008/98/EC) represents the more general legislative framework on waste

⁵ United Nations Environment Programme, “Global guidance principles for life cycle assessment databases: a basis for greener processes and products : ‘Shonan guidance principles’ / produced by the UNEP/SETAC Life Cycle Initiative,” UNEP(02)/G5622, [Nairobi, Kenya] : UNEP, 2011, ISSN 9280731742;

Based on the above, hides and skins from animals slaughtered for human food consumption purposes can be defined as Non-Determining Animal By-Products. They result from a multifunctional process of which they do not affect the production volume.

Exclusion

The uniformity of Life Cycle Assessment methodologies and requirements is highly dependent on the nature and importance of hides and skins as raw materials. For this reason, the present guidelines exclude references to hides or skins of animals that have not been slaughtered for human food consumption.

The scope of the Guidelines is therefore summarized in the following table:


	SCOPE OF THE GUIDELINES
PRODUCTS IN SCOPE	“Leather,” intended as a semi-processed or finished product to either be further processed in the tanning sector or, after completion of all processing steps, in various consumer articles’ manufacturing sectors.
GEOGRAPHY	Global
PRODUCT DEFINITION	Leather as defined by EN15987:2022: “hide or skin (of animal origin) with its original fibrous structure more or less intact, tanned to be imputrescible, where the hair or wool may or may not have been removed, whether or not the hide or skin has been split into layers or segmented either before or after tanning and where any surface coating or surface layer, however applied, is not thicker than 0.15 mm”.
EXCLUSIONS	All leathers produced from hides or skins of animals other than those slaughtered for human food consumption.
CLASSIFICATION	UN Central Product Classification (CPC) ⁶
UN CPC CODES	Division: 29 - Leather and leather products; footwear Group: 291 - Tanned or dressed leather; composition leather

Table 1: Scope of the Guidelines

⁶ United Nations Department of Economic and Social Affairs Statistics Division - Central Product Classification (CPC) see <https://unstats.un.org/unsd/classifications/unsdclassifications/cpcv21.pdf>

4. BACKGROUND: SCIENCE, LAWS, STANDARDS, MARKET ACTIONS

4.1 Introduction: The Context

Relevant global trends are rapidly evolving toward a scenario in which the private sector - particularly key market players - will play a pivotal role in defining and implementing of strategies to accelerate the processes required for the transition toward positive environmental change.

To promote proactive and effective action toward sustainable business and development, the need arises to seek evidence that such actions can be harmonized with specific interests of the private sector and the supply chains defining it, apart from being necessary for environmental improvement on a global scale.

To work on determining the evidence for joint market and environmental beneficial action, relevant trends regarding legislation and standards are summarized in this chapter in relation to the following themes:

- The evolution of planetary environmental pressures
- The evolution of legislation
- The evolution of standards
- The current response of some reference market players

Understanding the evolution from theoretical frameworks for sustainability action, promotion, and the legislative response to such premises, as well as the interaction with market dynamics, are all relevant components in defining the role of by-products' environmental impact assessment. This is essential to ensure alignment with declared regulatory frameworks and market interests.

4.1.1 The evolution of planetary environmental pressures

While the most globally relevant and debated environmental metric is the carbon footprint of corporations and products⁷, scientific research on environmental damage mitigation has long recognized that global warming is only one of several serious environmental issues the world must face, and not necessarily the most important.

The sustainability discourse has increasingly focused on the Planetary Boundaries Framework⁸ as a proper reference enabling a complete understanding of the complexity and interdependency of the key variables that govern the stability of Earth's ecosystem.

⁷ Savasta-Kennedy, M. (2014). The dangers of carbon reduction tunnel vision. Available at SSRN 2518613.

⁸ Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., ... & Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. *science*, 347(6223), 1259855.

First introduced in 2009, the Framework represents a set of nine processes that regulate the resilience of the Earth and delineates their progression to quantify the levels of anthropogenic perturbation. Since then, the Framework has been revised and updated several times.

A recent study from Richardson et al.⁹ published in September 2023, finds that six of the nine boundaries have been transgressed, suggesting that Earth is now well outside of the safe operating space for humanity.

Transgression of such boundaries was recorded in the years 2009, 2015 (Figure 1Figure 1), and 2023, showing a trend of continuously exceeding the thresholds imposed by our Earth’s ecosystems.

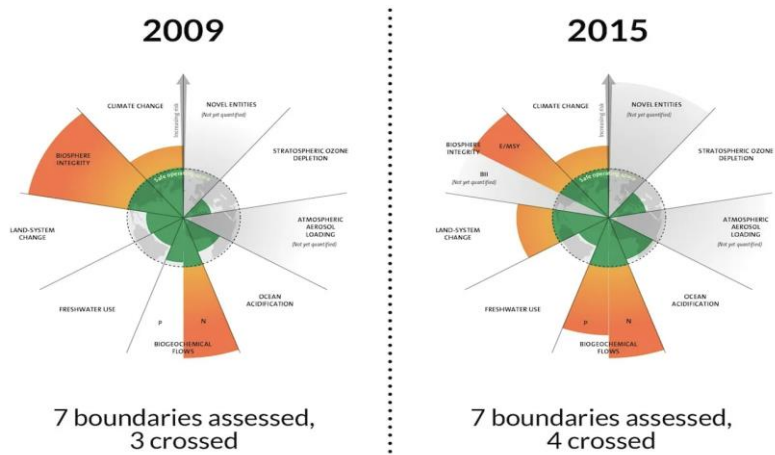


Figure 1: The evolution of the planetary boundaries framework (2009 – 2015)¹⁰.

The nine Earth-system processes are listed below and evaluated according to the latest 2023 assessment, together with an indication of whether they exceed their relevant planetary boundaries and the corresponding level of risk, as explained in Figure 2.

PROCESS	BOUNDARY EXCEEDED	LEVEL OF RISK
CLIMATE CHANGE	YES	VERY HIGH
BIOSPHERE INTEGRITY	YES	VERY HIGH
OZONE DEPLETION	NO	SAFE
OCEAN ACIDIFICATION	NO	SAFE
PHOSPHORUS AND NITROGEN BIOGEOCHEMICAL FLOWS	YES	VERY HIGH
LAND SYSTEM CHANGE	YES	INCREASING
FRESHWATER CHANGE	YES	INCREASING
ATMOSPHERIC AEROSOL LOADING	NO	SAFE
CHEMICAL POLLUTION/NOVEL ENTITIES	YES	VERY HIGH

⁹ Richardson, K., Steffen, W., Lucht, W., Bendtsen, J., Cornell, S. E., Donges, J. F., ... & Rockström, J. (2023). Earth beyond six of nine planetary boundaries. *Science advances*, 9(37), eadh2458

¹⁰ Azote for Stockholm Resilience Centre, Stockholm University. Based on Richardson et al. 2023, Steffen et al. 2015, and Rockström et al. 2009

Table 2: List of planetary boundaries processes

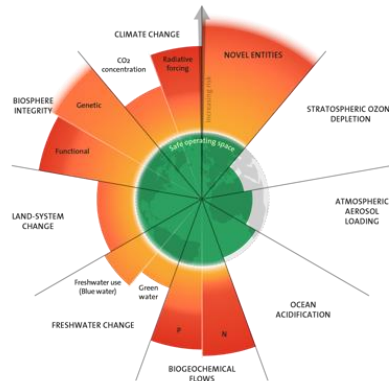


Figure 2: Current status of control variables for all nine planetary boundaries (2023)¹¹

Therefore, considering the impact economic systems produce on the nine planetary boundaries, GWP and climate change are not the only environmental issues that science is recognizing as important, with at least five other boundaries in need of urgent attention.

4.1.2 The evolution of legislative action

In full coherence with the environmental emergency outlined in tracking the transgression of planetary boundaries, the leather market, among others, is witnessing a rapid evolution of sustainability legislation at global scale, particularly in Europe. The most relevant pieces of legislation that are affecting or will affect the global operating environment are worth mentioning and examining in order to identify key elements to be used for future strategies on sustainability. A summary of relevant regulations and directives at the European level is provided as follows:

- ‘Eco-design for Sustainable Products Regulation’ ESPR
- ‘Regulation on Deforestation-free products’ EUDR
- ‘Corporate Sustainability Reporting Directive’ CSRD
- ‘Corporate Sustainability Due Diligence Directive’ CSDDD
- ‘Green Claims Directive’
- ‘Product Environmental Footprint Guide’ PEFCR

¹¹ Azote for Stockholm Resilience Centre, Stockholm University. Based on Richardson et al. 2023, Steffen et al. 2015, and Rockström et al. 2009

All these efforts reflect a broader political and market-driven shift toward value chain transparency and performance-based environmental accountability. The implementation of LCA (Life Cycle Assessment) and environmental footprinting methods is explicitly or implicitly embedded in most of these initiatives, as a foundational tool for environmental data provision, third-party verification, and eco-design.

Essential elements required across this emerging regulatory framework include:

- Traceability of materials and production flows
- Proper supply (value) chain knowledge
- Third party verified environmental footprints of products and corporations
- Products technical and safety characteristics
- Products durability and end-of-life information
- Standard practices on reporting

It is important to underline the rapid evolution of this legislative framework.

Key information for each piece of regulation or directive described above is reported in the fact sheets in Annex 1.

4.1.3 The evolution of standards

The evolution of the requirements of specific ISO standards that focus on environmental management systems, organizational and product environmental foot printing is relevant in determining fundamental principles for the development of LCA harmonization guidelines. The evolution of ISO standards and the issuance of new standards to tackle emergent practices and topics in the field of sustainability is discussed in Figure 3.

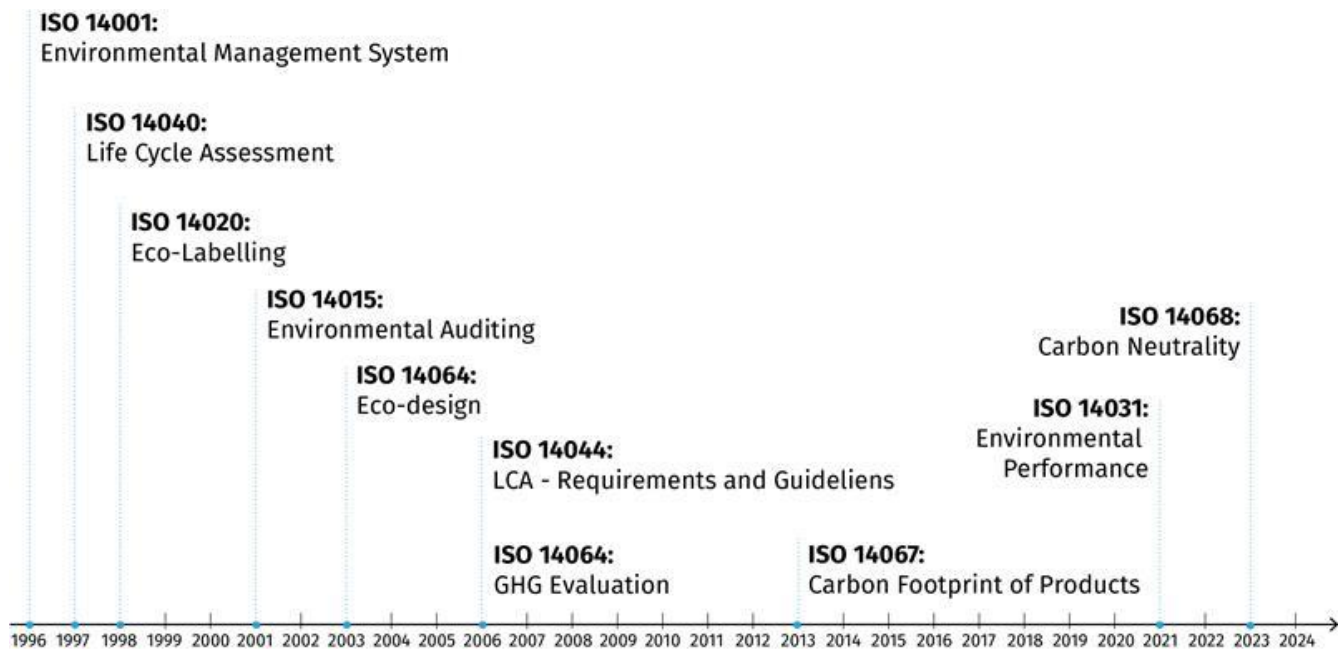


Figure 3: Evolution of ISO environmental standards: 1996 - 2023

The first ISO environmental management system standard was issued in 1996: ISO 14001 – Environmental Management systems. It focuses on the definition and implementation of a management system, to be applied to physical sites of organizations, with the main aims of supporting companies in the implementation of actions for full compliance with applicable legislation, identification of significant environmental aspects and impacts, definition of improvement objectives, implementation, and monitoring of improvement programs.

The initial standards had very limited applicability to Life Cycle Management, had no or very limited application in supply chains, and were very much focused on organizations rather than on products.

The first standard on LCA was issued one year later: ISO 14040: Life Cycle Assessment.

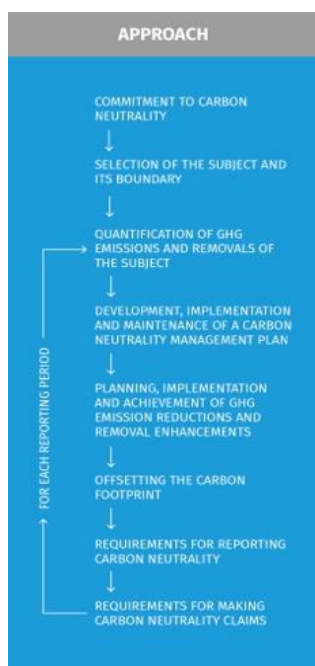
The first focus on GHG accounting of business and corporations' dates back to 2006, when the ISO 14064: GHG Accounting was introduced, and the first specific carbon footprint calculations of products made possible due to ISO 14067, introduced in 2013.

The focus of these standards was very technical and described mainly the principles and framework for life cycle assessment and the implementation of LCA studies and GHG accounting studies. They were not focused on the reduction and neutralization of environmental impacts. It is only in 2023 that ISO published ISO 14068: Carbon Neutrality, a standard with the specific focus of quantifying and defining actions for the abatement of enterprise environmental impact, remains nevertheless concentrated on GHG.

The Science Based Target initiative (SBTi) standard is herewith taken as a referenced approach for corporations to go beyond neutrality. Accordingly, it is based on such premises that the role of Life Cycle and Impact Assessment is defined as a relevant instrument in

determining solutions for the quantification and reduction of the environmental burdens of products. Therefore, it is relevant to understand the content of ISO 14068 and SBTi standards in order to define the framework for the development of harmonization guidelines for the environmental impact assessment of leather.

4.1.3.1 ISO 14068: Carbon Neutrality



ISO 14068 (**Error! Reference source not found.**) specifies principles, requirements, and guidance for achieving and demonstrating carbon neutrality through the quantification, reduction and offsetting of the carbon footprint¹².

The document also provides guidance on the actions necessary to achieve and demonstrate carbon neutrality. It is applicable to a wide range of subjects such as organizations (including companies, local authorities, and financial institutions) and products (goods or services, including buildings and events).

ISO 14068 establishes a hierarchy for carbon neutrality where GHG emission reductions (direct and indirect) and GHG removal enhancements within the value chain take priority over offsetting.

Therefore, the standard includes requirements for carbon neutrality commitments, the making of carbon neutrality claims and defines a framework for achieving and demonstrating carbon neutrality, as

herewith described in **Error! Reference source not found.**

Figure 4 ISO 14068 Framework for Carbon Neutrality¹³

According to the ISO 14068 framework, entities allocatable determine a carbon neutrality pathway starting from a trajectory to minimize the carbon footprint of the subject. The carbon neutrality pathway shall include short and long-term targets with specified dates and a target year by which only residual GHG emissions will remain.

¹² International Organization for Standardisation (2023). Climate change management – Transition to net zero – Part 1: Carbon Neutrality (ISO Standard No. 14068-1:2023)

¹³ Re-elaboration from International Organization for Standardisation (2023). Climate change management – Transition to net zero (ISO Standard No. 14068-1:2023), Figure 2, p. 10.

When the carbon neutrality management plan includes GHG removal enhancements within the boundary of the subject, the entity shall ensure that they are backed by empirical and demonstrable data.

ISO 14068 provides some interesting definitions that are and will be of high interest to leather makers and users, as well as of the makers and users of other “Biobased Design Materials”, the most important being:

3.1.1 carbon neutral: condition in which, during a specified period of time, the carbon footprint (3.2.4) has been reduced as a result of greenhouse gas (GHG) emission reductions (3.2.3) or GHG removal enhancements (3.2.8) and, if greater than zero, is then counterbalanced by offsetting (3.3.1)

Note 1 to entry: Carbon credits (3.3.2) used for offsetting shall meet certain criteria (see Clause 11) and are only used after GHG emission reductions and GHG removal enhancements have been made in line with the carbon neutrality management plan.

Note 2 to entry: The specified period of time is a finite number of years, for organizations (3.4.3), or the full or partial life cycle, for products (3.4.4).

3.2.3 greenhouse gas emission reduction: GHG emission reduction decrease in GHG emissions (3.2.2) quantified between two points in time or relative to a baseline (3.2.13)

Note 1 to entry: Adapted from ISO 14064-2:2019, 3.1.7.

3.2.4 carbon footprint: sum of greenhouse gas (GHG) emissions (3.2.2) and GHG removals (3.2.7) of the subject (3.4.2) expressed as carbon dioxide equivalents (3.2.12)

Note 1 to entry: For a product (3.4.4), the carbon footprint is based on a life cycle assessment using the single impact category of climate change in accordance with ISO 14067.

Note 2 to entry: For an organization (3.4.3), the carbon footprint is equivalent to the sum of the direct GHG emissions (3.2.5), indirect GHG emissions (3.2.6) and GHG removals, if applicable, within the boundary (3.2.16) of the subject quantified in accordance with ISO 14064-1.

3.2.7 greenhouse gas removal: GHG removal withdrawal of a GHG (3.2.1) from the atmosphere by a GHG sink (3.2.10)

Note 1 to entry: Examples of ways in which GHG removals can be achieved include reforestation, carbon sequestration in soils, sustainable bioenergy with carbon capture and storage, and direct air carbon capture and storage.

[SOURCE: ISO 14064-1:2018, 3.1.6, modified — “GHG sink” made singular. Note 1 to entry added.]

3.2.10 greenhouse gas sink GHG sink: process that removes a GHG (3.2.1) from the atmosphere

Note 1 to entry: A process can be natural or anthropogenic.

[SOURCE: ISO 14064-1:2018, 3.1.3, modified — Note 1 to entry added.]

Here, the point of particular interest for the leather value chain lies in the fact that de facto, ISO 14068 opens a very important methodological point, by allowing reforestation and carbon sequestration in soils to be considered as ways in which GHG removals can be achieved.

4.1.3.2 Science-Based Target initiative

While the identification of the most relevant variables causing global environmental challenges, as well as the most appropriate methods to measure such variables, is still being debated

among scientists, the SBTi standard¹⁴ defines the different procedures a corporation shall undertake to define and implement quantitative environmental impact reduction targets.

The SBTi standard sets out four key elements that make up a corporate net-zero target:

- Near-term science-based target
- Long-term science-based target
- Neutralization of any residual emissions
- Beyond value chain mitigation (BVCM)

Accordingly, a re-interpretation of these four key elements, which were originally thought only to be applicable to climate-related targets, must be performed to extend their applicability to other environmental variables, such as those underpinning the other eight planetary boundaries. Accordingly, a definition of each of the four elements is provided below:

SBTI STANDARD: NEAR-TERM SCIENCE-BASED TARGET

WHAT: These are 5–10-year GHG mitigation targets in line with 1.5°C pathways. When companies reach their near-term target date, they must calculate new near-term science-based targets to serve as milestones on the path towards reaching their long-term science-based target.

WHY: Near-term targets galvanize the action required for significant emissions reductions to be achieved by around 2030. Near-term emissions reductions are critical to not exceeding the global emissions budget and are not interchangeable with long-term targets.

SBTI STANDARD: LONG-TERM SCIENCE-BASED TARGET

WHAT: These targets show companies how much they must reduce value chain emissions to align with reaching net-zero at the global or sector level in eligible 1.5°C pathways by 2050 or sooner.

WHY: Long-term targets drive economy-wide alignment and long-term business planning to reach the level of global emissions reductions needed to meet climate goals based on science.

SBTI STANDARD: NEUTRALIZATION OF ANY RESIDUAL EMISSIONS

WHAT: Measures companies take to remove carbon from the atmosphere and permanently store it, counterbalancing the impact of emissions that remain unabated after the long-term science-based target is achieved. Emissions that were excluded from the long-term target boundary and GHG emissions inventory must also be neutralized.

WHY: Although most companies will reduce emissions by at least 90% through their long-term science-based targets, not all companies will be able to achieve complete decarbonization and therefore some residual emissions may remain. These emissions must be neutralized to reach net-zero emissions and a state of no impact on the climate from GHG emissions.

A company cannot claim to have reached net-zero until the long-term science-based target for all scopes is achieved and the company has neutralized residual emissions.

¹⁴ Science Based Target Initiative (2025); SBTi CORPORATE NET-ZERO STANDARD Version 1.3

SBTi STANDARD: BEYOND VALUE CHAIN MITIGATION (BVCM)

WHAT: Mitigation action or investments that fall outside of a company's value chain. This includes activities that avoid or reduce GHG emissions, and those that remove and store GHGs from the atmosphere.

WHY: The climate and ecological crises require bold and decisive action from companies. Decarbonizing a company's value chain in line with science and reaching net-zero emissions by 2050 is increasingly becoming the minimum societal expectation for companies.

4.1.3.3 The SBTi FLAG and leather specific requirements

FLAG (Forest Land and Agriculture) emissions, as defined by the SBTi, represent a subset of GHG Scope 3 emissions, focusing specifically on **land-based emission sources**. The difference between the above-mentioned industry SBTs and FLAG targets is that the latter cover the specific portion of emissions that is related to the land sector, including, but not limited to, emissions and removals from agricultural and forestry production "up to the farm gate". FLAG targets cover forests, land, and agriculture while a company's energy and industrial targets cover all other fossil-based emissions.

The SBTi provides two approaches to FLAG target setting:

- The FLAG sector pathway for companies with diversified FLAG emissions. In this regard, companies required to set FLAG targets must have land intensive activities in their value chain (food production from animal sources is one of those) or have FLAG-related emissions that total more than 20% of overall emissions across scopes 1, 2 and 3.
- The FLAG commodity pathways, which include 11 pathways for specific commodities: beef, chicken, dairy, leather, maize, palm oil, pork, rice, soy, wheat, and timber & wood fibre. The SBTi FLAG leather-specific pathway is expressed on an intensity basis (i.e., emissions reduction target is measured relative to a specific unit of production or activity – tCO_{2e}/t fresh weight, rather than as an absolute reduction in total emissions).

In summary, the SBTi's FLAG targets is the first framework for companies in sectors to set science-based targets that include land-based emissions reductions, carbon removals and storage.

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Figure 5 provides the main categories in scope for FLAG emissions and carbon removals and storage (SBTi, 2023a).

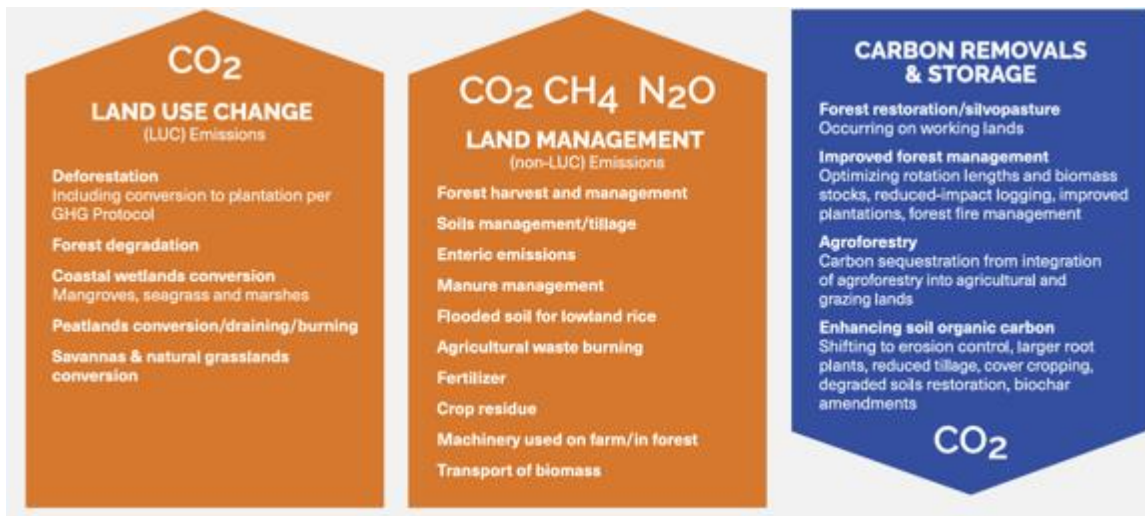


Figure 5: FLAG emissions and removals categories.

It is important to note that the SBTi's FLAG also includes carbon removals and storage. According to the GHG Protocol Land Sector and Removals Guidance, net biogenic CO₂ emissions are defined as decreases in net land carbon stock, whereas net biogenic CO₂ removals refer to increases in net land carbon stock, where carbon is stored for a period of time and meets certain reporting criteria.

Also in this case, the point of particular interest for the leather value chain lies in the recognition of reforestation and enhanced soil organic carbon as valid means for achieving GHG removals under the SBTi FLAG framework.

5. LEATHER: TRENDS AND WORLDWIDE TRADE

5.1 Meat as a protein source on a global scale

This section provides the necessary contextual foundation for recognizing hides and skins as Non-Determining Animal By-products and supports their treatment in LCA as dependent outputs of multifunctional systems. Establishing this background is essential to ensure methodological consistency, especially when assessing allocation rules, system boundaries, and upstream environmental burdens.

As “Non-Determining Animal By-products”, in fact, hides and skins are inherently tied to animal protein production. Analyzing trends in this sector provides insights into the future availability of raw materials for the leather industry.

In 2022, the global population reached 8 billion and is projected to stabilize at around 10 billion by 2100, with growth rates slowing from 2.1% in 1968 to 1.08% in 2019¹⁵.

As developing countries become key players in the global economy, food demand, particularly for animal proteins, has surged.

The share of animal proteins in the human diet increased by 90% from 1961 to 2021¹⁶, with growing livestock production meeting this demand.

Accordingly, as will be evident from analyzing the following six figures, global trends in livestock (bovine, sheep, and goats) have shown an increase over the last 50 years, with a particular sharp rise in the new millennium period.

This trend reflects the growing demand for animal proteins, which has surged alongside the rise in global food demand. The close association between livestock production and the increasing human population highlights the growing need for food to support this demographic shift.

This interpretation is further supported when we examine regional livestock trends: the areas where the population has grown more are also those where the number of bovine, sheep and goat populations have increased.

¹⁵ ourworldindata.org (2024), World population growth, 1970-2100, accessed on 18 Nov. 2024

¹⁶ ourworldindata.org (2021), Daily protein supply from animal and plant-based foods, World, 1961 to 2021, accessed on 20 Nov. 2024

Figure 6 provides a summary of bovine livestock trends from 1972 to 2022 (FAO data)¹⁷, denoting a 50-year trend of + 39% (CAGR: +0.7%).

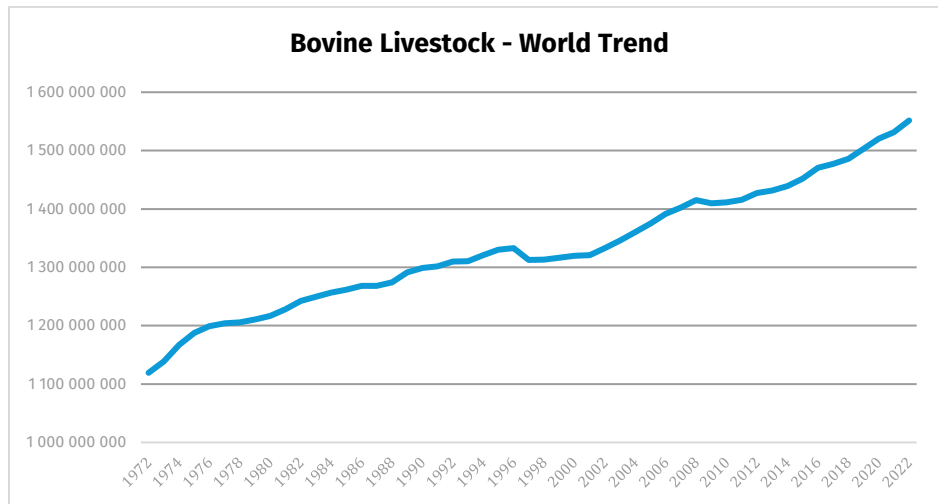


Figure 6: Bovine livestock global trend from 1972 to 2022

5.2 Global production of leather

In 2023 global finished leather production values are estimated by UNIC to be 18.2 billion US\$ (41% Europe, 31% Asia, 10% Latin America, 18% Others).

Italy is the leading global exporter of finished leather (in terms of value) for all major animal origins used in the tanning industry.

When considering global exports of finished leather, Italian exports account for 34% of the total. It is worth noting the significant role played by India as the second-largest global exporter of sheep and goat leather.

The statistics on the world's main importers of the various kinds of finished leather reflect the global framework of leather product manufacturing activities. In line with this, China and Vietnam are the largest importers of bovine leather as they are also two of the most significant global producers of shoes, furniture, and cars (sectors highly utilizing bovine leather) on a global level.

¹⁷ Food and Agriculture Organization, "Meat Market Review, Emerging trends and outlook 2022", UN FAO, 2022

Data for 2023 shows a decrease in production trends for bovine finished leather production volume: 1.082 billion m² (53% Asia, 20% Latin America, 13% Europe, 13% Others). In terms of volume, China is the world's leading producer of bovine finished leather, accounting for an estimated 39% of the total, followed by Brazil (16%) and Italy (8%).

For sheep and goat finished leather production, data for 2023 shows a production volume of 305 million m² (62% Asia, 9% Europe, 29% Others).

China is also the leading global producer of sheep and goat leather, accounting for an estimated 37% of total production, followed by Turkey (17%) and India (8%).

5.3 Global distribution of finished leather usage markets

Leather has long been a versatile material used across various industries. Over the past 20 years, its demand has shifted significantly. Footwear, historically the largest consumer, has declined due to the rise of cheaper synthetic and textile alternatives. Furniture followed a similar trend in the early 2000s but has shown some recovery in recent years. Meanwhile, leather goods and the automotive sector have grown, driven by overall industry expansion. Garments, affected by fashion trends, have become a niche market.

6. LEATHER LCA REQUIREMENTS: HARMONIZATION

6.1 Methodological Outlook

The development of a robust methodology for assessing the environmental impacts of leather has become an especially important global topic. In recent years, LCA results for leather have been utilized in various ways, including scientific publications, information exchanges along the value chain, and as key criteria in international competitions within specific markets.

In this context, the need for the present guidelines has emerged, as specific methodological choices can significantly affect LCA study results, making comparisons challenging. This lack of comparability can arise between different materials of the same type (e.g., two different bovine leathers) or between entirely different materials (e.g., bovine leather and a coated synthetic textile). Such inconsistencies create confusion, particularly for market players that rely on LCA as a key tool for material selection but may lack the expertise to assess specific study quality or understand methodological differences that impact results.

The following figure (Figure 7) illustrates the steps and methodology used to develop the current version of the guidelines.

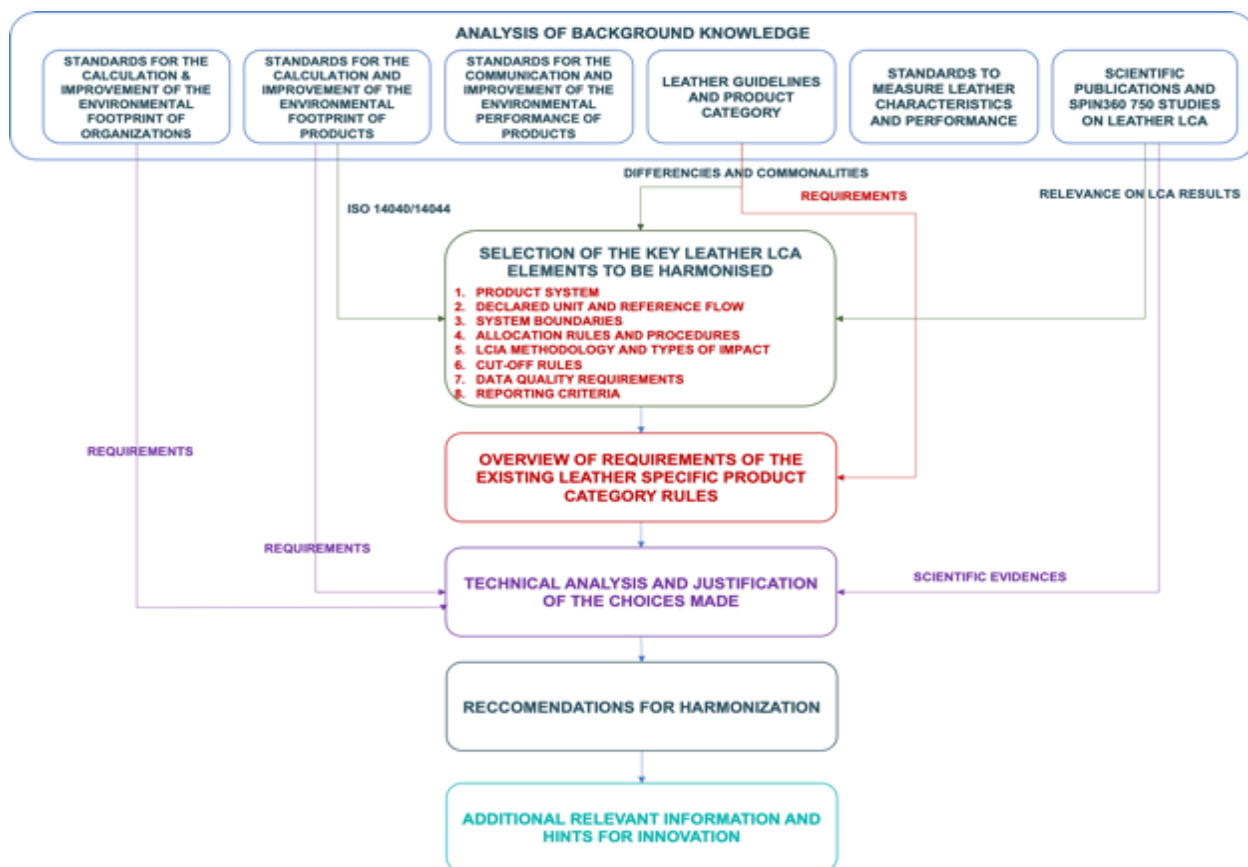


Figure 7: Steps and methodology for the guideline's development

The following paragraphs provide details on each of the steps followed, as well as details on the overview of requirements, justification of choices made, recommendations and additional information and hints for innovation, where relevant.

Over the past three decades, a significant amount of knowledge has been generated on topics highly relevant to the scope of these guidelines, including key definitions, methodologies, and calculation methods.

Four categories of standards encompass the majority of this knowledge, which has been utilized in the development and creation of these guidelines:

1. Standards for the calculation of the environmental footprint of organizations
2. Standards for the calculation of the environmental footprint of products
3. Standards for the communication of the environmental performance of products
4. Leather-specific guidelines and product category rules

The following tables provide details on each category of the selected background knowledge analysed.

6.2 Existing Standards, Guidelines and Guiding Documents

DOCUMENT TYPE: STANDARDS FOR THE CALCULATION AND IMPROVEMENT OF THE ENVIRONMENTAL FOOTPRINT OF ORGANIZATIONS		
YEAR	ORGANIZATION	TITLE
2004	World Resources Institute World Business Council for Sustainable Development,	<i>The Greenhouse Gas Protocol</i>
2014	ISO - International Organization for Standardization	<i>ISO 14046: Environmental management — Water footprint — Principles, requirements, and guidelines</i>
2018	ISO - International Organization for Standardization	<i>ISO 14064-1: Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals</i>
2019	ISO - International Organization for Standardization	<i>ISO 14064-2: Greenhouse gases - part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements</i>
2019	ISO - International Organization for Standardization	<i>ISO 14064-3: Greenhouse gases - Part 3: Specification with guidance for the verification and validation of greenhouse gas statements</i>
2021	ISO - International Organization for Standardization	<i>ISO 14031:2021 Environmental management — Environmental performance evaluation — Guidelines</i>
2025	SBTI – Science Based Target - initiative	<i>SBTI Corporate Net-Zero Standard</i>
2021	European Commission	<i>COMMISSION RECOMMENDATION (EU) 2021/2279 15/12/2021 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations</i>

Table 3: Standards for the calculation and improvement of the environmental footprint of organizations

DOCUMENT TYPE: STANDARDS FOR THE CALCULATION AND IMPROVEMENT OF THE ENVIRONMENTAL FOOTPRINT OF PRODUCTS		
YEAR	ORGANIZATION	TITLE
2002	ISO - International Organization for Standardization	<i>ISO 14062: Environmental management – Integrating environmental aspects into product design and development</i>
2006	ISO - International Organization for Standardization	<i>ISO 14040+A1:2020 - Life Cycle Assessment. Principles and Framework</i>
2006	ISO - International Organization for Standardization	<i>ISO 14044+A2:2020 - Environmental Management. Life Cycle Assessment. Requirements and guidelines</i>
2010	JRC - EU-Joint Research Centre	<i>ILCD Handbook – International Reference Life Cycle Data System</i>
2014	ISO - International Organization for Standardization	<i>ISO 14046: Environmental management — Water footprint — Principles, requirements, and guidelines</i>
2018	ISO - International Organization for Standardization	<i>ISO 14067: Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification</i>
2021	European Commission	<i>Commission Recommendation (EU) 2021/2279 15/12/2021 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations</i>
2021	ISO - International Organization for Standardization	<i>ISO 14031:2021 Environmental management — Environmental performance evaluation — Guidelines</i>
2021	ISO - International Organization for Standardization	<i>ISO 14031:2021 Environmental management — Environmental performance evaluation — Guidelines</i>
2023	ISO - International Organization for Standardization	<i>ISO 14068: Climate change management – Transition to net zero, Part 1: Carbon neutrality</i>
2024	EPD - Environmental Products Declaration (EPD) System	<i>GPI: General Program Instructions, Version 5.0.0 Published on 2024 – 06 - 19</i>

Table 4: Standards for the calculation and improvement of the environmental footprint of products

DOCUMENT TYPE: STANDARDS FOR THE COMMUNICATION AND IMPROVEMENT OF THE ENVIRONMENTAL PERFORMANCE OF PRODUCTS		
YEAR	ORGANIZATION	TITLE
2006	ISO - International Organization for Standardization	<i>ISO 14025: Environmental labels and declarations. Type III environmental declarations. Principles and procedures</i>
2016	ISO - International Organization for Standardization	<i>ISO 14021+A1:2021: Environmental labels and declarations — Self-declared environmental claims (Type II environmental labelling)</i>
2022	ISO - International Organization for Standardization	<i>ISO 14020 Environmental statements and programmes for products — Principles and general requirements</i>

Table 5: Standards for the communication and improvement of the environmental performance of products

DOCUMENT TYPE: <i>LEATHER PRODUCT CATEGORY RULES</i>		
YEAR	ORGANIZATION	TITLE
2017	CEN - European Committee for Standardization	<i>EN 16887 - Leather - Environmental footprint - Product Category Rules (PCR) - Carbon footprints</i>
2018	European Commission	<i>Product Environmental Footprint Category Rules (PEFCR), Final version Apr 25th, 2018 (Expired)</i>
2019	Environmental Products Declaration (EPD) System	<i>Product Category Rules, Finished bovine leather Programme operator: The International EPD® System; Publication date: 2019-05-06 (Version 3.1) (Expired)</i>

Table 6: Leather product category rules

6.3 LCA requirements to be harmonized

As the present guideline is primarily concentrated on life cycle assessment, the choice of the requirements to be harmonized must be in line and fully coherent with the content of ISO 14040 and ISO 14044.

Chapter 4 of ISO 14044 provides a full description of the methodological framework for LCA, including the following paragraphs:

ISO 14044 Point: 4.1 General requirements

- LCA studies shall include:
 - The goal and scope definition
 - The inventory analysis
 - The impact assessment
 - The interpretation of results

ISO 14044 Point: 4.2 Goal and scope definition

The **Goal** and **Scope** of an LCA shall be clearly defined and shall be consistent with the intended application.

Goal of the LCA study

In defining the goal of an LCA, the following items shall be unambiguously stated:

- The intended application
- The reasons for carrying out the study
- The intended audience, to whom the results of the study are intended to be communicated
- Whether the results are intended to be used in comparative assertions and disclosed to the public

Scope of the LCA study

In defining the scope of an LCA, the following items shall be considered and clearly described:

- The product system to be studied
- The functions of the product system or, in the case of comparative studies, the systems
- The functional unit
- The system boundary
- Allocation procedures
- LCIA methodology and types of impacts
- Interpretation to be used
- Data requirements
- Assumptions
- Value choices and optional elements
- Limitations
- Data quality requirements
- Type of critical review if any
- Type and format of the report required for the study

In the case of leather LCAs, some of these elements can have a higher influence on the impact calculation and therefore shall represent the focus of the present guidelines, to allow the required methodological harmonization and the identification of common criteria and methodologies to be used at a global scale.

According to the above, the present guideline focuses on eight key elements to be harmonized and consolidated into a set of clear recommendations to be followed, to minimize uncertainties and methodological differences as much as possible, whilst reflecting the reality of leather production. These elements are listed below:

1. LEATHER: PRODUCT SYSTEM
2. LEATHER: FUNCTIONAL UNIT AND REFERENCE FLOW
3. LEATHER: SYSTEM BOUNDARIES
4. LEATHER: ALLOCATION RULES AND PROCEDURES
5. LCIA METHODOLOGY AND TYPES OF IMPACT
6. CUT-OFF RULES
7. DATA QUALITY REQUIREMENTS
8. REPORTING CRITERIA

6.4 LEATHER: PRODUCT SYSTEM

6.4.1 Review of existing standards and recommended approach

	EPD PCR	PEFCR	EN 16887	RECOMMENDATIONS
PRODUCTS IN SCOPE	"Finished bovine leather"	"Finished leathers produced from raw hides and skins of bovine, ovine and caprine animals, which have been raised mainly for the production of milk, meat or wool, and slaughtered mainly for human consumption purposes, notably meat production."	"Leather", intended as a semi-processed or finished product to either be further processed in the tanning sector or, after completion of all processing steps, in various consumer articles' manufacturing sectors	"Leather", intended as a semi-processed or finished product to either be further processed in the tanning sector or, after completion of all processing steps, in various consumer articles' manufacturing sectors
GEOGRAPHY	Global	Global	Global	Global
PRODUCT DEFINITION	Part of the product group "Tanned or dressed leather; composition leather" and of the product class "Other leather, of bovine or equine animals, furless"	Leather as defined by EN15987:2014: "hide or skin with its original fibrous structure more or less intact, tanned to be imputrescible, where the hair or wool may or may not have been removed, whether or not the hide or skin has been split into layers or segmented either before or after tanning and where any surface coating or surface layer, however applied, is not thicker than 0.15 mm".	Leather as defined by EN15987:2014: "hide or skin with its original fibrous structure more or less intact, tanned to be imputrescible, where the hair or wool may or may not have been removed, whether or not the hide or skin has been split into layers or segmented either before or after tanning and where any surface coating or surface layer, however applied, is not thicker than 0.15 mm".	Leather as defined by EN15987:2022: "hide or skin (of Animal Origin) with its original fibrous structure more or less intact, tanned to be imputrescible, where the hair or wool may or may not have been removed, whether or not the hide or skin has been split into layers or segmented either before or after tanning and where any surface coating or surface layer, however applied, is not thicker than 0.15 mm". Hides and Skins of animals slaughtered for human consumption purposes can be defined as "Non-Determining Animal By-Products", as they are the result of a Multifunctional process of which they do not affect the production volume, or the change in the production volume.
EXCLUSIONS	NA	All leathers produced from hides or skins of animals other than those slaughtered for human consumption, as well as synthetic leather alternatives.	NA	All leathers produced from hides or skins of animals other than those slaughtered for human food consumption
CLASSIFICATION	UN CPC	CPA codes	UN CPC	UN CPC
CODES	Division: 29 - Leather and leather products; footwear Group: 291 - Tanned or dressed leather; composition leather Class: 2912 - Other leather, of bovine or equine animals, furless	15 Leather and related products 15.1 Tanned and dressed leather; luggage, handbags, saddlery and harness; dressed and dyed fur 15.11.3 Leather, of bovine or equine animals, without hair 15.11.4 Leather of sheep, goat or swine, without hair	Division: 29 - Leather and leather products; footwear Group: 291 - Tanned or dressed leather; composition leather	Division: 29 - Leather and leather products; footwear Group: 291 - Tanned or dressed leather; composition leather Class: 2912 - Other leather, of bovine or equine animals, furless

Table 7: Leather - Existing standards and recommended approach

6.4.2 Justification of the choices made

The global dimension of these guidelines reflects needs and effort to create a more consistent global framework.

There is general consensus on the clear definition of leather provided by EN15987:2022, which did not require any significant change in this document, apart from a minor add-on recommended during peer review.

The uniformity of requirements and methodologies in life cycle assessment is highly dependent on the nature and importance of hides and skins as raw materials, therefore the present guidelines do not include references to hides or skins of animals that have not been slaughtered for human food consumption.

During the elaboration of the document, the need for a proper definition of the raw materials of the leather products in scope emerged.

Therefore, the following has been prepared: *Hides and skins of animals slaughtered for human food consumption purposes can be defined as “Non-Determining Animal By-Products”, as they are the result of a multifunctional process of which they do not affect the production volume, or the change in the production volume.*

6.5 DECLARED UNIT AND REFERENCE FLOW

6.5.1 Review of existing standards and recommended approach

	EPD PCR	PEFCR	EN 16887	RECOMMENDATIONS
DECLARED UNIT	The declared unit is 1 m ² of “Finished bovine leather”, measured according to ISO 11646	<p>The Declared Unit (DU) is a square meter (m²) of finished leather, measured according to ISO 11646 standard or EN ISO 19076.</p> <p>For finished sole leather, which is routinely measured and sold by weight (kg), an appropriate conversion factor from weight of finished product to surface area of finished product (kg/m²) shall be used.</p>	NN	The Declared Unit (DU) is a square meter (m ²) of leather, or a kilogram (kg) of sole leather, as routinely measured at the tannery according to ISO 11646 standard or EN ISO 19076.
FUNCTIONAL UNIT	NN	The functional Unit “defines the qualitative and quantitative aspects of the function(s) and/or service(s) provided by the product being evaluated. The functional unit definition answers the questions ‘what?’, ‘how much?’, ‘how well?’, and ‘for how long?’”	The functional unit shall be 1 m ² of leather. For the particular case of sole leather, the functional unit is 1 kg.	<p>What: Precise identification of the leather under study - See paragraph 6.5.2.1</p> <p>How Much: A square meter of leather (kg in case of sole leather), indicating mass intensity and unitary surface – See paragraph 6.5.2.2</p> <p>How Well: the declared unit should include technical performance of the leather under study – See paragraph 6.5.2.3</p> <p>How Long: Leather is an intermediate product and has no expiry date. Its life span depends on its final use but considering that use phase is beyond the system boundaries. “How long?” specification cannot be defined – See paragraph 6.5.2.4</p>
REFERENCE FLOW	The reference flow is the amount of product needed to fulfil the defined function and shall be measured in kg of raw hide or skin/m ²	The reference flow is the amount of product needed to fulfil the defined function and shall be measured in kg of raw hide or skin/m ² . All quantitative input and output data collected in the study shall be calculated in relation to this reference flow.	NN	The reference flow is the amount of product needed to fulfil the defined function and should be measured in kg of raw hide or skin/DU. All quantitative input and output data collected in the study should be calculated in relation to this reference flow.

Table 8: Declared unit and reference flow – Existing standards and recommended approach

6.5.2 Justification of the choices made

ISO 14044 is clear in the definition of the requirements regarding functional units and reference flows. In fact, according to these standards:

The **Functional Unit** is a “quantified performance of a product system for use as a reference unit”¹⁸ and a **Reference Flow** is the “measure of the outputs from processes in a given product system required to fulfil the function expressed by the functional unit”¹⁹.

The functional unit is one of the most important elements of an LCA study. It shall be clearly defined and measurable. The primary purpose of a functional unit is to provide a reference to which the input and output data are normalized (in a mathematical sense). The reference flow is the amount of product needed to provide the defined function. All other input and output flows in the analysis quantitatively relate to it. Having chosen the functional unit, the reference flow shall be coherently defined.

Additionally, in Chapter A.2.1, the EPD General Program instructions introduce the concept of **declared unit**: The declared unit is the reference unit to which the environmental performance of the product is related. In practice, the declared/functional unit consists of a qualitatively defined function or property and its quantification via one or several units.

The latest and more complete approach in the definition of a functional unit is the one adopted in the RECOMMENDATION (EU) 2021/2279, for which, the functional unit: “defines the qualitative and quantitative aspects of the function(s) and/or service(s) provided by the product being evaluated. The functional unit definition answers the questions ‘What?’, ‘How Much?’, ‘How Well?’, and ‘for How Long?’”

This definition:

- Allows for precisely identifying the product under study (**What**)
- Provides a reference to which the input and output data are normalized in a mathematical sense (**How Much**)
- Allows linking the environmental impact of a material with its technical performance and safety characteristics (**How Well**)

¹⁸ ISO 14044 Definition 3.20

¹⁹ ISO 14044 Definition 3.29

Regarding the “**How Long**” function, leather is an intermediate product and has no expiry date. Its lifespan depends on its final use but considering that use phase is beyond the system boundaries, “How Long?” specification cannot be defined.

6.5.2.1 Declared Unit - What?

LCA results in leather making may vary significantly, depending on several factors related to animal origins, raw materials, production processes and the stage of leather for which the results are reported. It is therefore very important to define a set of key elements that contribute to the unambiguous definition of a leather product.

The following ten elements are recommended to define a so-called “Leather Product Family”, that is a categorization of leather products, that have in common all the important characteristics that may represent a technological differentiation in terms of magnitude of environmental impact.

The ten recommended elements for a leather product family identification are:

1. NAME
2. LEATHER TYPE
3. PROCESS STAGE
4. ANIMAL TYPE
5. INTENDED USE
6. THICKNESS RANGE
7. RAW MATERIAL ORIGIN
8. RAW MATERIAL TYPE
9. TYPE OF TANNING
10. TYPE OF RE-TANNING

An eleventh element (TYPE OF FINISHING) may be added, in case the LCA study represents a specific leather product, and not a family.

The “What” function of the declared unit can be expressed in a “sentence-like” form or in a “tabular” form, as described in the following examples:

“SENTENCE LIKE” FORM - EXAMPLE

The material under study is represented by “**Leather-1**”, a grain split finished bovine leather for footwear (upper), 1.8 – 2.0 mm of thickness, starting from American wet salted raw hides, with a chrome tanning, organic re-tanning and aniline finishing²⁰

“TABULAR” FORM - EXAMPLE

PRODUCT UNDER STUDY	
1) PRODUCT FAMILY NAME	<i>“Leather-1”</i>
2) PRODUCT TYPE	<i>GRAIN SPLIT</i>
3) PROCESS STAGE	<i>FINISHED</i>
4) ANIMAL TYPE	<i>BOVINE</i>
5) INTENDED USE	<i>FOOTWEAR</i>
6) THICKNESS RANGE	<i>1.8 – 2.0</i>
7) RAW MATERIAL ORIGIN	<i>COUNTRY – (e.g. US)</i>
8) RAW MATERIAL TYPE	<i>WET SALTED</i>
9) TYPE OF TANNING	<i>CHROME</i>
10) TYPE OF RE-TANNING	<i>ORGANIC</i>
11) TYPE OF FINISHING	<i>ANILINE</i>

Table 9: Product under study

²⁰ Optional

6.5.2.2 Declared Unit - How Much?

The readers and users of the Leather LCA studies need to be provided with three essential pieces of information:

1. The reference unit to which the environmental performance of the product is related
2. The mass intensity of the leather product under study
3. The unitary surface of the product under study

These three elements are essential:

- To properly relate the inventory and impact assessment data to a specific unit
- To use data in subsequent studies of different leather types or finished products
- To allow proper comparison of the environmental performance of products, when needed

The recommended way to express the “How Much” function of the declared unit is tabular, as described in the following tables:


	DECLARED UNIT		
HOW MUCH	Reference unit	1 square meter of leather (1 kg of sole leather), as routinely measured at tannery	
	Mass intensity	(kg/piece)	
	Unitary surface	(m²/ piece)	

Table 10: Declared unit – How much

6.5.2.3 Declared Unit - How Well?

It is commonly understood that the “How Well” function strictly depends on the use for which a material has been designed. In the case of leather, the most important characteristics that can characterize the fit for use of a leather article are represented by:

- Technical compliance: measured through physical tests to evaluate conformity against either customer’s specifications and/or national and international standards
- Chemical compliance: measured through chemical tests to evaluate conformity against customers’ Product Restricted Substances Lists (PRSLs) and/or national and international standards

The recommended way to express the “How Well” function of the declared unit is to explicitly cite the technical compliance of the material to customer’s specifications and standards and to declare the chemical compliance to specific PRSLs and technical standards. The list of reference standards is provided in Annex 4.

The recommendation is also to provide a quantification of the values of the most important tests related to the technical performance of the material. The recommended declarative approach is tabular, as described in the following example:

	DECLARED UNIT			
HOW WELL	The leather article under study is compliant with the following technical reference standards <ul style="list-style-type: none"> • TECHNICAL REFERENCE STANDARD N°1 • TECHNICAL REFERENCE STANDARD N°2... 			
	The leather article under study is compliant with the following technical reference standards <ul style="list-style-type: none"> • CHEMICAL REFERENCE STANDARD (PRSL) N°1 • CHEMICAL REFERENCE STANDARD (PRSL) N°2... 			
	THE TECHNICAL PERFORMANCE OF THE LEATHER ARTICLE UNDER STUDY IS IN PARTICULAR HIGHLIGHTED BY THE FOLLOWING PARAMETERS:			
		PARAMETER²¹²²	(U.O.M.)	VALUE
		Tensile Strength (ISO 3376)	N/mm²	39,5
		Tear Resistance (ISO 3377-1)	N/mm²	82,9
		Flex resistance (ISO 32100)	Flex Cycles to grade >2	200.000

Table 11: Declared unit: How well

6.5.2.4 Declared Unit - How Long?

The EU PEFCR states that “Leather is an intermediate product and has no expiry date. Its lifespan depends on its final use but considering that the use phase is beyond the system boundaries of the PEFCR, the “How Long?” specification cannot be defined.”

In case of a standard application of a LCA study, the recommended approach is to follow the requirements of the PEFCR, and therefore to include the statement as in the following table:

	DECLARED UNIT
HOW LONG	Leather is an intermediate product and has no expiry date. Its lifespan depends on its final use but considering that the use phase is beyond the system boundaries of this LCA study, the “How Long?” specification cannot be defined.

Table 12: Declared unit – How long

²¹ Data included in the article are only to be seen as descriptive examples and not referring to Industry standards

²² Tests referred in this table are for exemplification only. Innovative approaches may include also Accelerated aging techniques, such as for example: Ollé L, Jorba M, Font J, Bacardit A. (2011). Comparison of the Effect of the Tropical Test on Both Chrome-tanned and Wet-white Upholstery Leather. JSLTC.; Thomasset A, Benayoun S. (2024). Assessing the durability of diverse leather tanning techniques for the manufacturing of leather goods through artificial aging processes. Cleaner Engineering and Technology.

6.5.2.5 Reference Flow

The recommended way to express and calculate the reference flow is to take into consideration the amount of kg of raw hide or skin/m² to produce one square meter of leather. All quantitative input and output data collected in the study shall be calculated in relation to this reference flow.

6.5.2.6 Declared Unit - Example

	DECLARED UNIT			
WHAT	PRODUCT NAME	"Leather-1"		
	PRODUCT TYPE	Grain Split		
	PROCESS STAGE	Finished		
	ANIMAL TYPE	Bovine		
	INTENDED USE	Footwear		
	THICKNESS RANGE	1.8 – 2.0		
	RAW MATERIAL ORIGIN	United States		
	RAW MATERIAL TYPE	Wet Salted		
	TYPE OF TANNING	Chrome		
	TYPE OF RE-TANNING	Organic		
	TYPE OF FINISHING ²	Aniline		
HOW MUCH	Reference unit	1 m ² of leather		
	Mass intensity	(kg/piece)	1,04	
	Unitary surface	(m ² / piece)	3,4	
HOW WELL	The leather article under study is compliant with the following technical reference standards			
	<ul style="list-style-type: none"> • TECHNICAL STANDARD N°1 • TECHNICAL STANDARD N°2... 			
	The leather article under study is compliant with the following technical reference standards			
	<ul style="list-style-type: none"> • CHEMICAL STANDARD (PRSL) N°1 • CHEMICAL STANDARD (PRSL) N°2... 			
	THE TECHNICAL PERFORMANCE OF THE LEATHER ARTICLE UNDER STUDY IS IN PARTICULAR HIGHLIGHTED BY THE FOLLOWING PARAMETERS:			
		PARAMETER	(U.O.M.)	VALUE
		Tensile Strength (ISO 3376)	N/mm ²	39,5
	Tear Resistance (ISO 3377-1)	N/mm ²	82,9	
	Flex resistance (ISO 32100)	Flex Cycles to grade >2	200.000	
HOW LONG	Leather is an intermediate product and has no expiry date. Its lifespan depends on its final use but considering that the use phase is beyond the system boundaries of this LCA study, the "How Long?" specification cannot be defined.			

Table 13: Declared Unit - Example

6.5.3 Usable surface concept

6.5.3.1 The “How Much” Function and the concept of usable surface

In paragraph 6.4.3.3, the recommended way to express the “How Much” function of the declared unit is tabular, as described in the following table:

	DECLARED UNIT		
HOW MUCH	Reference unit	1 square meter of leather (1 kg of sole leather), as measured at tannery	
	Mass intensity	(kg/piece)	
	Unitary surface	(m²/ piece)	

Additionally, it is important to underline the fact that declaring only the surface measured at tannery level may not be enough to properly evaluate the quality requirements and performance of the material for its intended use. In this paragraph the aim is only to introduce some important concepts, to improve the availability of common knowledge between tanneries and their customers.

Apart from the specific case of Sole Leather, the vast majority of leather is traded on the basis of its surface. The first phase a piece of leather goes through when entering the production processes of the customer is to be cut into pieces.




A particularly important parameter that governs this important process is the so-called “Cutting Yield,” which can be expressed as follows:

$$\text{Cutting Yield (\%)} = \text{Surface Out (m}^2\text{)} / \text{Surface In (m}^2\text{)}$$

Where:

- **Surface Out** is the total surface of the pieces that the cutting system has been able to obtain from the leather entering the process
- **Surface In** is the surface of leather entering the process

Innovation projects carried out jointly between tanneries and their customers may go in the direction of the optimization of the cutting yield, in order to minimize the environmental impact of consumer products manufacturing. To do this the following definitions and considerations may serve as an important piece of knowledge:

	TOTAL LEATHER SURFACE (TLS)
	<i>Area of leather at the exit gate of the tannery (entry gate of the cutting center)</i>
	GROSS USABLE SURFACE (GUS)
	<i>Area of leather that can be used for the intended purpose due to its good technical characteristics²³</i>
	NON-USABLE SURFACE (NOS)
	<i>Area of leather that cannot be used for the intended purpose, in relation to its poor technical characteristics</i>

The Cutting Yield is maximized when all the leather entering the cutting table has the technical characteristics to allow it to be used on the final product, i.e., to be “cuttable”. In numbers this means that a maximization of Cutting Yield is achievable when:

$$\mathbf{GUS/TLS = 100\%}$$

A low **GUS/TLS** ratio normally implies:

- **At the tannery:** the use of resources (Water, Energy, Chemistry etc.) to produce something that will not be used later
- **At the cutting facility:** an increased production of post-industrial and pre-consumer waste

There are no additional recommendations deriving from the present paragraph, as its main aim is to share knowledge and favour the implementation of innovation projects aiming at reaching the important goal of environmental impact minimization throughout the whole leather-related value chains.

²³ See the “how well” section 1.24.3

6.5.3.2 Environmental amortization

Environmental amortization is the link between environmental and technical performance. An example is e.g. Carbon amortization. Environmental Amortization is a parameter that measures the potential distribution of the environmental impact generated to produce such material over the useful life of the product or material itself.

It is essential for assessing sustainability by tracking the transition from a negative environmental impact during manufacturing to a positive impact during usage.

The useful life is related to its technical performance and to the intended use. Some physical tests in fact are conducted to evaluate and simulate the performance of the product in the defined conditions of use of the consumer products they are used for and in particular their resistance to repetitive stresses experienced in a given application, e.g., flex resistance of leather uppers in footwear.

Environmental amortization or e.g. Carbon amortization is the practice of spreading the total greenhouse gas emissions from manufacturing a product over its expected useful life. By dividing the "embodied carbon" (emissions from raw material extraction and manufacturing) by the number of years or other units of service, we get an annual or per-unit emissions rate, making the upfront environmental cost easier to manage and understand over time.

How it works

- Calculate total embodied carbon: The total emissions generated during a product's production are calculated first.
- Determine useful life: The expected lifespan of the product, typically in years, is determined based e.g. on technical performance.
- Divide: The total embodied carbon is divided by the useful life to find the annual rate.
 - Formula: Amortized Carbon = Total Embodied Carbon / Useful Life or Technical Performance

Benefits to use Environmental Amortization

- *Provides a more manageable metric:* It makes the large upfront carbon cost of a product more accessible for accounting and comparison. Including comparison between different products and/or materials
- *Highlights the importance of product longevity:* It shows that extending the life of a product by using and repairing it reduces the amortized emissions per year.
- *Encourages efficiency:* By making the amortized emissions a key metric, it encourages designing more carbon-efficient products and using e.g. materials more efficiently

It is commonly understood that the “How Well” function strictly depends on the use for which a material has been designed for.

“How well” or technical performance is linked also with “How long” and durability. Technical performance is key to extending the life of apparel & footwear products and thus improving their environmental impacts. It refers to the lifespan of a product and how many times it can be worn given the properties of the different fibers, the resistance (e.g. sole abrasion), and product appearance (e.g. pilling, or colourfastness testing).

Environmental amortization parameter is important for transparency and comparison products and materials. In the case of leather, since very often customers and leather users do not take proper account of how its technical performance can benefit the environmental footprint of their products over time, and this factor may lead in certain cases to the choice and use of alternative materials as a substitute, even if these have lower technical performances and at the end higher environmental impact.

Better technical performances lead to a lower environmental footprint of goods in their use phase due to:

- A reduced number of production and replacement cycles
- A possible reduced need for repair activities during the use phase of the consumer product
- Less frequent replacement leads to less product waste ending up in landfills or being incinerated
- Durable products are a cornerstone of the circular economy, as they stay in use for longer, preserving their value and utility

How to calculate the environmental amortization: an example of leather for footwear

This example aims to better explain the concept of environmental amortization. In the case of a leather product, a set of physical parameters and tests recently used by the FILK Freiberg Institute gGmbH to evaluate the technical performance of leather and of some leather alternatives²⁴ and the corresponding performance values of the material have been used. The example leads the user through 5 steps listed and explained below:

1. Specify the declared unit (What, How Much, How Well)
2. Quantify the unitary environmental impact of the material under analysis

²⁴ Meyer, Michael, Sascha Dietrich, Haiko Schulz, and Anke Mondschein. "Comparison of the technical performance of leather, artificial leather, and trendy alternatives." *Coatings* 11, no. 2 (2021): 226. Data included in the article are only to be seen as descriptive examples and not referring to Industry standards

3. Identify the parameter that best represents the most relevant technical performances (stress) of the material for the intended use
4. Calculate the environmental depreciation of the material
5. Integrate the “How Well” function of the declared unit

The text and tables below explain each of these 5 steps supported by numbers.

1. **STEP 1: Specify the declared unit (What, How Much, How Well).** Here is the example taking into account what is recommended in Par. 6.5.2.6:

	DECLARED UNIT		
WHAT	PRODUCT NAME	“Leather-1”	
	PRODUCT TYPE	Grain Split	
	PROCESS STAGE	Finished	
	ANIMAL TYPE	Bovine	
	INTENDED USE	Footwear	
	THICKNESS RANGE	1.93	
	RAW MATERIAL ORIGIN	United States	
	RAW MATERIAL TYPE	Wet Salted	
	TYPE OF TANNING	Chrome	
	TYPE OF RE-TANNING	Organic	
TYPE OF FINISHING	Aniline		
HOW MUCH	Reference unit	1 square meter of leather as measured at tannery	
	Mass intensity	(kg/piece)	1,04
	Unitary surface	(m ² / piece)	3,4
HOW WELL	The leather article under study is compliant with the following technical reference standards		
	<ul style="list-style-type: none"> • TECHNICAL REFERENCE STANDARD N°1 • TECHNICAL REFERENCE STANDARD N°2... 		
	The leather article under study is compliant with the following technical reference standards		
	<ul style="list-style-type: none"> • CHEMICAL REFERENCE STANDARD (PRSL) N°1 • CHEMICAL REFERENCE STANDARD (PRSL) N°2 		
	THE TECHNICAL PERFORMANCE OF THE LEATHER ARTICLE UNDER STUDY IS IN PARTICULAR HIGHLIGHTED BY THE FOLLOWING PARAMETERS:		
		PARAMETER	(U.O.M.)
	Tensile Strength (ISO 3376)	N/mm ²	39,5
	Tear Resistance (ISO 3377-1)	N/mm ²	82,9
	Flex resistance (ISO 32100)	Flex Cycles to grade >2	200.000
HOW LONG	Leather is an intermediate product and has no expiry date. Its lifespan depends on its final use but considering that the use phase is beyond the system boundaries of this LCA study, the “How Long?” specification cannot be defined.		

2. **STEP 2: Quantify the unitary environmental impact of the material under analysis.**
For exemplification purposes and considering GWP as a reference Impact Category, we can take into consideration **22,4 kg CO_{2e}/m²** of leather²⁵.
3. **STEP 3: Identify the parameter that best represents the most relevant technical performances (solicitations) of the material for the intended use.** For exemplification purposes we have selected ISO 32100 Flex Resistance, measured in Flex Cycles Grade 2. The analysis conducted by FILK during the experiment led to a value for Leather of over 200.000 cycles.
4. **STEP 4: Calculate the environmental amortization of the material** using the formula presented above:

PARAMETER	UNIT OF MEASURE	VALUE
UNITARY IMPACT	kg CO _{2e} /m ² of leather	22,40
FLEX CYCLES	Flex Cycles	200.000
ENVIRONMENTAL DEPRECIATION	kg CO _{2e} /Flex Cycles	0,00012

5. STEP 5: Integrate the “How Well” function of the declared unit

HOW WELL	The leather article under study is compliant with the following technical reference standards		
	<ul style="list-style-type: none"> • TECHNICAL REFERENCE STANDARD N°1 • TECHNICAL REFERENCE STANDARD N°2... 		
	The leather article under study is compliant with the following technical reference standards		
	<ul style="list-style-type: none"> • CHEMICAL REFERENCE STANDARD (PRSL) N°1 • CHEMICAL REFERENCE STANDARD (PRSL) N°2 		
	THE TECHNICAL PERFORMANCE OF THE LEATHER ARTICLE UNDER STUDY IS IN PARTICULAR HIGHLIGHTED BY THE FOLLOWING PARAMETERS:		
	PARAMETER	(U.O.M.)	VALUE
	Tensile Strength (ISO 3376)	N/mm²	39,5
Tear Resistance (ISO 3377-1)	N/mm²	82,9	
Flex resistance (ISO 32100)	Flex Cycles to grade >2	200.000	
Environmental Amortization	kg CO_{2e}/m² Flex Cycles	0,00012	

²⁵ Data provided for exemplification purposes and that does not reflect any default data to be adopted for leather for footwear.

The adoption of this approach is not limited to the comparison of similar materials but also extends to the comparison of different materials that are used for same or similar applications or products and on which similar tests can be performed. This opens new possibilities in purchasing and procurement decisions, allowing not only the initial impact of production to be considered, but also the durability and replacement frequency of a material over time. The link between the environmental amortization of leather and the durability of products will be explored in more detail in section 6.7.1, offering further evidence of how this methodology can contribute to a more sustainable choice of materials.

Extending product life yields a greater environmental impact and benefit than any other measure.

6.6 SYSTEM BOUNDARIES

6.6.1 Review of existing standards and recommended approach

	EPD PCR	PEFCR	EN 16887	RECOMMENDATIONS
GENERAL SYSTEM BOUNDARIES	<p>The International EPD® System uses an approach where all attributional processes from “cradle to grave” should be included using the principle of “limited loss of information at the final product.”</p> <p>The life cycle of products is divided into three different life cycle stages: UPSTREAM attributional processes included:</p> <ul style="list-style-type: none"> • Animal Farming • Slaughtering • Production of chemicals • Production of energy • Manufacturing of packaging <p>CORE processes attributional processes included:</p> <ul style="list-style-type: none"> • Transportation to the core processes • Preparation of the material • Production of the product • Maintenance if activities more frequent than once every three years • Waste treatment of waste generated during manufacturing • Production of electricity and fuels used in the core module <p>DOWNSTREAM processes (from gate-to-grave) are excluded</p>	<p>The system boundaries include the livestock and slaughter phases, as prescribed in the PEFCR Guidance version 6.3.9.</p> <p>As finished leather is an intermediate product, downstream processes such as B2B distribution, further manufacturing into finished consumer products, distribution to customers, use phase and end-of-life treatment of used products are out of scope.</p>	<p>For the leather PCF calculation, the following system boundaries shall be considered:</p> <ul style="list-style-type: none"> • collection of hides and skins from the slaughterhouse floor; • ending at the exit gate of the tannery, but including wastewater treatment, waste, and by-product management, as appropriate. <p><small>NOTE 1 All operations up to and including flaying are excluded from this PCR because they are an integral part of meat production.</small></p>	<p>The product system of leather can be represented as divided into three different life cycle stages:</p> <ul style="list-style-type: none"> • UPSTREAM PROCESSES, (from cradle to entry gate of the tannery) • CORE PROCESSES, (from gate to gate of the tannery) • DOWNSTREAM PROCESSES, are the ones using/managing the outputs of the tannery <p>The following attributional UPSTREAM PROCESSES are to be included:</p> <ul style="list-style-type: none"> • Animal Farming • Slaughtering • Curing • Production Of Chemicals • Energy Production • Water Delivery • Packaging Manufacturing • Transportations <p>The following attributional CORE PROCESSES are to be included:</p> <ul style="list-style-type: none"> • PRODUCTION <ul style="list-style-type: none"> • Beamhouse • Tanning • Post-Tanning, • Finishing • All TRANSPORTS TO CORE PROCESSES • Waste Management • Water treatment <p>DOWNSTREAM processes (from gate-to-grave) are excluded</p>

Table 14: System boundaries – Review of existing standards and recommended approach

6.6.2 Justification of the choices made

A clear reference on the concept of system boundaries can be found again in ISO 14044/2006, which in its chapter 4.3.3 states: “The system boundary determines which unit processes shall be included within the LCA. The selection of the system boundary shall be consistent with the goal of the study. The criteria used in establishing the system boundary shall be identified and explained.”

In addition, very importantly: “The deletion of life cycle stages, processes, inputs, or outputs is only permitted if it does not significantly change the overall conclusions of the study. Any decisions to omit life cycle stages, processes, inputs, or outputs shall be clearly stated, and the reasons and implications for their omission shall be explained.”

International debate has been very intense and sometimes harsh over the past 10-12 years on whether animal farming and slaughtering processes should have been included in leather system boundaries or not.

A result of this international debate is that only two out of the three existing Leather-specific PCRs include them in the system boundaries. In Chapter 3 we have clearly identified hides and skins as **“Non-Determining Animal By-Products”**.

The definition of “Non-Determining Animal By-Products” is based on:

1. Hides and skins are the result of multifunctional processes (animal farming and slaughtering)
2. Hides and skins do not affect the production volume, or the change in the production volume of the multifunctional processes that have generated them (animal farming and slaughtering)

Deleting the multi-functional processes of animal farming and slaughtering would significantly change the overall conclusions of the study.

These two elements above bring us to the conclusion that these two processes shall be considered as part of the Life Cycle of Leather.

6.6.3 Additional Information

6.6.3.1 Technical Boundaries

The recommended approach for the calculation and representation of LCA results of Leather is to include all attributional processes from “**cradle to tannery gate.**”

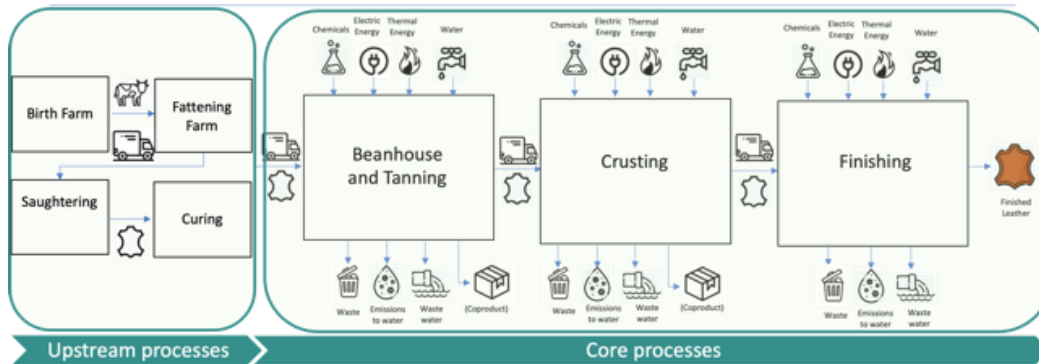


Figure 8: Cradle to tannery gate approach

The processes to be included in each category should represent the actual operative structure of the tanneries involved in the production of the leather product under study. All elementary flows at resource extraction should be included.

The system should not include:

- Manufacturing of production equipment, buildings, and other capital goods
- Business travel of personnel
- Travel to and from work by personnel
- Research and development activities

6.6.3.2 Boundary towards nature

Boundaries to nature are defined as flows of material and energy resources from nature into the system. Emissions to air, water and soil cross the system boundary when they are emitted from or leave the product system.

6.6.3.3 Boundaries in time

The Life Cycle Inventory (LCI) data shall be representative of the calendar year in which they have been collected and declared in the LCA study. As explained in the following paragraph on data quality, time representativeness of the date decreases as the study becomes older.

6.6.3.4 Boundaries towards geography

The data for the upstream process shall be as accurate as possible in terms of geographical representativeness of the country/region where the processes are taking place. The data for

the core module shall be representative of the actual production processes and representative of the site/region where the respective process is taking place.

6.6.4 Hints for innovation

6.6.4.1 The “How Long” Function, and Environmental performance of Consumer products

A particularly important opportunity that leather has as a material is linked to the environmental performance associated with its use of leather in life cycle stages that fall outside of the system boundaries defined above.

The following table provides an overview of the life cycle stages that are part of the product systems of the consumer products made with leather, but that nevertheless could be considered in the environmental performance of such products.

-	PROCESS	NOTES
DOWNSTREAM	CONSUMER PRODUCTS MANUFACTURING	<p>Here leather delivered to the manufacturer is cut in pieces whose number and shape depend on the consumer product that will be manufactured. The two most important characteristics of leather that are pertinent to the LCA of the consumer products in this process are linked to its “Usable Surface” and its possible “End of Life” destinations.</p> <p>For the “Usable Surface” we rely on Paragraph 6.5.3.1: The “How Much” Function and the concept of usable surface.</p> <p>End of Life destinations of leather have an important influence on the manufacturing process, since also here, the offcuts of leather may be treated as Allocatable By-products or as waste, with the consequences described in the following paragraph 6.8.</p>
CONSUMER PRODUCTS	USE	<p>Here the most important characteristic of leather that is pertinent to the LCA of the consumer products is linked to the “Environmental Depreciation²⁶” of leather that are linked with the so called “DURABILITY” of the consumer products itself.</p>
	END OF LIFE	<p>Again, End of Life destinations of leather have an important influence on this Life Cycle Stage of the Consumer product.</p>

Table 15: Overview of the life cycle stages that are part of the product systems of the consumer products made with leather

²⁶ See paragraph 6.5.3.2 for details

In order to link the environmental performance of leather and of the consumer products that are made with leather, it is necessary to start with two basic concepts that have been officially defined by the European Commission in its ESPR Regulation²⁷:

- **Product:** the physical asset that is placed on the market or put into service
- **Durability:** the ability of a product to maintain its function and performance over time under certain conditions of use, maintenance, and repair

An important international debate is underway on how to measure the durability of products, but convergence is occurring around the concept of:

“Duration of Service” (DoS)²⁸: “The lifetime of a product with use appropriate for the functions for which it is intended”

DoS depends on:

- **Inherent durability:** Product-specific attributes that contribute to its potential durability (e.g., physical toughness and design features)
- **Extrinsic durability:** External factors that affect the likelihood of a product reaching its potential lifespan
- **Repairability potential:** The feasibility and ease of restoring the product to working condition when it fails.

It is essential that all three parameters are clearly and rigorously defined to avoid any misunderstanding or ambiguity. A robust and consistent assessment of the DoS relies on precise definitions and agreed-upon criteria for each parameter, ensuring the reliability and comparability of results across products and contexts.

²⁷ REGULATION (EU) 2024/1781 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 June 2024_ ecodesign requirements for sustainable products, amending Directive (EU) 2020/1828 and Regulation (EU) 2023/1542 and repealing Directive 2009/125/EC 28 (2024). *Draft Product Environmental Footprint Category Rules (PEFCR): Apparel and Footwear, Version 2.0*. From https://webgate.ec.europa.eu/cas/login?loginRequestId=ECAS_LR-3610137-OBiJEUT3zfr5YUWKV3lIBWktTfnCwlRrzspWrh5i9KkVwGylZ7wP52jAJS83PjxdYOZpiikOcWXetHeVszPP7TW-yntOf97TTHgRPp5LcAV83u-WGhpEjZBsocUUdSpPoyS3SICWDEuFzS7Zzl1dAiurETJwhcFHDPNSMp5KS1wMgmSAbb59Om

For the purposes of the present guidelines, it is important therefore to link the concept of “**inherent durability**” with the one of “**environmental amortization**”, as described in the previous paragraph 6.5.3.2 and therefore to link the “How Well” function of the declared unit of leather to the “How Long” function of the consumer products made with leather.

This approach could lead to transparency, linking the technical performance of materials with environmental impacts of consumer products, making it evident how durable materials and components lead to durable products and to a reduced environmental impact, when compared to less durable options.

To achieve this, several methodological steps must be followed:

1. Define the “What” declared unit of the consumer product under study
2. Define the “How Much” declared unit of the consumer product under study
3. Define the “Function” of the consumer product
4. Describe the “Use Case” linked with the function
5. Quantify the product’s technical stress linked with the “Use Case” defined
6. Identify the “Determining Material”, the material whose technical performance will influence the DOS of the consumer product
7. Link the products technical stress to the most relevant technical performance of the material
8. Measure the technical performance of the material, linked with the identified parameter
9. Calculate the “Designed DoS,” based on the above

Additionally, if the purpose is also to calculate the environmental performance of the material in the consumer products, the following additional steps should be followed:

10. Measure the environmental impact of the material
11. Measure the use of the material, per declared unit of the consumer product
12. Calculate the environmental impact of the material per use

Also in this case, the best way to explain a common and understood methodological approach is to provide an example, as in the following table²⁹:

²⁹ All the data and technical performance of products and materials, as well as indications of use case scenarios are for exemplification purposes only and should not be considered as reference values or industry standards

1	WHAT	PRODUCT DESCRIPTION	<i>Closed toe women shoes, heel higher than 10 cm</i>
2	HOW MUCH	PRODUCT DESCRIPTION	<i>One pair of closed toe women shoes, size 7</i>
3	FUNCTION	DESCRIPTION OF THE FUNCTION	<i>Elegant shoes to be worn in specific and particular professional and personal occasions</i>
4	USE CASE	DESCRIPTION	<i>The shoes are intended to be worn indoor and in dry conditions, not to be used for commuting or long walks</i>
5	PRODUCT TECHNICAL STRESS	N° OF STEPS	<i>400 (200 per foot)</i>
6	DETERMINING MATERIAL	IDENTIFICATION	<i>Upper Leather³⁰</i>
7	LINK TO TECHNICAL PERFORMANCE	MATERIAL SOLICITATIONS	<i>Flex cycles grade >2</i>
8	MEASURED TECHNICAL PERFORMANCE	FLEX CYCLES GRADE >2	<i>200.000</i>
9	CALCULATED DURATION OF SERVICE	N° OF USES BY DESIGN: FLEX CYCLES GRADE >2/N° OF STEPS PER FOOT	<i>1.000</i>

Additional steps:

10	ENVIRONMENTAL IMPACT OF THE MATERIAL	Kg CO2e/m ² of leather	<i>22,40</i>
11	USE OF THE DETERMINING MATERIAL	m ² of upper leather /pair of shoes	<i>0,2</i>
12	CALCULATED DURATION OF SERVICE	Kg CO2e/ N° OF USES BY DESIGN	<i>0,045</i>

Table 16: Example (2)

³⁰ It is clear that there could be more than one determining materials per consumer product (in the example also sole leather). In this case the evaluation shall be done on all the other ones and the final DOS of the product will be determined by the lower performance per solicitation of the different determining materials

6.7 ALLOCATION RULES

6.7.1 Review of existing Standards and Recommended approach

	EPD PCR	PEFCR	EN 16887	RECOMMENDATIONS
ANIMAL FARMING	<p>BOVINES Subdivision shall be used for processes that can be directly attributed to certain outputs (e.g., energy use and emissions related to milking processes). When the processes cannot be subdivided due to the lack of separate data or because it is technically impossible, the upstream burden, e.g., feed production, shall be allocated to farm outputs using a biophysical allocation method.</p> <p>Default values shall be used by PEF studies unless company-specific data are collected. The change of allocation factors is allowed only when company-specific data are collected and used for the farm module. In case generic data are used for the farm module, no change of allocation factors is allowed and the ones listed below shall be used for reproductive mammals:</p> <ul style="list-style-type: none"> ▪ Milk: 88.0% ▪ Live animal to slaughter: 12.0% <p>For non-reproducing mammals 100% of the impact should be allocated to the "live animal to slaughter".</p>	<p>BOVINES Subdivision shall be used for processes that can be directly attributed to certain outputs (e.g., energy use and emissions related to milking processes). When the processes cannot be subdivided due to the lack of separate data or because it is technically impossible, the upstream burden, e.g., feed production, shall be allocated to farm outputs using a biophysical allocation method. Default values shall be used by PEF studies unless company-specific data are collected. The change of Bovine farming Biophysical allocation factors is allowed only when company-specific data are collected and used for the farm module. In case generic data are used for the farm module, no change of allocation factors is allowed and the ones listed below shall be used:</p> <ul style="list-style-type: none"> • Milk: 88,0% • Live animal to slaughter: 12,0% <p>CAPRINES AND OVINES Subdivision shall be used for processes that can be directly attributed to certain outputs (e.g., energy use and emissions related to milking processes). When the processes cannot be subdivided due to the lack of separate data or because it is technically impossible, the upstream burden, e.g., feed production, shall be allocated to farm outputs using a biophysical allocation method. Default values shall be used by PEF studies unless company-specific data are collected. The change of allocation factors is allowed only when company-specific data are collected and used for the farm module. In case generic data are used for the farm module, no change of allocation factors is allowed and the ones listed below shall be used:</p> <ul style="list-style-type: none"> • Milk: 73,85% • Wool: 23,64% • Live animal to slaughter: 2,51% 	NON-APPLICABLE	<p>ALL SPECIES Subdivision should be used for processes that can be directly attributed to certain outputs.</p> <p>When the processes cannot be subdivided the upstream burdens should be allocated to farm outputs using a biophysical allocation method.</p> <p>The impact should be allocated on the biophysical basis to the different outputs of the Farm, such as for example:</p> <ul style="list-style-type: none"> • Reproductive mammals at the end of career • Milk • Live animals exiting the farm (to another farm or to slaughter) • Wool • Any other Allocatable By-Product <p>Farm specific data should be preferred, including, if possible, calculations on Carbon Mineralization and fixation in soils.</p> <p>In case default or generic data are used, their choice should be duly justified and related data quality highlighted in the LCA Report.</p> <p>For non-reproducing mammals 100% of the impact should be allocated to the "live animal to slaughter".</p>

	EPD PCR	PEF (PEFCR)	EN 16887	RECOMMENDATIONS
SLAUGHTERING ³¹	<p>Subdivision shall be used for processes that can be directly attributed to certain outputs. When the processes cannot be subdivided, the remaining (e.g., excluding that already allocated to milk for milk producing system and/or to wool for wool producing system) upstream burden shall be allocated to slaughterhouse and rendering outputs using the economic allocation method. The default values that shall be used for economic allocation is reported below:</p> <ul style="list-style-type: none"> ▪ Fresh meat and edible offal: 92.9% ▪ Hides and skins: 3.5% ▪ Food grade fat: 1.8% ▪ Food grade bones: 1.0% ▪ Cat. 3 slaug. co-products: 0.8% ▪ Cat 1/2 material & waste: 0.0% No change of allocation factors is allowed. 	<p>Bovine slaughtering Subdivision shall be used for processes that can be directly attributed to certain outputs. When the processes cannot be subdivided, the remaining (e.g., excluding that already allocated to milk for milk producing system and/or to wool for wool producing system) upstream burden shall be allocated to slaughterhouse and rendering outputs using the economic allocation method. The default values that shall be used for economic allocation are reported below:</p> <ul style="list-style-type: none"> • Fresh meat and edible offal: 92,9% • Hides and skins: 3,5% • Food grade fat: 1,8% • Food grade bones: 1,0% • Cat. 3 slaug. By-products: 0,8% • Cat 1/2 material & waste: 0,0% <p>No change of allocation factors is allowed.</p> <p>Ovine slaughtering Subdivision shall be used for processes that can be directly attributed to certain outputs. When the processes cannot be subdivided, the remaining (e.g., excluding that already allocated to milk for milk producing system and/or to wool for wool producing system) upstream burden shall be allocated to slaughterhouse and rendering outputs using the economic allocation method. The default values that shall be used for economic allocation are reported below:</p> <ul style="list-style-type: none"> • Fresh meat and edible offal: 97,8% • Hides and skins: 1,6% • Cat. 3 slaug. By-products: 0,618% • Food grade fat: 0,19% • Food grade bones: 0,0127% • Cat 1/2 material & waste: 0,0% <p>No change of allocation factors is allowed.</p>	NON-APPLICABLE	<p>ALL SPECIES The outputs of a Slaughterhouse can be identified as follows:</p> <ul style="list-style-type: none"> • Fresh meat and edible offal • Food grade fat • Food grade bones • Hides and skins • Cat. 3 slaughtering By-products • Cat 1/2 material & waste <p>The environmental impact for each output of the slaughterhouse should be evaluated using use the Allocation Ratio ³², calculated as follows:</p> $AR = \frac{EA (\%)}{MF (\%)}$ <p>Where: EA (%) is the Economic Allocation of meat and all the other outputs, expressed as the percentage of the value of the output on the total value of all the outputs of the slaughterhouse. MF (%) is the Mass Fraction of meat and all the other outputs, expressed as the percentage of the mass of the output on the total mass of all the outputs of the slaughterhouse. Both EA and MF should be calculated considering the rolling average economic of the past three years, with annual verification of updates; these values should be available in the LCA Report, along with a description of sources and main hypotheses done for the calculation. Supply Chain specific data should be preferred. In case default or generic data are used, their choice should be duly justified and related data quality highlighted in the LCA Report. Default data for Bovine leather are Mass Fraction 7.33 % Economic allocation 1.50 %, as described in Chapter 6.7.3.1.3</p>

³¹ The present table provides a reference only of the requirements included in the analyzed standards. The COMMISSION RECOMMENDATION (EU) 2021/2279 of 15 December 2021 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations provides additional elements also for other animal types. Interesting to not e that for Pig Skins the proposed default allocation at the slaughterhouse is 0%.

³² *Baseline Approaches for the Cross-Cutting Issues of the Cattle Related Product Environmental Footprint Pilots in the Context of the Pilot Phase 2013-2016*

	EPD PCR	PEFCR	EN 16887	RECOMMENDATIONS
CORE PROCESSES	<p>Allocation in leather tanning processes between full grain leather and its co-products shall be based on the hide substance content.</p> <p>Allocatable by-products considered:</p> <ul style="list-style-type: none"> • Grain Split • Flesh Split • Hair 	<p>Allocation in leather tanning processes between full grain leather and Bovine raw substance its co-products shall be based on the hide substance content.</p> <p>Allocatable by-products considered:</p> <ul style="list-style-type: none"> • Grain Split • Flesh Split • Hair 	<p>Allocation between different products and by-products (e.g., fleshings) shall be based on weight in proportion to the different products and co-products</p> <p>Allocation between different products and co-products (e.g., splits) shall be based on surface area in proportion to the different products and co-products.</p>	<p>Allocation factors to be applied in the different core processes should be calculated according to the following steps:</p> <ol style="list-style-type: none"> 5. Identification of all offcuts generated during the process and their destination 6. Verification of the definition of Allocatable By-products 7. Mass balance calculation 8. Allocation factors calculation <p>Tannery/Supply Chain specific data should be preferred. In case default or generic data are used, their choice should be duly justified and related data quality highlighted in the LCA Report.</p> <p>Potential Allocatable by-products to be considered:</p> <ul style="list-style-type: none"> • Recovered Hair • Green Fleshings • Green Splits • Lime Fleshings • Lime Trimmings • Lime Splits • Tanned Shavings • Tanned Splits • Tanned Trimmings • Crust Trimmings • Crust Buffing Dust • Finished Trimmings

Table 17: Allocation rules – Existing standards and recommended approach

6.7.2 Justification of the choices made

6.7.2.1 Allocation and Attributional LCA

Life Cycle Assessment can be performed following the “Attributional” or the “Consequential” modelling approaches. As defined by the ILCD Handbook, the Attributional approach “depicts the potential environmental impacts that can be attributed to a system (e.g., a product) over its life cycle, i.e., upstream along the supply-chain and downstream following the system's use and end-of-life value chain. Attributional modelling makes use of historical, fact-based, measurable data of known (or at least know-able) uncertainty, and includes all the processes that are identified to relevantly contribute to the system being studied.” Omissis..” In attributional modelling the system is hence modelled as it is or was.” (ILCD Handbook, page 71).

On the other hand, still from the ILCD Handbook, the Consequential approach, “ [...] aims at identifying the consequences that a decision in the foreground system has for other processes and systems of the economy, both in the analyzed system's background system and on other systems. It models the analyzed system around these consequences. The consequential life cycle model is hence not reflecting the actual (or forecasted) specific or average supply-chain, but a hypothetical generic supply-chain is modelled that is identified along market-mechanisms and potentially including political interactions and consumer behavior changes.” (ILCD Handbook, page 72).

One more element of methodological alignment comes from the EPD system, whose “General Program Instructions,” section “A.1 MODELLING APPROACH” states: “The LCA modelling approach of the International EPD System is attributional LCA (in contrast to consequential

LCA), meaning that:

- Specific or average data shall be used (i.e., not marginal data), and
- Allocation problems that cannot be avoided by subdividing the unit process into two or more subprocesses, shall be solved via allocation..”

As a consequence of this, and as these Guidelines are meant to harmonize approaches for the environmental footprint of leather and not to harmonize methodologies to elaborate long term strategies that evaluate possible scenarios, we must consider the “Attributional” modelling approach.

Same applies to all other relevant documents that represent the important background knowledge that we analyze in every chapter here, such as PCRs, PEFCRs.

In Attributional LCA, the impacts of a process shall be attributed to all the outputs of the same process that are not a waste, these are called “Multifunctional processes.” In other words, Allocation is the method applied in the attributional approach to convert multi-product activities into single-product activities when partition or subdivision of product system flows is not possible.

ISO 14040 provides the definition **3.17 of Allocation**: “partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems”

More in particular ISO 14040 defines this stepwise procedure for multifunctional processes:

1. Allocation shall be avoided, if possible, by dividing the unit process into two or more sub-processes and collecting the environmental data related to these sub-processes
2. If allocation cannot be avoided, the inputs and outputs of the system shall be partitioned between its different products or functions in a way that reflects the underlying physical relationships between them; i.e., they should reflect the way in which the inputs and outputs are changed by quantitative changes in the products or functions delivered by the system
3. Where physical relationships alone cannot be established or used as the basis for allocation (or they are too time consuming), the most suitable allocation procedure shall be used and documented

A consistent methodology to be applied to the leather product system refers to the “Allocation and cutoff by classification” approach well described in the article related to the Ecoinvent fundamentals³³.

In the Allocation and cutoff by classification System model, all exchanges within the Technosphere are classified into:

- Main products³⁴
- Allocatable by products
- Recyclable materials
- Wastes

³³ <https://support.ecoinvent.org/system-models#Allocationclassification>

³⁴ Add on by the author for clarity, in the original approach of the cutoff by classification System model there is no distinction between main products and allocatable by-products

In this system model, wastes are the producer's responsibility ("polluter pays principle"), and there is an incentivization to transform all outputs of processes into "Allocatable by-products" and into "Recyclable materials" to reduce the overall environmental impacts of the product system.

The classification is based on expert judgment of an exchange's value, use potential, and predicted fate. Depending on this classification, by-products (i.e., products that are not the reference flow) in multi-functional activities are handled differently³⁵.

To facilitate the interpretation of these rules for the Leather Product system, the following definitions and related allocation procedures are proposed:

The **Main Product** of a multifunctional process is the product for which the production process is taking place. Within the activities' system boundaries that include the production of leather, main products can be represented by milk (in dairy farms), meat (in beef farms and in slaughterhouses), finished leather (in tanneries). **Main products** are allocated against other products based on the allocation factors specified for the specific system model, e.g., on physical relations, energy, price, or mass.

To be defined as an **Allocatable By-Products**, an output of a multifunctional process shall:

1. Have economic value. This may be reflected in an economic gain or in an avoided cost for the facility producing it
2. Be intentionally produced, potentially also through specific technological setups, in order to increase the fitness for purpose of the output
3. Be then "transformed in" or "used as" a usable product with a dedicated market

In case of leather making and specifically in the core processes, examples of allocatable by-products may include:

- Fleshings to tallow
- Fleshings to biostimulants
- Recovered hair to fertilizers or keratin production
- Lime splits and trimmings to gelatine
- Tanned flesh splits to re-tanning and finishing
- Finished leather scraps to reuse

³⁵ Theecoinvent database version 3 (part I): overview and methodology Gregor Wernet & Christian Bauer & Bernhard Steubing & Jürgen Reinhard 5 & Emilia Moreno-Ruiz 1 & Bo Weidema; International Journal of Life Cycle Assessment (2016)

Allocatable By-Products are allocated against other products based on the allocation factors specified for the specific system model, e.g., on physical relations, exergy, price, or mass.

Recyclable Materials have no economic value but there is interest in collecting them, as they can serve as inputs or resources for recycling (upcycling and downcycling) activities. The producer often has to pay to have someone else collect the materials. In the case of leather making, and specifically in the core processes, examples of recyclable materials may include finished leather scraps to fertilizers.

Recyclable materials are separated from the producing product system, meaning they are removed without any associated burden from the production activity, and no impacts or benefits are allocated to them. They are then available free of burden to any recycling activities.³⁶

Wastes are materials with no economic value and for which no interest exists in collection and disposal without compensation from third parties for such services. The producer typically has to pay to dispose of these materials, thereby consuming the service of disposing of them. In the case of leather making, and specifically in the core processes, examples of **waste products** may include sludge from water treatment to landfill.

Wastes are disposed of in a treatment activity, and the burden of the disposal is completely attributed to the activity producing the waste. As the burdens of waste treatment are to be fully attributed to the producing activity of the waste, any non-waste by-products of waste treatments (e.g., heat from waste incineration) are available free of burden in the system model.

As the geographical scope of these guidelines is global, there are relevant distinctions in applying the above-defined rules that need to be clarified:

1. There may be significant differences in the application of environmental legislation, meaning that some outputs of the processes may be classified differently by law in different countries. This may lead to variable possibilities to valorize the outputs of multifunctional processes. For example, the EU legislation on waste defines specific waste codes for outputs from tanneries, which are treated differently elsewhere in the world.
2. There may be relevant differences in geography and the availability of logistic solutions that enable the valorization of the outputs. For example, raw hides that cannot be collected in certain regions, leading them to be classified as waste.
3. There may be significant differences in economic conditions and technological development that can allow the valorization of the outputs of multifunctional processes.

³⁶ Secondary materials thus bear only the burden of the recycling process and no burdens from the primary production of the material.

As an example, fleshings may be converted into high value biostimulants or other products in some regions of the world, while being landfilled in others.

For these reasons, the same output of a multifunctional process can be an Allocatable By-Product in some specific conditions and a Waste Product in others.

The Classification of the output material in one of the categories above should be very well justified in the LCA report, as it is an important parameter to influence the results of the LCA itself.

The following flowchart represents a synthesis of the different steps that need to be taken for a proper allocation process.

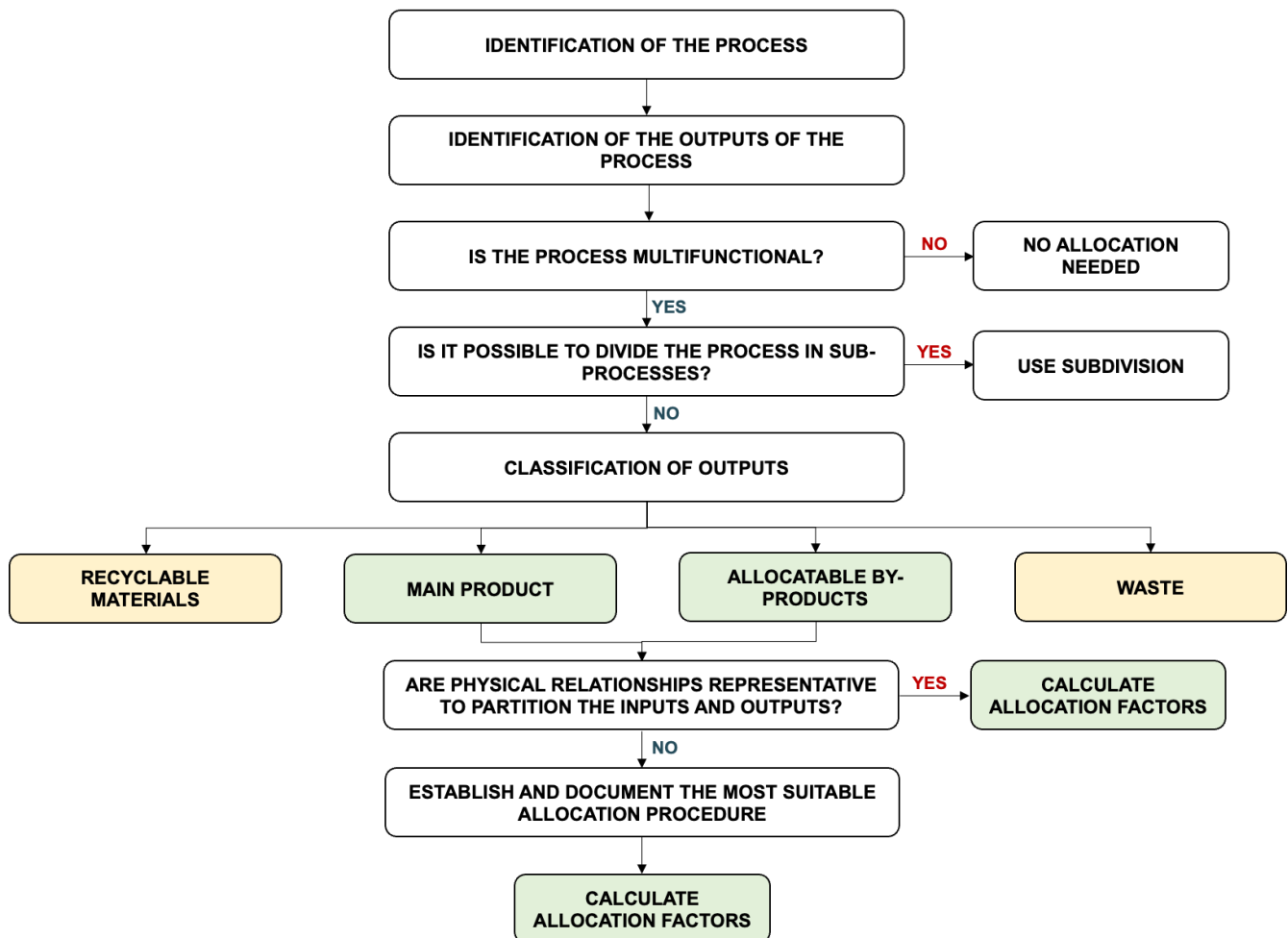


Figure 9: Steps to be considered for a proper allocation process

6.7.3 Additional Information

6.7.3.1 Upstream processes

The recommendation provided in the former section 6.1 foresees that a portion of the environmental impacts of animal farming and slaughtering should be allocated to hides and skins.

This topic has been the subject of extensive debate over the years by the scientific community and among stakeholders, and even now disparities persist. Among the three Product Category Rules that have been analyzed, EPD PCR and PE FCR include animal farming and slaughtering while EN 16887 does not include animal farming and slaughtering within the system boundaries of the leather lifecycle.

During the review the Guidelines consensus could not be achieved. The issue remains whether hides and skins are to be classified as “allocatable by-products” (in other words co-product) or “recyclable materials” (by-products).

Keeping aligned with widely used methodologies, the approach recommended in these Guidelines retains an allocation on hides and skins. Consequently, it is recommended to always display the footprint of the upstream process separate from the core process.

6.7.3.1.1 Animal Farming

As described in detail in Chapter 3, hides and skins of animals slaughtered for human food consumption purposes can be defined as “Non-Determining Animal By-Products”, as they are the result of a multifunctional process of which they do not affect the production volume, or the change in the production volume.

This means that hides and skins are not drivers of any environmental change, as the processes they derive from are carried out mainly for other “Determining Products.” Stakeholders linked with a specific leather supply chain share the animal farming element with other players, who are active in different industrial sectors, such as for example meat, milk, feed, wool, etc.

This is particularly important both for the proper environmental impact assessment of the different outputs of animal farming, and (even more importantly) for the proper definition of environmental improvement strategies of the farming systems.

Following the recommended approach, some clarifications are needed to provide the basis for a harmonized approach in allocation both of animal farming and of slaughtering.

The combination of the stepwise procedure for multifunctional processes defined by ISO 14040 and the “Allocation and cutoff by classification” approach for animal farming is summarized in the following “Allocation Check List”³⁷

ALLOCATION CHECK LIST: ANIMAL FARMING – EXAMPLE DAIRY FARM			
1	IDENTIFICATION OF THE PROCESS	ANIMAL FARMING	
2	IDENTIFICATION OF THE OUTPUT OF THE PROCESS	<ul style="list-style-type: none"> • MILK • LIVE ANIMALS EXITING THE FARM (TO ANOTHER FARM OR TO SLAUGHTER) • WOOL (AND OTHER ANIMAL FIBERS) • ANY OTHER ALLOCATABLE BY-PRODUCT (TO BE SPECIFIED) 	
3	IS THE PROCESS MULTIFUNCTIONAL?	YES	
4	IS IT POSSIBLE TO DIVIDE THE PROCESS IN SUB-PROCESSES?	NO ³⁸	
5	CLASSIFICATION OF OUTPUTS	MAIN PRODUCT	MILK
		ALLOCATABLE BY-PRODUCTS	LIVE ANIMALS EXITING THE FARM
		RECYCLABLE MATERIALS	(FARM SPECIFIC)
		WASTE	(FARM SPECIFIC)
6	REPRESENTITIVENESS OF PHYSICAL RELATIONSHIPS	NO	
7	MOST SUITABLE ALLOCATION PROCEDURE	BIOPHYSICAL ³⁹	

Table 18: Allocation check list

³⁷ The table is just for exemplification purposes, as “The classification is based on expert judgment of an exchange’s value, use potential, and predicted fate” and as same specific product output can be a waste in certain operative conditions and a “Non-Waste output” in others.

³⁸ It is not possible to divide the process of animal farming into single sub-process, associated with single outputs. This condition does not allow subdivision.

³⁹ There are several different Biophysical methodologies and approaches. Their selection and evaluation is out of scope of the present guidelines. Nevertheless it is important to note that, even if the PEFCR proposed biophysical approach is based on **energy partitioning** (e.g., equations 7,8 9, and references 43 and 44), and is based on the IPCC 2006 NGGI guidance to calculate emissions. Specific research and papers on animal farming LCA suggest instead protein-based biophysical allocations as more appropriate.

6.7.3.1.2 Slaughtering

The combination of the stepwise procedure for multifunctional processes defined by ISO 14040 and the “Allocation and cutoff by classification” approach for slaughtering is summarized in the following “Allocation Check List”⁴⁰

ALLOCATION CHECK LIST: SLAUGHTERING			
1	IDENTIFICATION OF THE PROCESS	SLAUGHTERING	
2	IDENTIFICATION OF THE OUTPUT OF THE PROCESS	<ul style="list-style-type: none"> • FRESH MEAT AND EDIBLE OFFAL • FOOD GRADE FAT • FOOD GRADE BONES • HIDES AND SKINS • CAT. 3 SLAUGHTERING BY-PRODUCTS • CAT 1/2 MATERIAL & WASTE 	
3	IS THE PROCESS MULTIFUNCTIONAL?	YES	
4	IS IT POSSIBLE TO DIVIDE THE PROCESS IN SUB-PROCESSES?	NO ⁴¹	
5	CLASSIFICATION OF OUTPUTS	MAIN PRODUCT	FRESH MEAT
		ALLOCATABLE BY-PRODUCTS	FOOD GRADE FAT FOOD GRADE BONES HIDES AND SKINS CAT. 3 SLAUGHTERING BY-PRODUCTS
		RECYCLABLE MATERIALS	(SUPPLY CHAIN SPECIFIC)
		WASTE	CAT 1/2 MATERIAL & WASTE
6	REPRESENTITIVENESS OF PHYSICAL RELATIONSHIPS	NO	
7	MOST SUITABLE ALLOCATION PROCEDURE	ALLOCATION RATIO: $AR = \frac{EA (\%)}{MF (\%)}$	

Table 19: Allocation check list – Slaughtering (1)

Slaughtering occurs due to the demand for meat. Therefore, meat is the “determining product” for slaughtering. If physical relationships (mass) were used as a reference for allocation at the slaughterhouse, the role of meat would not be evident, as the impacts of all outputs of the slaughterhouse would be the same.

⁴⁰ The table is just for exemplification purposes, as “The classification is based on expert judgment of an exchange’s value, use potential, and predicted fate” and as same specific product output can be a waste in certain operative conditions and a “Non-Waste output” in others.

⁴¹ It is not possible to divide the process of animal farming (input to slaughtering) into single sub-process, associated with single outputs of the slaughterhouse. This condition does not allow subdivision.

The use of the allocation ratio, as proposed by the Cattle Model Working Group⁴² instead reflects the relative importance of the different outputs of the slaughterhouse, as well as assigning this “importance” (and the consequent environmental impacts) to a specific output, characterized by its mass.

$$\textit{Allocation Ratio (AR)} = \frac{\textit{EA} (\%)}{\textit{MF} (\%)}$$

Where:

EA (%) is the Economic Allocation of meat and all the other outputs, expressed as the percentage of the value of the output on the total value of all the outputs of the slaughterhouse.

MF (%) is the Mass Fraction of meat and all the other outputs, expressed as the percentage of the mass of the output on the total mass of all the outputs of the slaughterhouse.

Supply Chain specific data should be preferred for the calculation of the Allocation Ratio. In case default or generic data are used, their choice should be duly justified and related data quality highlighted in the LCA Report.

In order to mitigate the consequences of market variations and price fluctuations, both EA and MF should be calculated considering the rolling average economic data of the past three years, with annual verification of updates; these values should be available in the LCA Report, along with a description of sources and main hypotheses made for the calculation.

6.7.3.1.3 Slaughtering: Default Allocation Factors

During the pilot phase of the PEFCR, the EU Commission supported the work of the so-called “Cattle Model Working Group” (CMWG), which issued a report defining the default values for allocation at the slaughterhouse level for bovines⁴³: EA 3,5%, MF 7%, leading to an allocation ratio of 0,5.

This 3,5% economic allocation adopted by the PEFCR has been widely adopted on a global scale, even if under profound discussion for years among industry players.

⁴² *Baseline Approaches for the Cross-Cutting Issues of the Cattle Related Product Environmental Footprint Pilots in the Context of the Pilot Phase 2013-2016. Report prepared by DG ENV A1 in the context of the Environmental Footprint Pilot phase (2013-2016).*

⁴³ *Baseline Approaches for the Cross-Cutting Issues of the Cattle Related Product Environmental Footprint Pilots in the Context of the Pilot Phase 2013-2016” - Table 1 page 14*

Analyzing in detail the data sources that are at the origin of such data, the conclusion drawn is that the Allocation Ratio 0,5 should not be adopted as a default value at global scale.

The main reasons behind this recommendation are linked with the data quality and in particular:

- **Geographical representativeness:** Data refer only to the Netherlands
- **Time representativeness:** Data derived from a study carried out in 2009 and some 2014 - 2015 selected sources

Studies conducted by SPIN360 demonstrate that the allocation factors calculated in the PEFCR might not correspond to the current reality of the industry and allow us to propose a new Default Allocation Ratio based on primary data of the past three years.

The statistical analysis has been based on 299 studies executed by SPIN360 between 2022 and 2024 referring to finished leather from adult bovines, processed in 87 tanneries located in 26 different countries. As the work included the identification of the economic allocation and mass fractions of the raw materials purchased, all tanneries have involved their suppliers in order to collect primary and specific data.

Based on the study conducted by SPIN360, the averages for mass fraction and economic allocation are respectively **7.33 %** (standard deviation: 0.024) and **1.50 %** (standard deviation: 0.00925). The median value for mass fraction distribution is 7.00 %, while for economic allocation 1.06 %. Apart from a limited number of exceptional cases related to economic allocation, both distributions present a very limited interval of two standard deviations where more than 80 % of all values are collected.

Accordingly, the following information should be adopted in case no primary data are available for allocation factors:

Economic Allocation: 1,50 %
Mass Fraction: 7,33 %

The corresponding Allocation Ratio that derives from this value is 0,205.

$$EA 1,50 \% / MF 7,33 \% = AR 0,205$$

Even if studies with primary data on Economic allocation and Mass fraction have been conducted by SPIN360 also on other materials and animal types (mainly Ovines and Caprines),

their statistical representativeness is not enough to propose the results as global average defaults.

Further knowledge should be developed in order to provide the international community of leather makers and users (but not only) with updated data from stable and reliable sources. This is going to be one of the crucial next steps deriving from the effort of drafting the present guidelines.

6.7.3.2 Core Processes

The combination of the stepwise procedure for multifunctional processes defined by ISO 14040 and the “Allocation and cutoff by classification” approach for Core Processes can be summarized as in the following “Allocation Check List”⁴⁴

ALLOCATION CHECK LIST: CORE PROCESSES			
1	IDENTIFICATION OF THE PROCESS	CORE PROCESSES (TANNERY GATE-TO-GATE)	
2	IDENTIFICATION OF THE OUTPUT OF THE PROCESS	<ul style="list-style-type: none"> • LEATHER • RECOVERED HAIR • GREEN FLESHINGS • GREEN SPLITS • LIME FLESHINGS • LIME TRIMMINGS • LIME SPLITS • TANNED SHAVINGS • TANNED SPLITS • TANNED TRIMMINGS • CRUST TRIMMINGS • CRUST BUFFING DUST • FINISHED TRIMMINGS 	
3	IS THE PROCESS MULTIFUNCTIONAL?	YES	
4	IS IT POSSIBLE TO DIVIDE THE PROCESS IN SUB-PROCESSES?	NO	
5	CLASSIFICATION OF OUTPUTS	MAIN PRODUCT	LEATHER
		POTENTIAL ALLOCATABLE BY-PRODUCTS	<ul style="list-style-type: none"> • RECOVERED HAIR • GREEN FLESHINGS • LIME FLESHINGS • LIME TRIMMINGS • LIME SPLITS • TANNED SPLITS • CRUST BUFFING DUST • FINISHED TRIMMINGS
		POTENTIAL RECYCLABLE MATERIALS	<ul style="list-style-type: none"> • TANNED SHAVINGS • TANNED TRIMMINGS • CRUST TRIMMINGS • CRUST BUFFING DUST • FINISHED TRIMMINGS

⁴⁴ The table is just for exemplification purposes, as “The classification is based on expert judgment of an exchange’s value, use potential, and predicted fate” and as same specific product output can be a waste in certain operative conditions and a “Allocatable By-products” in others.

		WASTE	• WASTEWATER SLUDGE
6	REPRESENTITIVENESS OF PHYSICAL RELATIONSHIPS	YES, DRY MATTER CONTENT	
7	MOST SUITABLE ALLOCATION PROCEDURE		

Table 20: Allocation check list – Slaughtering (2)

All hide-related offcuts and their destination shall be identified during data collection. The life cycle stage here identified is the production (core processes) of leather in four different phases: beamhouse, tanning, crusting, and finishing. The reference flow is identical for all four phases, and it is represented by 1 square meter of leather at the factory gate.

Dry matter content provides the most appropriate allocation factor for environmental burdens in core processes of leather manufacturing. The dry mass allocation factor is also consistent with the specific physical properties of leather offcuts, including hair, trimmings, shavings, etc. To determine the dry matter of leather and all offcuts resulting from its production, a mass balance calculation is required. Calculating mass balance requires ascertaining that the dry mass of the different categories defined above during the manufacturing of leather is correctly measured, providing precise allocation factors of environmental burdens.

The mass balance procedure requires drying of both the main product and its production offcuts. Mass balance is ensured when the dry matter weight of the input (raw material) minus the dry matter of all offcuts returns the dry matter of the main finished product.

The process of leather drying is defined by measuring the weight of leather after multiple over drying passes in the oven. The dry matter is therefore the weight of leather that is reached when the difference between the weight before and after the last drying pass is below a certain cut-off (usually 10^{-3} g), as established also in the ASTM D3790-79 standard (Standard Test Method for Volatile Matter (Moisture) of Leather by Oven Drying).

The drying process is extremely important, as errors in calculation of the dry matter content of leather might result in the over- or underestimation of the dry matter weight of leather. A relevant component of mass balance is not only the matter of raw material being processed, but also the amount of chemicals that bind to leather during wet processes, therefore increasing its weight. Accordingly, specific correction factors are introduced in order to account for chemicals that are deposited on the leather during wet processes and readjust the mass balance accordingly.

6.8 IMPACT METHODS

6.8.1 Review of existing Standards and Recommended approach

METHOD	INDICATOR	UOM/m ² of leather	EPD PCR	PEFCR	EN 16887	RECOMMENDATIONS
EF 3.1	CLIMATE CHANGE	kg CO ₂ eq	INCLUDED	INCLUDED	INCLUDED	INCLUDED
EF 3.1	BIOGENIC	kg CO ₂ eq	INCLUDED	INCLUDED	INCLUDED	INCLUDED
EF 3.1	FOSSIL	kg CO ₂ eq	INCLUDED	INCLUDED	INCLUDED	INCLUDED
EF 3.1	LAND USE/LAND USE CHANGE	kg CO ₂ eq	INCLUDED	INCLUDED		INCLUDED
EF 3.1	OZONE DEPLETION	kg CFC-11 eq	INCLUDED	INCLUDED		INCLUDED
EF 3.1	IONISING RADIATION	kBq U235 eq		INCLUDED		INCLUDED
EF 3.1	PHOTOCH. OZONE FORMATION	kg NMVOC eq	INCLUDED	INCLUDED		INCLUDED
EF 3.1	PARTICULATE MATTER	disease incidence		INCLUDED		INCLUDED
EF 3.1	HUMAN TOXICITY, NON-CANCER	CTUh		INCLUDED		INCLUDED
EF 3.1	HUMAN TOXICITY, CANCER	CTUh		INCLUDED		INCLUDED
EF 3.1	ACIDIFICATION	mol H ⁺ eq	INCLUDED	INCLUDED		INCLUDED
EF 3.1	EUTROPHICATION, FRESHWATER	kg P eq	INCLUDED	INCLUDED		INCLUDED
EF 3.1	EUTROPHICATION, MARINE	kg N eq	INCLUDED	INCLUDED		INCLUDED
EF 3.1	EUTROPHICATION, TERRESTRIAL	mol N eq	INCLUDED	INCLUDED		INCLUDED
EF 3.1	ECOTOXICITY, FRESHWATER	CTUe		INCLUDED		INCLUDED
EF 3.1	LAND USE	Pt		INCLUDED		INCLUDED
EF 3.1	WATER USE	m ³ world eq		INCLUDED		INCLUDED
EF 3.1	RESOURCE USE, FOSSILS	MJ		INCLUDED		INCLUDED
EF 3.1	RESOURCE USE, MINERALS & METALS	kg Sb eq		INCLUDED		INCLUDED
CML1a BAS. 2013	EUTROPHICATION	kg PO ₄ ³⁻ eq	INCLUDED			INCLUDED
CML1a BAS. 2013	ABIOTIC DEPLETION, ELEMENTS	kg Sb eq	INCLUDED			INCLUDED
CML1a BAS. 2013	ABIOTIC DEPLETION, FOSSIL FUELS	MJ	INCLUDED			INCLUDED
AWARE	WATER DEPRIVATION POTENTIAL	m ³	INCLUDED			INCLUDED
USETOX	HUMAN TOXICITY	CTUh				INCLUDED
USETOX	ECOTOXICITY	CTUh				INCLUDED
SINGLE SCORE	MULTIPLE IMPACT CATEGORIES	Pt		INCLUDED		INCLUDED

Table 21: Impact methods – Existing standards and recommended approach

6.8.2 Justification of the choices made

Selection of impact indicators for leather LCA should be determined by three main drivers:

1. Indicators that can describe the environmental footprint of anthropogenic activities on the planetary boundaries, therefore allowing a holistic assessment of the human impact on global ecosystems and climate. A strict relation between impact indicators from methodologies such as the European EF 3.1 and EPD PCR and the planetary boundaries has been established⁴⁵, therefore allowing the calculation of environmental burdens based on the holistic framework and considering all potential hotspots in the impact of industries and products.
2. International compatibility standards are determined by institutions and accepted by certification bodies.
3. Indicators prevalently used by the market and its actors to facilitate exchange of information on the life cycle impact of multiple products and, in particular, natural products, focusing on supply chain information collection and key performance indicators of their sustainability.

On the international level, the Environmental Footprint framework developed by the European platform on LCA provides the most authoritative source for characterization methods and selection of impact factors toward the definition of product environmental footprint category rules (PEFCR) and Organizational Environmental Footprint Sectorial Rules (OEFSR), which are shared within and outside the European Union and constitute the basis for the decarbonization plans of the Consortium of Nations.

The Environmental Footprint (EF) 3.1 framework includes sixteen specific impact indicators, which collect multiple characterization methods developed for LCA that have become an established standard.

⁴⁵ Sala, S., Crenna, E., Secchi, M., & Sanyé-Mengual, E. (2020). Environmental sustainability of European production and consumption assessed against planetary boundaries. *Journal of environmental management*, 269, 110686.

A second source for impact factors derives from market analysis, and in particular two vehicles for information sharing among brands and companies regarding the environmental footprint of products:

1. The EPD Version 2.0 impact categories using characterization factors defined in the EN 15804 allow the exchange of data under the Environmental Product Declaration Programme, defined by a dedicated database of EPDs used throughout the industry. Furthermore, the presence of specific PCR defined for EPDs allows further standardization of the data to be transferred and communicated between parties. Furthermore, the characterization factors utilized are harmonized with the ones utilized in the EU PEF framework EF 3.1, allowing for further compatibility between the two systems.
2. The Higg Index standard, and in particular the Material Sustainability Index (MSI), as it has historically been utilized by several companies adhering to the Cascale coalition.

6.9 CUT-OFF RULES

6.9.1 Review of existing standards and recommended approach

	EPD PCR	PEFCR	EN 16887	RECOMMENDATIONS
CUT OFF RULES	All chemical products shall be included in the inventory if the total weight of the product (as commercial presentation) is $\geq 0.002\%$ respect to the mass of all chemical product inputs. As an only exception to this rule, for the average leather production it is allowed a cut-off of 0.1% of the total weight of the product (as commercial presentation) respect to the mass of all chemical product inputs.	According to this PEFCR, no cut-off is applicable.	Life Cycle Inventory data for a minimum of 99 % of total inflows to the core module shall be included. Inflows not included in the LCA shall be documented in the PCF. Data that fulfils the following cut-off criteria shall be included in the core module.	Life Cycle Inventory data for a minimum of 99 % of total inflows to the core module should be included. All chemical products should be included in the inventory if the total weight of the product (as commercial presentation) is $\geq 0.002\%$ respect to the mass of all chemical product inputs. As the only exception to this rule, for the average leather production it is allowed a cut-off of 0.1% of the total weight of the product (as commercial presentation) respect to the mass of all chemical product inputs.

Table 22: Cut-off rules – Existing standards and recommended approach

6.9.2 Justification of the choices made

The choice to include Life Cycle Inventory (LCI) data for a minimum of 99% of the total flows in the core module is based on the need to ensure a rigorous and representative approach in the life cycle assessment of leather products.

This criterion is in line with the principle of transparency and completeness required by environmental reporting standards, ensuring that the most relevant stages of the production process are adequately considered in the calculation of the environmental footprint.

The 99% threshold minimizes the uncertainty resulting from the exclusion of marginal flows, while maintaining a level of feasibility in data collection.

Regarding the inclusion of chemicals, the choice to consider all products whose weight (in commercial form) represents at least 0.002% of the total mass of chemical inputs ensures an accurate representation of the substances used in the tannery processes.

This threshold was defined to balance the need for a detailed inventory with the practicality of data collection, avoiding excessive fragmentation of information and focusing on the most significant elements in terms of environmental impact.

Furthermore, the derogation allowing a cut-off of 0.1% for the average leather production meets the need for simplification in studies considering aggregate production, reducing the burden of data collection without compromising the robustness of the results.

The approach adopted thus allows harmonizing the requirements of the different methodologies (EPD, PEFCR, EN 16887) while ensuring consistency, transparency, and reliability in the life cycle analysis of leather.

6.10 DATA QUALITY RULES; AND DATA RATING

6.10.1 Review of existing Standards and Recommended approach

	EPD PCR	PEFCR	EN 16887	RECOMMENDATIONS
TYPE OF DATA AND DATA SOURCE	Data on the life cycle of materials or energy inputs are classified into three categories – specific data, selected generic data, and proxy data.	Unless primary data on chemicals production and animal farming of appropriate quality (as defined in the PEF Recommendation) are made available from producers, default proxies as in ANNEX 7 – Default values shall be used. Upstream background datasets are defined in the PEFCR.	Distinction in primary and secondary data with specific data quality categories assessed for primary data and documentation of secondary data.	Data are distinguished between Life Cycle Inventory data representing the input/output of modelled flows, focusing in particular on core processes; Characterization factors , that associate the different impact categories to the of the inventory through the selection of representative to be associated to LCI data.
DATA QUALITY RATING CALCULATION	NOT APPLICABLE	The calculation of the DQR shall be based on the following formula with 4 criteria: $DQR = (TeR + GR + TiR + P) / 4$ Where TeR is the Technological-Representativeness, GR is the Geographical-Representativeness, TiR is the Time-Representativeness, and P is the Precision/uncertainty. Calculation of each category is weighted according to each flow's ratio on total impact.	NOT APPLICABLE	Data quality for each flow in the LCA study (DQ_i) can be calculated as the average between the Data Quality of the Inventory (DQI_i) and the Data Quality of the Emission factor ($DQEF_i$). $DQ_i = \frac{DQI_i + DQSi + DQEF_i}{3}$ Rata Quality Rating of the LCA Study: $DQR_{LCA} = \frac{\sum_{i=1}^n DQ_i \cdot EI_i}{\sum_{j=1}^n EI_j}$
MINIMUM DATA QUALITY RATING	Specific, selected generic and generic data quality is established according to PEFCR for chemical modelling.	A data needs matrix defines the minimum DQR per company, generic datasets in background and foreground.	For allowing the use of primary site-specific data, a number of pre-set characteristics are defined. The environmental impact of the processes where the other secondary data are used shall not exceed 10 % of the overall environmental impact from the product system. Data calculated with system expansion shall be used.	Rating is quantitatively assigned from 1-Very good, 2-Good, 3-Average, 4-Poor, 5-Very poor/unknown/not evaluated

Table 23: Data quality rules and data rating – Existing standards and recommended approach

6.10.2 Justification of the choices made

Data quality evaluation and continuous improvement in Life Cycle Assessment of leather is essential, as the set of decisions that are taken based on LCA data on a global scale are increasing in number and in importance.

In order to calculate the relative data quality of an LCA study, a primary distinction between inventory and emission factor data must be made, whereby:

$$EI_i = I_i \cdot EF_i$$

Where EI_i is the environmental impact of the i -th modelled inventory flow (or activity) I_i , and EF_i is the Emission factor associated to I_i .

An LCA is characterised by high data quality and a sound methodology if:

1. **Inventory Data (I)** are collected, to be reliable and representative in terms geographies and technologies, within a proper time frame
2. The **Selection (S)** of Emission Factors is done in such a way as to allow Technological, Geographical and Time representativeness of the process being modelled
3. **Emission Factors (EF)** derive from LCA studies carried out on site and precisely representing the input/output of the process through "Primary Data"

Accordingly, these guidelines suggest a calculation method for data quality of each modelled inventory flow in the LCA study (DQ_i).

DQ_i should be calculated as the simple average between the Data Quality of the Inventory (DQI_i); the quality of the Selection of the Emission Factor (DQS_i) and the Data Quality of the Emission factor ($DQEF_i$).

$$DQ_i = \frac{DQI_i + DQS_i + DQEF_i}{3}$$

6.10.2.1 Data quality for inventory and emission factors

Score	Grade
1	Very good
2	Good
3	Fair
4	Poor
5	Very poor / Unknown / Not evaluated

Table 24: Representativeness scores

The following paragraphs therefore are devoted to explaining the overall and general methodological approach and in detail the methodologies to calculate **DQI**, **DQS** and **DQEF**.

6.10.2.1.1 Data quality calculation: general methodological approach

The methodology chosen to calculate **DQ** derives from an approach extensively used in literature⁴⁶, that considers five categories of evaluation and five scores to be assigned to each of them, as represented in the following table:

Category	Description
Reliability (R)	Degree to which the source and method of collection of data reflects the true measurements of modelled flows.
Technological representativeness (TeR)	Degree to which the data set reflects the true population of interest regarding technology, including for included background data sets and operating conditions, if any.
Geographical representativeness (GeR)	Degree to which the data set reflects the true population of interest regarding geography (location, site, region, country, market, continent), including background data sets, if any
Time-related representativeness (TiR)	Degree to which the data set reflects the true population of interest regarding time / age (year, month range, day range) of the data, including for included background data sets, if any.
Precision (P)	Measure of the variability of the data values for each data expressed (e.g. low variance = high precision) to be evaluated on a system level.

Table 25: Categories of evaluation

While ISO 14044:2006 includes provisions for a “methodological appropriateness and consistency” data quality category, the uniform set of recommendations included in these guidelines already provides a number of indications on how to conduct the environmental impact study of leather, ensuring methodological appropriateness and consistency of LCA studies and allowing to exclude such category from the evaluation of data quality.

⁴⁶ Weidema B P, Bauer C, Hischier R, Mutel C, Nemecek T, Reinhard J, Vadenbo C O, Wernet G. (2013). Overview and methodology. Data quality guideline for the ecoinvent database version 3. Ecoinvent Report 1(v3). St. Gallen: The ecoinvent Centre.

Assignment of scores (from 1, “very good” to 5 “very poor”) to each data quality category should be performed according to a quantitative assessment methodology, which in these guidelines is best described using a comprehensive integrated approach, comprising the guidelines for data quality assessment by Weidema et al. (2013)⁴⁷ for the Ecoinvent database regarding category R, the US EPA⁴⁸ for categories TeR, GeR, TiR and C, and the ILCD Handbook indications for category P⁵⁹.

CATEGORY	1 – Very good	2 – Good	3 – Fair	4 – Poor	5- Very poor
Reliability (R)	Verified (by, e.g., on-site checking, recalculation, mass balance etc.) data based on measurements of input	Verified data partly based on assumptions or non-verified data based on measurements	Non-verified data partly based on qualified estimates	Qualified estimate (e.g. by industrial expert)	Non-qualified estimate
Technological representativeness (TeR)	All technology categories (process design, operating conditions, material quality, and process scale) are equivalent	Three of the technology categories are equivalent	Two of the technology categories are equivalent	One of the technology categories is equivalent	None of the technology categories are equivalent
Geographical representativeness (GeR)	Data from same resolution and same area of study	Within one level of resolution and a related area of study	Within two levels of resolution and a related area of study	Outside of two levels of resolution but a related area of study	From a different or unknown area of study
Time-related representativeness (TiR)	Less than 1 years of difference between the collected data and the reference year of the study	Less than 2 years of difference	Less than 3 years of difference	Between 3 to 5 years	Age of data unknown or more than 5 years
Precision (P)	Relative standard deviation (coefficient of variation) $\leq 7\%$	Relative standard deviation (coefficient of variation) > 7 and $\leq 10\%$	Relative standard deviation (coefficient of variation) > 10 and $\leq 15\%$	Relative standard deviation (coefficient of variation) > 15 and $\leq 25\%$	Relative standard deviation (coefficient of variation) $> 25\%$

Table 26: Methodology for assignment of scores

⁴⁷ Weidema B P, Bauer C, Hischier R, Mutel C, Nemecek T, Reinhard J, Vadenbo C O, Wernet G. (2013). Overview and methodology. Data quality guideline for the ecoinvent database version 3. Ecoinvent Report 1(v3). St. Gallen: The ecoinvent Centre.

⁴⁸ Edelen, Ashley, Ingwersen, Wesely, “Guidance on Data Quality Assessment for Life Cycle Inventory Data,” United States Environmental Protection Agency, National Risk Management Research Laboratory, (2016), Oak Ridge (US).

6.10.2.1.2 Inventory data quality calculation (DQI) methodology

Based on the analysis from relevant sources, following data quality categories, which determine the characteristics and metadata associated with the collected information for inventory and emission factor, are recommended to be considered for the evaluation:

Category	Description
Reliability (R)	Degree to which the source and method of collection of data reflects the true measurements of modelled flows.
Technological representativeness (TeR)	Degree to which the data set reflects the true population of interest regarding technology, including for included background data sets and operating conditions, if any.
Geographical representativeness (GeR)	Degree to which the data set reflects the true population of interest regarding geography (location, site, region, country, market, continent), including background data sets, if any.
Time-related representativeness (TiR)	Degree to which the data set reflects the true population of interest regarding time / age (year, month range, day range) of the data, including for included background data sets, if any.

The Data quality Rating for the inventory component should therefore be calculated as following:

$$DQI = \frac{R + TeR + GeR + TiR}{4}$$

Assignment of scores to the data quality categories has been defined in the general methodological section.

Data quality calculation for inventory considers the representativeness of the collected data relevant to modelled activities in the leather production system.

Accordingly, reliability of data acquisition methodology, as well as representativeness for technological, geographical, and temporal characteristics are all relevant aspects to be considered when evaluating collected data with respect to modelling a production activity. Whilst relevant for uncertainty analysis, the Precision category is excluded from the calculation of DQI as collection of primary data is promoted in these guidelines with the intent of reducing the uncertainty of the data for all inventory flows modelled. However, the calculation of data quality does not exclude uncertainty analysis, which can be produced by analysing the distribution of the collected data, when available, in a separate calculation.

6.10.2.1.3 Dataset representativity selection data (DQS) quality calculation

The appropriateness and representativeness of the dataset selected to be associated with the inventory data collected for the modelled activities in leather production determines how accurate the inventory of the selected datasets represents the inventory data of each modelled process. The selection of a dataset from commonly and reputable available sources allows the association of an emission factor to collected activity data via characterization of the inventory of the selected dataset with the impact methodologies described in the previous chapters. Therefore, the following data quality categories are considered relevant for the appropriateness analysis of the selected databases:

Category	Description
Technological representativeness (TeR)	Degree to which the data set reflects the true population of interest regarding technology, including for included background data sets and operating conditions, if any.
Geographical representativeness (GeR)	Degree to which the data set reflects the true population of interest regarding geography (location, site, region, country, market, continent), including background data sets, if any
Time-related representativeness (TiR)	Degree to which the data set reflects the true population of interest regarding time / age (year, month range, day range) of the data, including for included background data sets, if any.

The Data quality Rating for the selected dataset component should therefore be calculated as following:

$$DQS_i = \frac{TeR + GeR + TiR}{3}$$

Assignment of scores to the data quality categories has been defined in the general methodological section.

To determine the relevance of a selected dataset in representing collected activity data, technological, geographical, and temporal representativeness are compared to the data collection conditions for the associated inventory flow, as they define the specific conditions by which data have been collected. Therefore, the three categories determine the degree of approximation of dataset data to retrieval and measurement characteristics of the associated modelled inventory data.

6.10.2.1.4 Data quality for Emission Factor (DQEF_i) calculation

Data quality for emission factor (**DQEF_i**) is defined according to the Data Quality Rating of the associated dataset provided by the source from which it is extracted. Accordingly, data quality of emission factors defines the representativeness of the dataset inventory to the declared data quality categories and characteristics of the underlying LCA study. The emission factor results from the characterization, via the impact calculation methodologies explained in the previous

chapters, of the dataset inventory. Following the nomenclature of the EPD PCR, the data quality rating of each dataset can be determined according to the table below:

Data quality	Description	DQR_{EF}
Primary	Site-specific data from actual manufacturing and product-specific processes	1
Secondary: selected generic: high to average quality	Data from commonly available data sources (e.g. commercial databases and free databases) which are representative of the modelled flow ⁴⁹ and have DQR < 3 ⁵⁰	2
Secondary: selected generic: average to low quality	Data from commonly available data sources (e.g. commercial databases and free databases) which are representative of the modelled flow and have DQR > 2	3
Secondary: Generic	Data from commonly available data sources (e.g. commercial databases and free databases) which are partially representative of the modelled flow	4

Table 27: Determination of data quality rating of each dataset

Rating of emission factors is relevant to determine the internal consistency of selected datasets to represent modelled inventory flows. If the selected data belongs to a study with low data quality, it will impact the overall quality of the leather study due to misalignment between the declared characteristics of the datasets and its inventory.

⁴⁹ Modelled flow representativeness can be surmised by dataset metadata and consists in the matching of the product under study with the product being modelled in the selected secondary dataset. Selected generic dataset determines that inventory flows, while describing the same activity/product, are nevertheless divergent in the evaluation of specific representativeness category (e.g., different production technology, different geography, etc.)

⁵⁰ Most LCI databases provide either the final DQR calculation of their inventory data or the relevant representativeness categories through which is possible to calculate the DQR. In case a DQR were not provided, a DQR of 5 should be considered for the selected dataset.

6.10.2.1.5 Data quality Rating for LCA study (DQR_{LCA}) calculation

The Data Quality Rating for the entire LCA study (DQR_{LCA}) and its related datasets should therefore be calculated as the weighted average of the resulting DQR_f based on their individual contributions to the total environmental impact:

$$DQR_{LCA} = \sum_{i=1}^n \frac{DQ_i \cdot EI_i}{\sum_{j=1}^n EI_j}$$

Where DQ^{51}_i is the data quality rating for each i-th of n flows modelled in the study, EI_i its resulting environmental impact ratio on the total GWP⁵² of the i-th flow and n is the number of flows modelled in the LCA study. The weighted average analysis can also be performed in aggregated form, i.e. calculating the DQR for chemicals, transports, and other relevant environmental aspects.

As an example of the calculation of data quality, it is possible to consider the exemplary study of leather with following modelled flows:

- 1- Modelled flow for raw material production with DQR of 2 (DQ score: good) and impact relevance of 60 %.
- 2- Modelled flow for chemicals (aggregated) with DQR 3 (DQ score: fair) and impact relevance of 25 %
- 3- Modelled flow for energies (aggregated) with DQR 1 (DQ score: very good) and impact relevance 10 %
- 4- Modelled flow for transport with DQR 2 (DQ score: good) and impact relevance 5 %

Accordingly, total DQR_{LCA} will be:

$$\frac{(2 * 60 \%) + (3 * 25 \%) + (1 * 10 \%) + (2 * 5 \%)}{100 \%}$$

The resulting DQR_{LCA} will be therefore 2.15, which is on the threshold of the DQ score of “good.”

⁵¹ The proposed DQ_i currently provides qualitative information, future updates could lead to standardised methodologies for assigning uncertainty to input data, serving as a foundation for Monte Carlo simulation or other uncertainty propagation methods.

⁵² GWP is selected as the indicator used in most LCA studies, allowing for higher comparability with other datasets/LCAs as well as being used in multiple metrics and standards (ISO 14067/ISO 14068) as reliable impact category for impact reduction solutions, which are highly dependant on the data quality of the environmental footprint of products.

6.10.3 Additional Information: Available Animal farming datasets and data quality

The recommended approach for dataset selection and allocation value definition in upstream processes is to first identify primary data sources and, in the absence of primary data, select secondary representative data or default allocation values, contingent upon substantial justifications.

A detailed analysis of the selection of datasets and/or default allocation factors for animal farming and slaughtering is beyond the scope of these guidelines. Nevertheless, the following considerations can be taken into account. As depicted by Table 28 below, it is acknowledged that prominent databases, such as Ecoinvent, Agri-footprint, and EF Database, offer specific datasets that are confined to specific geographical regions and to different reference years.

The main purpose of the inclusion of the following table in the guidelines is not to suggest the use of one or the other data set, but rather to advocate for the urgency of industry players to obtain and use more primary data over time.

Animal type	Country/Region	GWP (kgCO ₂ eq/kg live animal)	Database	Reference Year
Beef cattle	Brazil (BR)	24.63	EF Database 3.1 Agrofoods	2018
Beef cattle	EU+EFTA+UK	12.54	EF Database 3.1 Agrofoods	2010
Beef cattle	Global (GLO)	16.32	EF Database 3.1 Agrofoods	2010
Beef cattle	USA (US)	10.20	EF Database 3.1 Agrofoods	2020
Beef cattle for slaughter, at beef farm, PEF compliant/IE Mass	Ireland (IE)	16.94	Agri-footprint - mass allocation	2013-2016
Beef cattle, national average, at farm gate	France (FR)	13.55	AGRYBALYSE	2005-2009
Calves, at dairy farm	Netherlands (NL)	10.19	Agri-footprint - mass allocation	2013-2016
Cattle for slaughtering, live weight	Brazil (BR)	34.28	Ecoinvent 3 - cut off by classification	2006
Cattle for slaughtering, intensive production, live weight	Brazil (BR)	23.40	Ecoinvent 3 - cut off by classification	2006
Cattle for slaughtering, weaned calves production, live weight	Rest of the World (RoW)	22.83	Ecoinvent 3 - cut off by classification	2006
Cows for slaughter, at dairy farm,	Netherlands (NL)	10.15	Agri-footprint - mass allocation	2013-2016

Table 28: Datasets offered by Ecoinvent, Agri-footprint and EF Database

6.11 REPORTING CRITERIA

6.11.1 Review of existing standards and recommended approach

	EPD PCR	PEFCR	EN 16887	RECOMMENDATIONS
REPORTING CRITERIA	<p>The reporting format of the EPD shall include the following sections:</p> <ul style="list-style-type: none"> • Cover page (Section 5.4.1) • Programme information (5.4.2) • Product information (5.4.3) • Content declaration (5.4.4) • Environmental performance (5.4.5) • Additional information (5.4.6) • References (5.4.9) <p>The following information shall be included, when applicable:</p> <ul style="list-style-type: none"> • Information related to Sector EPDs (5.4.7) • Differences vs previous versions (5.4.8) • Executive summary in English (5.4.10) 	<p>EF report – Document that summarizes the results of the EF study. For the EF report the template provided as an annex to the PECFR Guidance shall be used. In case the commissioner of the EF study decides to communicate the results of the EF study (independently from the communication vehicle used), the EF report shall be made available for free through the commissioner's website.</p> <p>The applicant shall calculate the PEF profile of its product in compliance with all requirements included in this PECFR. The following information shall be included in the PEF report:</p> <ul style="list-style-type: none"> - full life cycle inventory; - characterized results in absolute values, for all impact categories (including toxicity; as a table); - normalized and weighted result in absolute values, for all impact categories (including toxicity; as a table); - the aggregated single score in absolute values <p>Together with the PEF report, the applicant shall develop an aggregated EF-compliant dataset of its product in scope.</p> <ul style="list-style-type: none"> - The recycled content (R1) shall be reported. - Results with application-specific A-values, if relevant. <p>Additional environmental information shall include the carbon storage in the leather at the tannery gate.</p>	<p>4.14 Requirements for the product declaration</p> <p>The products shall be pertinent for their scope, satisfying the demands of health, safety and performance for the consumer made by international, national, or regional standards regarding the products.</p> <p>The product declaration shall contain at least the following information:</p> <ul style="list-style-type: none"> — Reference to this document and to CEN ISO/TS 14067, — reference to certifications (if any), — if it is a self-declaration then reference to EN ISO 14021, — the results shall be expressed in kilograms of CO₂ equivalent per square meter or per kg for sole leather, — the name of the product, — the name of the manufacturer, — the year of reference 	<p>LCA results should be presented in a Report, written on the basis of what included in ISO 14040/44 to ensure transparency, consistency, and credibility of the study. With the same aim, the Upstream and Core environmental impact results should be reported separately. The following sections to the report should at least be included:</p> <ul style="list-style-type: none"> 8- General information <ul style="list-style-type: none"> a. LCA commissioner and practitioner b. Date of reporting c. Validity of the study d. Reference Standards 9- Goal of the study <ul style="list-style-type: none"> a. Reasons to carry out the study b. Intended audience c. Intended applications 10- Scope of the study <ul style="list-style-type: none"> a. System boundaries b. Source of LCI data c. Definition of functional unit d. Assumptions and limitations e. Cut-off criteria 11- Life cycle inventory analysis <ul style="list-style-type: none"> a. Data collection and aggregation methods b. Description of unit processes c. References for non-primary data d. Allocation principles with justification e. Quantitative description of unit processes 12- Life cycle impact assessment <ul style="list-style-type: none"> a. LCIA procedures and methodologies b. References to characterization methods c. LCA Results (Reporting Upstream, Core and Downstream results separately) 13- Life cycle interpretation <ul style="list-style-type: none"> a. Results (Reporting Upstream and Core results separately) b. Data quality assessment c. Hotspot Analysis d. Additional Interpretations of results e. Additional environmental performance indicator 14- Critical review (if applicable) <ul style="list-style-type: none"> a. Name and affiliation of reviewers b. Critical review report c. Recommendations and responses d. Critical review statement

Table 29: Reporting criteria – Existing standards and recommended approach

6.11.2 Justification of the choices made

Based on the provided guidelines from EPD, PEFCR, and EN 16887, the decision to structure the reporting format as proposed in the following section is justified by several key considerations:

- ISO 14040 and ISO 14044 provide internationally recognized methodologies for conducting and reporting Life Cycle Assessment (LCA). Aligning the reporting format with these standards ensures consistency across different environmental declarations, facilitates comparability, and enhances credibility for stakeholders who rely on these assessments.
- The structured approach defined by ISO 14040/44 includes essential elements such as goal and scope definition, inventory analysis, impact assessment, and interpretation of results. This structure guarantees that all necessary methodological aspects are transparently documented, allowing for reproducibility and verification.
- In accordance with ISO 14040 and ISO 14044, the results of the Upstream and Core processes should be reported separately. The reason for this is to:
 - o Foster transparency and facilitate a clear understanding of the contribution of each life cycle stage to the total impact
 - o Distinguish between impacts under direct operational control (Core processes) and those occurring in the supply chain (Upstream processes), thereby supporting targeted improvement actions
 - o Facilitate comparability and interpretation in scenario analyses or future updates of the assessment.

This decision supports the development of a robust, verifiable, and widely accepted environmental performance declaration for leather products. In addition to these, any public communication of LCA results should be preceded by a critical review. This applies regardless of the communication channel or target audience. The critical review should assess whether the methods used are consistent with the standards, whether the data are appropriate and reasonable in relation to the goal of the study, and whether the interpretations reflect the limitations of the study. All public communications should disclose key assumptions, system boundaries, data quality assessment, and limitations. Such transparency not only enhances the credibility of environmental claims but also protects both producers and stakeholders from the misuse or misinterpretation of LCA results.

6.11.3 Additional Information: Carbon Removal and Stock

Leather is a Biobased material⁵³ and finished leather is primarily made of Biogenic Carbon⁵⁴ with the biogenic carbon content equal to the carbon removal during plant growth⁵⁵. These typical characteristics of leather highlight the importance of key principles and requirements on Carbon Footprint, carbon removals and biogenic carbon content, that are very well described in the ISO 14067 standard. For the purpose of these guidelines, the requirements of chapter 6.4.9 of the standard are the ones that provide higher value and that will be addressed in the present paragraph. Figure 28 (derived from ISO 14067), describes the specific component of the CFP and the way in which each of them needs to be included in the GWP results.

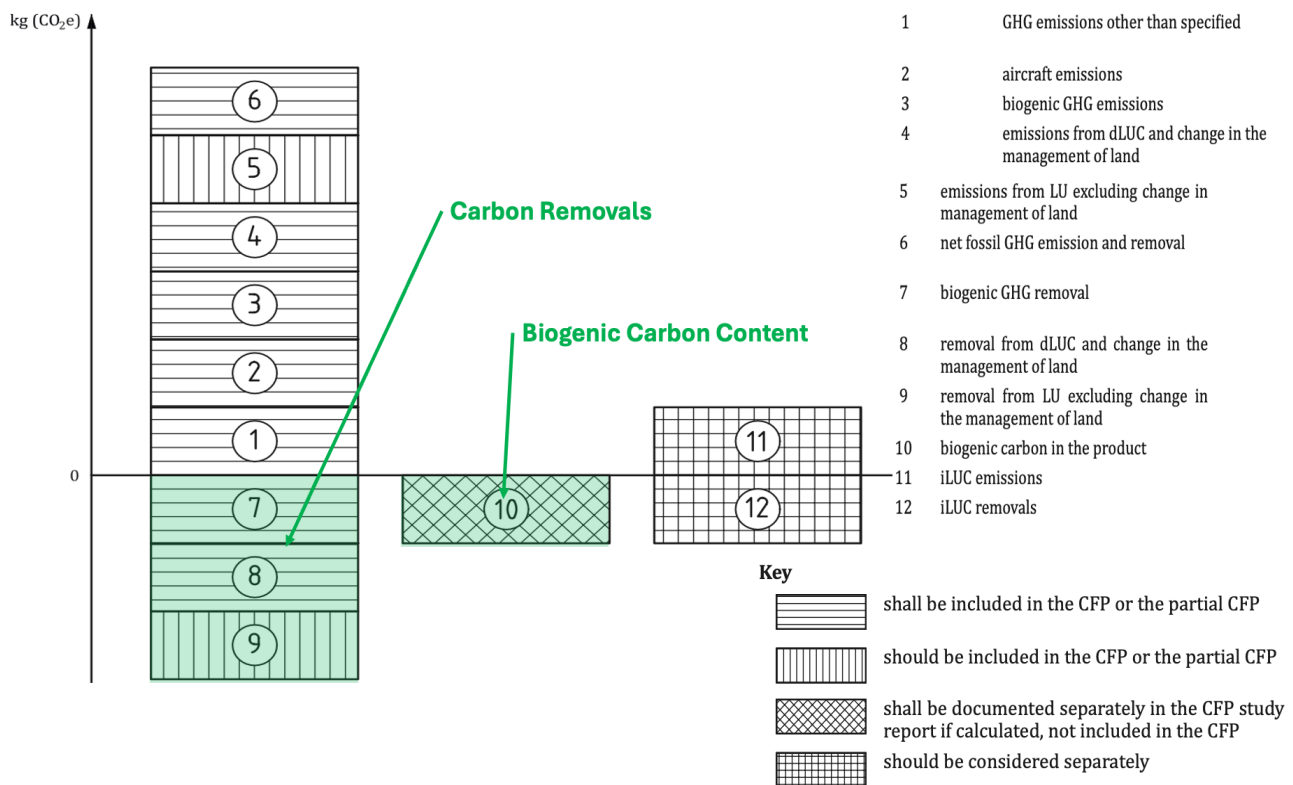


Figure 10. ISO 14067 - Illustration of the specific components to be included in the CFP

⁵³ See paragraph 7.2 for definitions

⁵⁴ ISO 14067 - NOTE 1 to point 6.4.9.3: Biomass-derived carbon contained in a product is referred to as the biogenic carbon content of the Product

⁵⁵ ISO 14067 - NOTE 2 to point 6.4.9.3: In the case of products containing biomass, the biogenic carbon content is equal to the carbon removal during plant growth. This biogenic carbon can be released in the end-of-life stage

6.11.3.1 *Biogenic Stored Carbon*

As said before, leather is a Biobased material and finished leather is primarily made of Biogenic Carbon and the biogenic carbon content is equal to the carbon removal during plant growth.

In this context, it is especially important that these guidelines provide indications on how to report on Biogenic carbon content of leather. To do this, some key references are needed:

Point 6.4.9.3 of the ISO 14067 states that: “When biogenic carbon is stored in a product for a specified time, this carbon shall be treated in accordance with the provisions in **6.4.8**. If a product’s biogenic carbon content is calculated, it shall be documented separately in the CFP study report, but it shall not be included in the result of CFP or partial CFP. **Information on stored biogenic carbon content shall be provided when performing cradle to gate studies, as this information may be relevant for the remaining value chain.**”

Point 6.4.8 of the ISO 14067 states that: “All GHG emissions and removals shall be calculated as if released or removed at the beginning of the assessment period without taking into account an effect of delayed GHG emissions and removals. Where GHG emissions and removals arising from the use stage (see [6.3.7](#)) and/or from the end-of-life stage (see [6.3.8](#)) occur over more than 10 years⁵⁶ (if not otherwise specified in the relevant PCR) after the product has been brought into use, **the timing of GHG emissions and removals relative to the year of production of the product shall be specified in the life cycle inventory**. The effect of timing of the GHG emissions and removals from the product system (as CO_{2e}), if calculated, shall be documented separately in the CFP study report. The method used to calculate the effect of timing shall be stated and justified in the CFP study report.

⁵⁶ ISO 14067 - NOTE 1 to point 6.4.8: The time period of 10 years has been selected to avoid undue burden in data collection and additional reporting of GHG emissions and removals over shorter time periods and to achieve comparability in reporting. This value might be revised in future based on experience or improved scientific knowledge

Following the provisions of point **6.4.9.3** of the ISO 14067, the recommended approach for studies on finished leather is to report separately in the LCA Report information on the biogenic carbon content of leather, following a simple three step approach as described in the following table:

BIOGENIC STORED CARBON IN FINISHED LEATHER ⁵⁷ : A 3 STEPS APPROACH			
STEP	DESCRIPTION	METHODOLOGY	Unit of Measure
1	QUANTIFICATION OF THE BIOGENIC CARBON CONTENT IN FINISHED LEATHER	<ul style="list-style-type: none"> Analytical Determinations Estimations, based on Biogenic C content of hides and chemistry 	Biogenic C = g/m ² of leather
2	CONVERSION OF CARBON CONTENT IN CARBON OXIDE EQUIVALENT	Biogenic C * 3,664 ⁵⁸	Biogenic CO _{2e} = gCO _{2e} /m ² of leather
3	PROVISION OF THE RESULTS IN THE LCA REPORT	<i>Report the results in gCO_{2e}/m² of leather in the session "6e" of the LCA report (Additional environmental information).</i>	gCO _{2e} / m ² of leather

Table 30: Biogenic stored carbon in finished leather – A 3 steps approach

Point 6.4.8 of the ISO 14067 states that: “All GHG emissions and removals shall be calculated as if released or removed at the beginning of the assessment period without taking into account an effect of delayed GHG emissions and removals. Where GHG emissions and removals arising from the use stage (see 6.3.7) and/or from the end-of-life stage (see 6.3.8) occur over more than 10 years⁵⁹ (if not otherwise specified in the relevant PCR) after the product has been brought into use, the timing of GHG emissions and removals relative to the year of production of the product shall be specified in the life cycle inventory. The effect of timing of the GHG emissions and removals from the product system (as CO_{2e}), if calculated, shall be documented separately in the CFP study report. The method used to calculate the effect of timing shall be stated and justified in the CFP study report.

⁵⁷ The example is based on finished leather, but the approach is applicable to all leather products

⁵⁸ CONVERSION FACTOR: Ratio between molar Mass of CO₂ (44,009 g/mol) and Atomic mass of C (12,011 u)

⁵⁹ ISO 14067 - NOTE 1 to point 6.4.8: The time period of 10 years has been selected to avoid undue burden in data collection and additional reporting of GHG emissions and removals over shorter time periods and to achieve comparability in reporting. This value might be revised in future based on experience or improved scientific knowledge

Provisions of point 6.4.8 of the ISO 14067 are more related to processes that are downstream from leather making and to the durability of products made with leather and therefore are out of scope of these guidelines. It is nevertheless important to state that:

1. A further potential source of emissions in the processes downstream from the tannery derives from the degradation of finished leather, already at the cutting table of customers. In this sense, compostability of leather can provide a very good option to create a virtuous and circular approach having important effects of the carbon cycle of leather making
2. The durability of products made with leather is again an essential element, in this case to assess the period over which the biogenic carbon remains stored in the products during the use phase of consumer products made with leather
3. The different end-of-life scenarios of the products made with leather represent another potential source of emissions in the processes downstream from the tannery, with the same considerations done at point 1.

6.11.3.2 *Carbon Removals in Agricultural Systems*

In accordance with ISO 14067 and chapter 6.11.3, CO₂ removals from agricultural systems should be included in the assessment.

Point 3.1.1 of the ISO 14067 states that: "Quantification of the carbon footprint of a product consists of the sum of GHG emissions and removals in a product system, expressed as CO₂ equivalent and based on an LCA, using the single impact category of climate change.

Point 6.4.9.5 of the ISO 14067 states that: "GHG emissions and removals that occur as a result of direct land use change should be assessed according to internationally recognized methods such as the IPCC Guidelines for National Greenhouse Gas Inventories and can be included in the CFP. The direct land use change GHG emissions and removals shall be documented separately in the CFP study report. If site-specific data are applied, they shall be transparently documented in the CFP study report. If a national approach is used, the data shall be based on a verified study, a peer reviewed study or similar scientific evidence and shall be documented in the CFP study report."

Point 6.4.9.6 of the ISO 14067 states that: "GHG emissions and removals occurring as a result of changes in soil and biomass carbon stocks that are not the result of changes to management of land should be assessed in accordance with internationally recognized methods, such as the IPCC Guidelines for National Greenhouse Gas Inventories and included in the CFP. When changes in management of land cause changes in soil and biomass carbon stocks, compared with the reference land use, the GHG emissions and removals shall be documented and assigned to the system under study."

Following the provisions of point **6.4.9.5** and **6.4.9.6** of the ISO 14067, the recommended approach for studies on finished leather is to quantify (1) direct land use change GHG removals and (2) removals occurring as a result of changes in soil and biomass carbon stocks that are not the result of changes to management of land and to report them as part of the CFP results. A simple example of how this calculation can be done is described in the following table:

CARBON REMOVALS FROM AGRICULTURAL SYSTEMS: A 3 STEPS APPROACH			
STEP	DESCRIPTION	METHODOLOGY	Unit of Measure
1	QUANTIFICATION OF THE CARBON STOCK CHANGE IN FARMING SYSTEM IN THE REFERENCE YEAR	Analytical Determinations Estimations, based on IPCC Tier 1 Standard	ton C/year
2	CONVERSION OF CARBON STOCK CHANGE IN CARBON DIOXIDE EQUIVALENT	Removed C * 3,66460	ton CO _{2e} /year
3	DEFINITION OF THE TOTAL EMISSION FROM THE PRODUCT SYSTEM IN THE REFERENCE YEAR	Calculation of the CF of the Farming system for the same reference period	ton CO _{2e} /year
4	PROVISION OF THE NET RESULTS FROM THE PRODUCT SYSTEM IN THE REFERENCE YEAR	CO _{2e} balance as the difference between CF and Removed C in the reference period	ton CO _{2e} /year
5	ATTRIBUTION OF THE RESULTS OF THE SYSTEM TO A SPECIFIC PRODUCT UNIT (See ISO 14067 3.11)	CARBON FOOTPRINT CALCULATION	kg CO _{2e} /Declared Unit

Table 31: Carbon removals from agriculture systems – A 5 steps approach

The quantification of carbon removals obviously requires studies and measurements at farm level. These include for example the determination of actual changes in soil and biomass carbon stocks through established methods such as the IPCC Guidelines.

⁶⁰ CONVERSION FACTOR: Ratio between molar Mass of CO₂ (44,009 g/mol) and Atomic mass of C (12,011 u)

7. BIOBASED DESIGN MATERIALS: COMMONALITIES IN LCA

7.1 Introduction

Biobased materials are gaining relevance in sustainable production chains due to their renewable origin and potential to replace fossil-based alternatives. This chapter defines biobased design materials and identifies shared sustainability characteristics that are relevant to harmonized Life Cycle Assessment (LCA) approaches.

7.2 What is a biobased material?

According to **ISO 59004:2024** (Circular economy - Vocabulary, principles, and guidance for implementation), the term “biobased” refers to a resource derived from biomass, such as trees, crops, grasses, tree litter, algae, microorganisms, animals, and wastes of biological origin⁶¹.

Similarly, the **USDA** defines the term “biobased” as a commercial or industrial product (excluding food or feed) composed, entirely or to a significant degree, of biological products, including renewable agricultural materials, renewable chemicals, and forestry materials. These products are derived from renewable raw materials, such as agricultural, marine and forestry resources, and provide an alternative to conventional petroleum-based products⁶².

These definitions converge on the concept that biobased materials originate from renewable sources, including agriculture and animal farming. In contrast, non-biobased materials are synthesised from abiotic, often fossil-based extracted non-renewable resources.

7.3 What is a Biobased Design Material?

For the purposes of the present guidelines and for future scientific developments, a further definition has been identified as necessary. The need arises from the fact that some materials share many commonalities in their **ORIGIN**, the **PRODUCTION PROCESSES** they undergo, and their **USES**.

Here, BIOBASED DESIGN MATERIALS are defined as materials that share the following characteristics:

⁶¹ International Organization for Standardization. (2024). *Circular economy - Vocabulary, principles and guidance for implementation* (Standard number ISO 59004:2024) <https://www.iso.org/standard/80648.html>

⁶² United State Department of Agriculture. “BioPreferred|Biobased Products.” Biopreferred.gov, 2025. [BioPreferred|Biobased Products](https://www.biopreferred.gov/biobased-products)

- **ORIGIN:** Biobased materials that originate from renewable sources, including agriculture and animal farming, where the creation of the fibers and their aggregation thereof is not carried out through man-made industrial processes.
- **PRODUCTION PROCESSES:** The industrial production processes applied have a primary purpose of stabilising the fibers and their aggregation materials while enhancing aesthetic and technical properties to make them fit-for use for various applications.
- **USE:** The most relevant uses include the realization of consumer products in the following market segments: apparel, fashion and luxury, footwear, automotive, furniture, home décor, and interior design.

Many materials across the world fall under this definition, such as: Leather⁶³, Wool, Mohair, Cashmere, Alpaca, Silk, Cotton, Hemp, Linen, and Cork.

7.4 Commonalities of Biobased Design Materials

7.4.1 On the potential application of standards

ISO 14068 introduces a particularly important methodological point, by allowing reforestation and carbon sequestration in soils to be considered as valid methods to achieving GHG removals.

The SBTi 14068 applies to all Biobased Design Materials, and it also includes carbon removals and storage. According to the GHG Protocol Land Sector and Removals Guidance, net biogenic CO₂ emissions are defined as decreases in net land carbon stock, while net biogenic CO₂ removals refer to increases in net land carbon stock, where carbon is stored for a period of time and meets specific reporting criteria. In this context, a particular important aspect is that the SBTi FLAG allows for the consideration of reforestation and carbon sequestration in soils to be recognised as valid methods for achieving GHG removals.

⁶³Tasaki, A. N., & Tasaki, K. (2022). Mitigation of Environmental Impact of Intensive Animal Farming through Conversion of Animal Wastes to Value-Added Products. IntechOpen

7.4.2 Related to the requirements harmonized in these guidelines

PRODUCT SYSTEM

All Biobased Design Materials can be precisely defined, and most also have a synthetic alternative that provides the same or a similar function in the same customer sectors.

DECLARED UNIT AND REFERENCE FLOW

The Declared unit of all Biobased Design Materials can be defined in the same way:

- **What:** The declared unit is defined using an official, internationally recognized definition of the material.
- **How Much:** The declared unit is defined using a physical unit that is commonly used in international trade (e.g., meters, kilograms, tons etc.).
- **How Well:** The 'How Well' function can be defined using a set of technical parameters and standards that establish physical and chemical market acceptance criteria.
- **How Long:** The use phase is beyond the system boundaries, so the "How Long?" specification cannot be defined – see paragraph 6.5.2.4.

SYSTEM BOUNDARIES

All Biobased Design Materials share the same structure of their System boundaries, where:

- The most important upstream processes involve agriculture and/or animal farming.
- Core Processes are primarily represented by discrete industrial operations that use water, chemistry, and energy, relying on transports at a global scale.
- Downstream processes (which are excluded from the system boundaries of the materials themselves) involve the production, use, care and repair, and end-of-life of similar consumer products.

ALLOCATION RULES AND PROCEDURES

Allocation occurs in all upstream processes of Biobased Design Materials that involve animals, in some upstream processes based on vegetable fibers, and in most of the Core processes.

The proposed stepwise procedure, which combines the ISO 14040 approach, the allocation and cutoff by classification system model, is perfectly applicable to all Biobased Design Materials.

LCIA METHODOLOGY AND TYPES OF IMPACT

LCIA methodologies and impact categories selected for leather would also be applicable to all other Biobased Design Materials, as:

1. The indicators enable a holistic assessment of their impacts across all processes.
2. The indicators are compatible with the most important reference standards determined by institutions and recognized by certification bodies insisting on the same or similar supply chains.

CUT-OFF RULES

This criterion aligns with the principle of transparency and completeness required by environmental reporting standards, ensuring that the most relevant stages of the production process are adequately considered in the calculation of the environmental footprint.

DATA QUALITY REQUIREMENTS

Data quality harmonization requires an understanding of its usage in the context of determining the representativeness and precision of data used in LCA studies.

The proposed data quality assessment, based on the two main components (Life Cycle Inventory data and Emission Factors) is fully applicable to all Biobased Design Materials. Additionally, it highlights the same lack of quality data for very relevant life cycle stages.

REPORTING CRITERIA

The proposed approach is generally applicable to all LCA reports:

“LCA results should be presented in a report written in accordance with ISO 14040/44 to ensure transparency, consistency, and credibility of the study.”

It is also appropriate for all Biobased Design Materials to report LCA results separately for the upstream and core processes.

Moreover, the presence of biogenic carbon as a main constituent of Biobased Design Materials, along with agricultural soil-based processes in the supply chain, makes it possible to include the same predefined set of additional information in the LCA reports, specifically referring to:

- Biogenic Stored Carbon
- Carbon Removals in Agricultural Systems

8. CONCLUSIONS AND NEXT STEPS

This guideline represents an important milestone in the development of a harmonized methodological framework for assessing the environmental performance of leather. Some of the most important achievements linked with the publication of the guidelines can be described as follows:

Hides and skins from animals slaughtered for human food consumption purposes have been defined as “Non-Determining Animal By-Products” as they result from a multifunctional process which do not affect the production volume.” The important related conclusion is that: Non-Determining Animal By-Products are by definition not drivers of environmental change.

A detailed picture of the most important leather-related market data has been provided, starting from the livestock growth trend at global and regional scale, to the availability of raw materials, to tanning production, highlighting the need for a proper data update, with particular reference to the difference between the raw hides and skins that are globally available and those valorised through the international tanning industry

A methodologically sound identification of 8 key elements for developing Life Cycle Assessment studies of Leather, for which a harmonization of requirements is necessary, and for each of them specific recommendations have been issued, supported by explicit justifications of the choices made, and when needed, additional information to support the recommended methodological approach.

When relevant and potentially useful for the global value chain, specific information on innovative approaches has been described in detail and linked with possible environmental improvements along the value chain.

It has been possible to define and introduce the concept of “**Environmental Amortization**” of a material, a broader and more comprehensive way of assessing the environmental footprint of a material such as leather, through the inclusion of its technical performance.

On the important topic of **Consumer Products Durability**, it has been possible to create the innovative link between the environmental performance of a consumer product, the important definition of its “Duration of Service” (DoS), and with the environmental impacts and technical performances of leather.

Regarding in particular **Allocation**, it has been possible to merge the requirements of the ISO 14040/44 with the relevant and reviewed “Allocation and cutoff by classification” approach, developing a simple methodology that allows classification of the different outputs of the various Life Cycle Stages linked with leather making between “Main products”, “Allocatable by-products”, “Recyclable materials” and “Wastes”.

9. ABBREVIATIONS, TERMS AND DEFINITIONS

9.1 Abbreviations used in the report

CF	Carbon Footprint
CFP	Carbon Footprint of Product
CF-PCR	Carbon footprint product category rules
CO_{2e}	Carbon Dioxide Equivalent
DIS	Draft International Standard
FAO	Food and Agriculture Organization
FLAG	Forest, Land and Agriculture
GHG	Green House Gasses
GUS	GROSS USABLE SURFACE
GWP	Global Warming Potential
IEA	International Energy Agency
ILCD	International Reference Life Cycle Data System
IPCC	Intergovernmental Panel on Climate Change
IPP	Integrated Pollution Prevention
IPP	Integrated Product Policy
ISO	International Standard Organisation
JMA	Japan Meteorological Agency
LCA	Life Cycle Analysis or Assessment
LCI	Life Cycle Inventory Analysis
LCIA	Life Cycle Impact Assesment
MSI	Material Sustainability Index of the Higg framework
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NUS	NON-USABLE SURFACE
OEM	Original Equipment Manufacturer
PCF	Product Carbon Footprint
PCR	Product Category Rules
SBTi	Science-Based Targets initiative
TLS	TOTAL LEATHER SURFACE
TOE	Tonnes of Oil Equivalent

UK-MetOffice	United Kingdom Meteorological Office
UNEP	United Nations Environment Programme
UNIC	[ITA] Unione Nazionale Industria Conciaria (National Italian Union of Tannery Industry)
UNIDO	United Nations Industrial Development Organizations
UOM	Unit of Measure
USDA	United States Department of Agriculture
WBCSD	World Business Council for Sustainable Development

9.2 Terms and definitions

It is assumed that usual terms and definition related to this subject are known. However, for easy understanding, only the most important are reported here. The following terms and definition are taken from ISO 14040⁶⁴ and PEFCR guidance document ⁶⁵and are repeated for the convenience of users of the international standard.

- **Carbon footprint (CF):** weighted sum of greenhouse gas emissions and greenhouse gas removals of a process, a system of processes or a product system, expressed in CO₂equivalents
- **Carbon Footprint of Product (CPF):** carbon footprint of a product system according to ISO 14067
- **Product Carbon Footprint (PCF):** carbon footprint of a product system according to EN 16887
- **Product Category Rules (PCR):** set of specific rules, requirements, and guidelines for developing environmental declarations for one or more product categories
- **Product system (ISO 14040):** collection of unit processes with elementary and product flows, performing one or more defined functions, and which models the life cycle of a product”
- **Life Cycle Assessment (LCA) (ISO 14040):** compilation and evaluation of the inputs, outputs, and the potential environmental impacts of a product system throughout its life cycle
- **Life Cycle Inventory Analysis (LCI) (ISO 14040):** phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life cycle
- **Functional unit (ISO 14040):** quantified performance of a product system for use as a reference unit
- **Product (ISO 14040):** any goods or service
- **Primary data (ISO 14067:2018):** quantified value originating from a direct measurement or a calculation based on direct measurements of a unit process of the product system at its original source
- **Secondary data (ISO 14067:2018):** quantified value of an activity or life cycle process obtained from sources other than the direct measurement or calculation from direct measurements

⁶⁴ ISO 14040:2006(E), Environmental management – Life cycle assessment – Principles and framework

⁶⁵ European Commission, PEFCR Guidance document, - Guidance for the development of Product Environmental Footprint Category Rules PEFCRs), version 6.3, December 2017

- **Greenhouse Gas (GHG)⁶⁶ (ISO 14067:2018)**: gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds.
- **Global Warming Potential (GWP) (ISO 14067:2018)**: factor describing the radiative forcing impact of one mass- based unit of a given GHG relative to an equivalent unit of carbon dioxide over a given period of time
- **Carbon dioxide equivalent (CO_{2e}) (ISO 14067:2018)**: unit for comparing the radiative forcing of a GHG to carbon dioxide. For the purposes of this document, the terms and definitions given in EN 15987 and CEN ISO/TS 14067 and the following apply.
- **Leather (EN 16887)⁶⁷** hide or skin with its original fibrous structure more or less intact, tanned to be imputrescible, where the hair or wool may or may not have been removed, whether or not the hide or skin has been split into layers or segmented either before or after tanning and where any surface coating or surface layer, however applied, is not thicker than 0,15 mm

Note 1 to entry: If the tanned hide or skin is disintegrated mechanically and/or chemically into fibrous particles, small pieces, or powders and then, with or without the combination of a binding agent, is made into sheets or other forms, such sheets or forms are not leather.

Note 2 to entry: If the grain layer has been completely removed, the term leather will not be used without further qualification, e.g., split leather, suede leather. [SOURCE: EN 15987:2015, 4.1.1, modified — Note 2 to entry was slightly modified]

- **Sole leather, vegetable tanned (EN 16887) leather** tanned with vegetable tannins and finished for the outsoles of footwear
- **Crust (EN 16887) leather** which is tanned, fatliquored and dried, before finishing⁶⁸
- **Split leather (EN 16887)** layer from a hide or skin made from a flesh split or a middle split, without any grain structure, tanned to be imputrescible

Note 1 to entry: A split is a layer of hide or skin obtained by dividing it horizontally (splitting) to obtain at least two separate layers; the top layer is called grain split, and the bottom layer is called flesh split; for heavy hides also, a middle split can be obtained.

Note 2 to entry: If the name of the animal whence it originates, or the part of the animal whence it comes, is included in the description, the term “split leather” will be used as a noun, e.g., pig split leather. [SOURCE: EN 15987:2015, 4.1.2]

⁶⁶ GHGs include among others carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆).

⁶⁷ EN 16887: 2017 definition is taken from EN 15987

⁶⁸ [SOURCE: EN 15987:2015, 4.1.3] BS EN 16887:2017, EN 16887:2017 (E)

- **Fleshings (EN 16887) small** pieces of connective and adipose tissues cut from the inner surface of hides and skins in the fleshing operation
- **Semi-processed leather (EN 16887) intermediates** of leather production, like wet blue, wet-white, crust, pickled pelt, etc.
- **Upstream process (EN 16887) process** occurring along the supply chain of purchased goods/services prior to entering the core process
- **Product system (core process) (EN 16887) collection** of unit processes with elementary and product flows, performing one or more defined functions, and which models the life cycle of a product

[SOURCE: EN ISO 14040:2006, 3.28]

- **Downstream process (EN 16887) process** occurring along a product supply chain after entering the core process

BS EN 16887:2017

EN 16887:2017 (E)

- **Primary data (EN 16887)** quantified value of a unit process or an activity obtained from a direct measurement, or a calculation based on direct measurements at its original source

Note 1 to entry: Primary data need not necessarily originate from the product system under study because primary data relate to a different but comparable product system to that being studied.

Note 2 to entry: Primary data include Green House Gases (GHG) emission factors and/or GHG activity data (defined in EN ISO 14064-1:2012, 2.11).

- **Site-specific data (EN 16887)** data obtained from a direct measurement, or a calculation based on direct measurement at its original source within the product system

Note 1 to entry: All site-specific data are primary data, but not all primary data are site-specific data because they also relate to a different product system.

- **Secondary data (EN 16887)** data obtained from sources other than a direct measurement, or a calculation based on direct measurements at the original source

Note 1 to entry: Such sources include databases and published literature validated by stakeholders.

- **Product (EN 16887)** result of activities or processes; a product can be tangible or intangible, or a combination of both

Note 1 to entry: The product is categorized as follows:

- services (e.g., transport, subcontractors' activity);
- processed materials (e.g., hides).

Note 2 to entry: Services have tangible and intangible elements. Provision of a service involves, for example, the following:

- an activity performed on a customer-supplied tangible product (e.g., hide to be fleshed).
- Processed materials are generally tangible and their amount is a continuous characteristic.

Note 3 to entry: Adapted from EN ISO 14021:2016 and EN ISO 9000:2015.

- **Reference flow (ISO 14040 3.29)** measure of the outputs from processes in a given product system required to fulfil the function expressed by the functional unit
- **carbon neutral:** condition in which, during a specified period of time, the carbon footprint (3.2.4) has been reduced as a result of greenhouse gas (GHG) emission reductions (3.2.3) or GHG removal enhancements (3.2.8) and, if greater than zero, is then counterbalanced by offsetting (3.3.1)

Note 1 to entry: Carbon credits (3.3.2) used for offsetting shall meet certain criteria (see Clause 11) and are only used after GHG emission reductions and GHG removal enhancements have been made in line with the carbon neutrality management plan.

Note 2 to entry: The specified period of time is a finite number of years, for organizations (3.4.3), or the full or partial life cycle, for products (3.4.4).

- **Greenhouse gas emission reduction GHG emission reduction** decreases in GHG emissions (3.2.2) quantified between two points in time or relative to a baseline (3.2.13)

Note 1 to entry: Adapted from ISO 14064-2:2019, 3.1.7.

- **Carbon footprint** sum of greenhouse gas (GHG) emissions (3.2.2) and GHG removals (3.2.7) of the subject (3.4.2) expressed as carbon dioxide equivalents (3.2.12)

Note 1 to entry: For a product (3.4.4), the carbon footprint is based on a life cycle assessment using the single impact category of climate change in accordance with ISO 14067.

Note 2 to entry: For an organization (3.4.3), the carbon footprint is equivalent to the sum of the direct GHG emissions (3.2.5), indirect GHG emissions (3.2.6) and GHG removals, if applicable, within the boundary (3.2.16) of the subject quantified in accordance with ISO 14064-1.

- **greenhouse gas removal GHG removal** withdrawal of a GHG (3.2.1) from the atmosphere by a GHG sink (3.2.10)

Note 1 to entry: Examples of ways in which GHG removals can be achieved include reforestation, carbon sequestration in soils, sustainable bioenergy with carbon capture and storage, and direct air carbon capture and storage.

[SOURCE: ISO 14064-1:2018, 3.1.6, modified — “GHG sink” made singular. Note 1 to entry added.]

- **greenhouse gas sink GHG sink** process that removes a GHG (3.2.1) from the atmosphere
- **Gross Usable Surface (GUS)** Area of leather that can be used for the intended purpose due to its good technical characteristics
- **Total Leather Surface (TLS)** Area of leather at the exit gate of the tannery (entry gate of the Cutting Center)
- **Non-Usable Surface (NOS)** Area of leather that cannot be used for the intended purpose, in relation to its poor technical characteristics
- **Multifunctional process:** A process that simultaneously generates more than one product, function, or output. In Life Cycle Assessment (LCA), multi-functional processes require special methodological consideration to allocate environmental burdens among the various co-products or by-products

- **Allocation (ISO 14040)** partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems”

ANNEX 1 LEGISLATIVE EVOLUTION - FACTSHEETS

FACT SHEET: “Ecodesign for Sustainable Products Regulation” - ESPR

TITLE
Ecodesign for Sustainable Products Regulation - ESPR
DESCRIPTION
<p>The ESPR replaces the current Ecodesign Directive 2009/125/EC and establishes a framework for setting Ecodesign requirements on specific product groups.</p> <p>It enables the setting of performance and information conditions – known as ‘Ecodesign requirements’ – for almost all categories of physical goods (with some exceptions, such as food and feed, as defined in Regulation 178/2002), including to:</p> <ul style="list-style-type: none">• Improve product durability, reusability, upgradability, and reparability• Make products more energy and resource-efficient• Address the presence of substances that inhibit circularity• Increase recycled content• Make products easier to remanufacture and recycle• Set rules on carbon and environmental footprints• Improve the availability of information on product sustainability• For groups of products that share enough common characteristics, the framework allows horizontal rules to be set <p>The ESPR also contains several other new measures:</p> <ul style="list-style-type: none">• Digital Product Passport (DPP)• Green Public Procurement (GPP)
ENTRY INTO FORCE
18 July 2024
MORE INFO AT:
https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/sustainable-products/ecodesign-sustainable-products-regulationen#timeline

FACT SHEET “Regulation on Deforestation-free products” - EUDR

TITLE
Regulation on Deforestation-free products - EUDR
DESCRIPTION
<p>The main driver of deforestation is the expansion of agricultural land that is linked to the production of commodities like cattle, wood, cocoa, soy, palm oil, coffee, rubber, and some of their derived products, such as leather, chocolate, tyres, or furniture. As a major economy and consumer of these commodities linked to deforestation and forest degradation, the EU, as partly responsible, has initiated anti-deforestation trailblazing legislative action.</p> <p>Under the Regulation, any operator or trader who places these commodities on the EU market, or exports from it, must be able to prove that the products do not originate from recently deforested land or have contributed to forest degradation.</p> <p>The Regulation on deforestation-free products repeals the EU Timber Regulation. As of 29 June 2023, operators and traders will have until 30/12/2025 to implement the new rules. Micro and small enterprises will enjoy a longer adaptation period, as well as other specific provisions.</p>
ENTRY INTO FORCE
29 June 2023
MORE INFO AT:
https://environment.ec.europa.eu/topics/forests/deforestation/regulation-deforestation-free-productsen#implementation

FACT SHEET: “Corporate Sustainability Reporting Directive” - CSRD

TITLE
“Corporate Sustainability Reporting Directive” - CSRD
DESCRIPTION
<p>The CSRD modernizes and strengthens the rules concerning the social and environmental information that companies have to report. A broader set of large companies, as well as listed SMEs, will now be required to report on sustainability. Some non-EU companies will also have to report if they generate over EUR 150 million on the EU market.</p> <p>The new rules will ensure that investors and other stakeholders have access to the information they need to assess the impact of companies on people and the environment, and for investors to assess financial risks and opportunities arising from climate change and other sustainability issues. Finally, reporting costs will be reduced for companies over the medium to long term by harmonizing the information to be provided.</p> <p>The first companies will have to apply the new rules for the first time in the 2024 financial year, for reports published in 2025.</p> <p>Companies subject to the CSRD will have to report according to European Sustainability Reporting Standards (ESRS). The standards are developed in a draft form by the EFRAG, previously known as the European Financial Reporting Advisory Group, an independent body bringing together different stakeholders.</p>
ENTRY INTO FORCE
05 January 2023
MORE INFO AT:
https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting/en

FACT SHEET: “Corporate Sustainability Due Diligence Directive” - CSDDD

TITLE
“Corporate Sustainability Due Diligence Directive” - CSDDD
DESCRIPTION
<p>The Directive establishes a corporate due diligence duty. The core elements of this duty include identifying and addressing potential and actual adverse human rights and environmental impacts in the company’s own operations, their subsidiaries and, where related to their value chain(s), those of their business partners.</p> <p>In addition, the CSDDD sets out an obligation for large companies to adopt and put into effect, through best efforts, a transition plan for climate change mitigation aligned with the 2050 climate neutrality objective of the Paris Agreement as well as intermediate targets under the European Climate Law.</p>
ENTRY INTO FORCE
25 July 2024
MORE INFO AT:
https://commission.europa.eu/business-economy-euro/doing-business-eu/sustainability-due-diligence-responsible-business/corporate-sustainability-due-diligence/en#which-companies-will-the-new-eu-rules-apply-to

FACT SHEET: “Green Claims Directive (Proposal)”

TITLE
“Green Claims Directive”
DESCRIPTION
New criteria to stop companies from making misleading claims about the environmental merits of their products and services. The proposal complements and further operationalizes the proposal for a Directive on empowering consumers in the green transition. To ensure consumers receive reliable, comparable, and verifiable environmental information on products, the proposal includes: <ul style="list-style-type: none">• Clear criteria on how companies should prove their environmental claims and labels• Requirements for these claims and labels to be checked by an independent and accredited verifier• New rules on governance of environmental labelling schemes to ensure they are solid, transparent, and reliable The proposal targets explicit claims that: <ul style="list-style-type: none">• Are made on a voluntary basis by businesses towards consumers• Cover the environmental impacts, aspects or performance of a product or the trader itself• Are not currently covered by other EU rules
ENTRY INTO FORCE
22 March 2023
MORE INFO AT:
https://environment.ec.europa.eu/topics/circular-economy/green-claimsen#timeline

FACT SHEET: “Product Environmental Footprint Recommendation” PEFCR

TITLE
“Product Environmental Footprint Recommendation” - PEFCR
DESCRIPTION
Use the PEF method or the OEF method and related PEFCRs and OEFSRs in voluntary policies involving the measurement or communication of the life cycle environmental performance of products or organizations, as appropriate while ensuring that such policies do not create obstacles to the free movement of goods in the EU. Consider life cycle environmental performance information or claims based on the use of the PEF method or the OEF method and related PEFCRs and OEFSRs as valid in relevant national schemes involving the measurement or communication of the life cycle environmental performance of products or organizations. Make efforts to increase the availability of high-quality life cycle data by setting up actions to develop, review and make available national databases and contributing to populating existing public databases, based on requirements for Environmental Footprint compliant datasets. Coherence between the different databases should be ensured between themselves.
ENTRY INTO FORCE
16 December 2021
MORE INFO AT:
https://environment.ec.europa.eu/publications/recommendation-use-environmental-footprint-methodsen

ANNEX 2 DATA COMPENDIUM: INTERNATIONAL LEATHER IMPORT/EXPORT

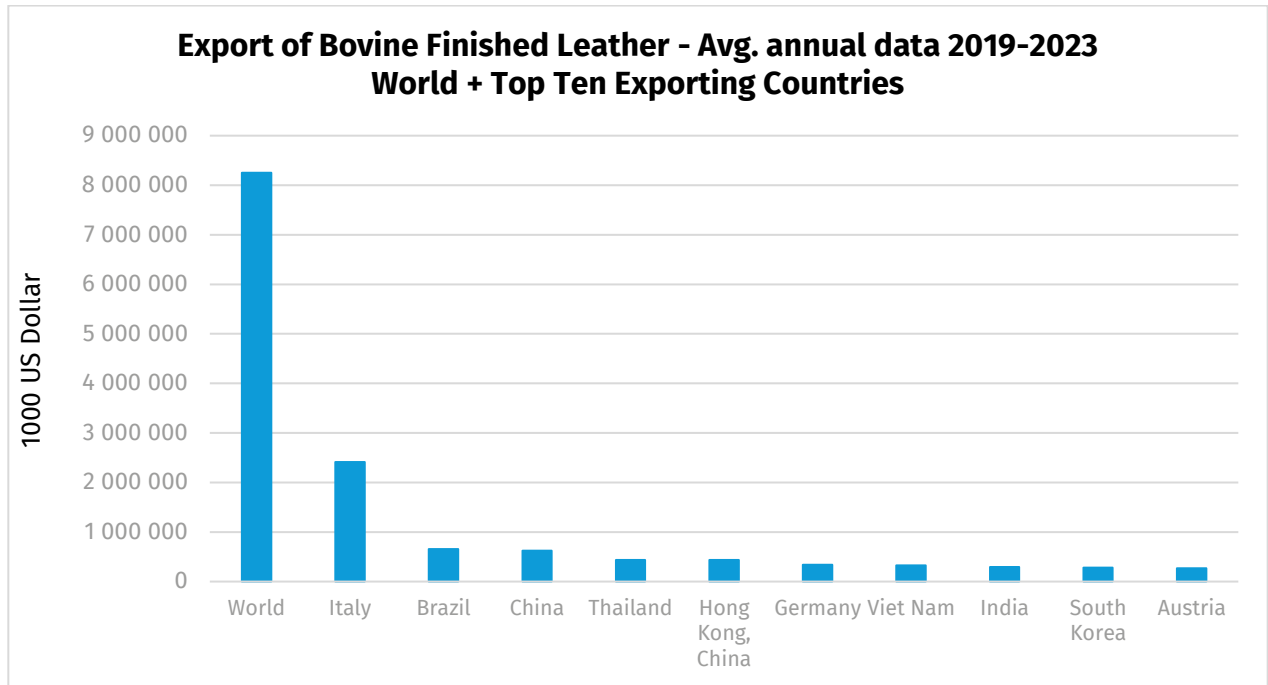


Figure A2.1: Finished Leather International Trade: export of bovine finished leather (UN/WTO Data)⁶⁹

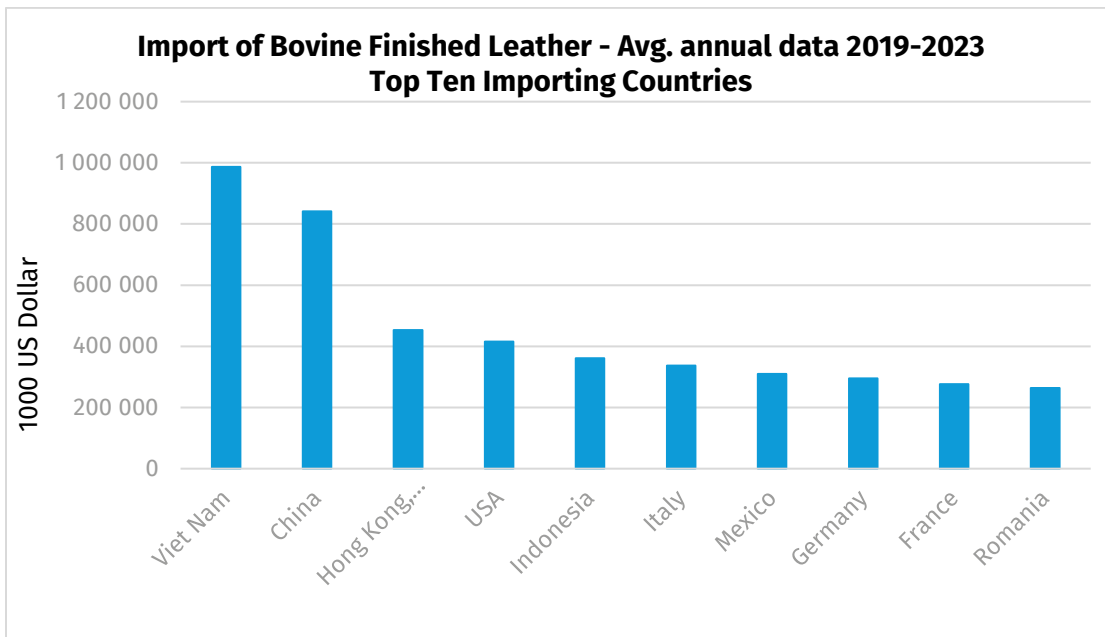


Figure A2.2: Finished Leather International Trade: import of bovine finished leather (UN/WTO Data)

⁶⁹ World Trade Organization, "World Trade Statistical Review 2023", WTO, 2023

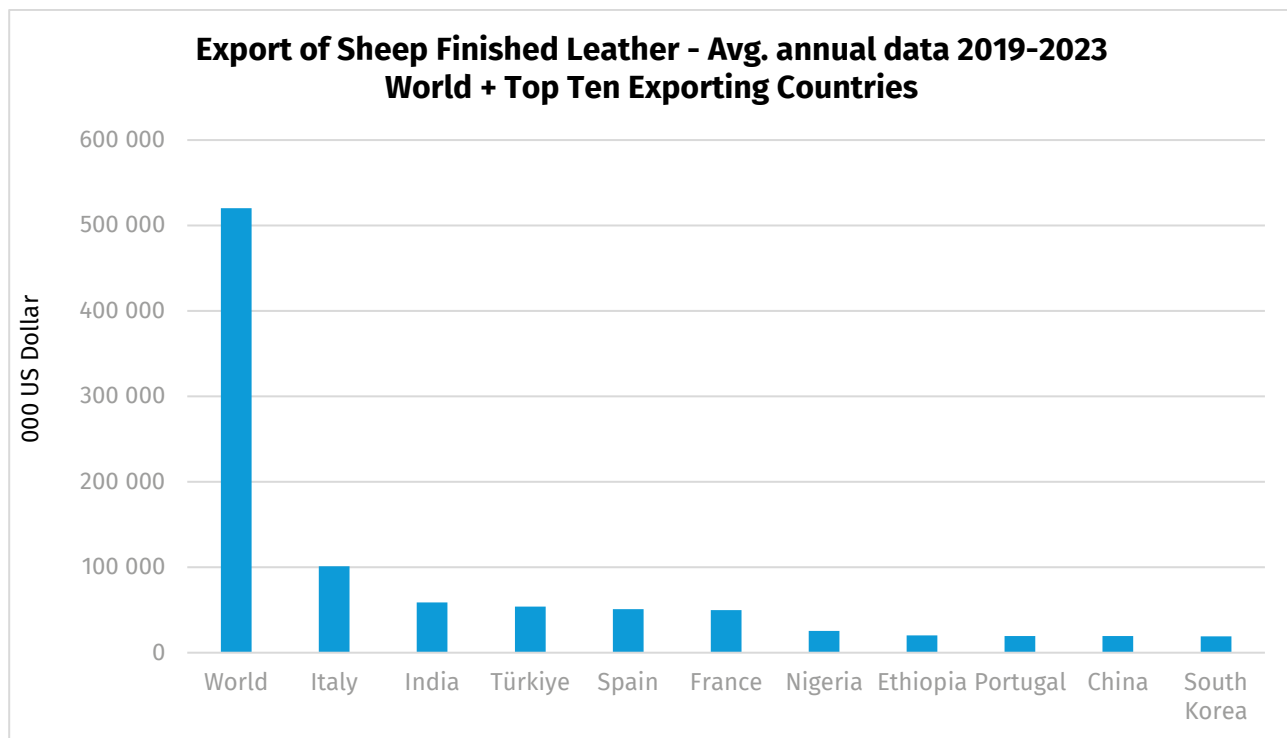


Figure A2.3: Finished Leather International Trade: export of sheep finished leather (UN/WTO Data)⁷⁰

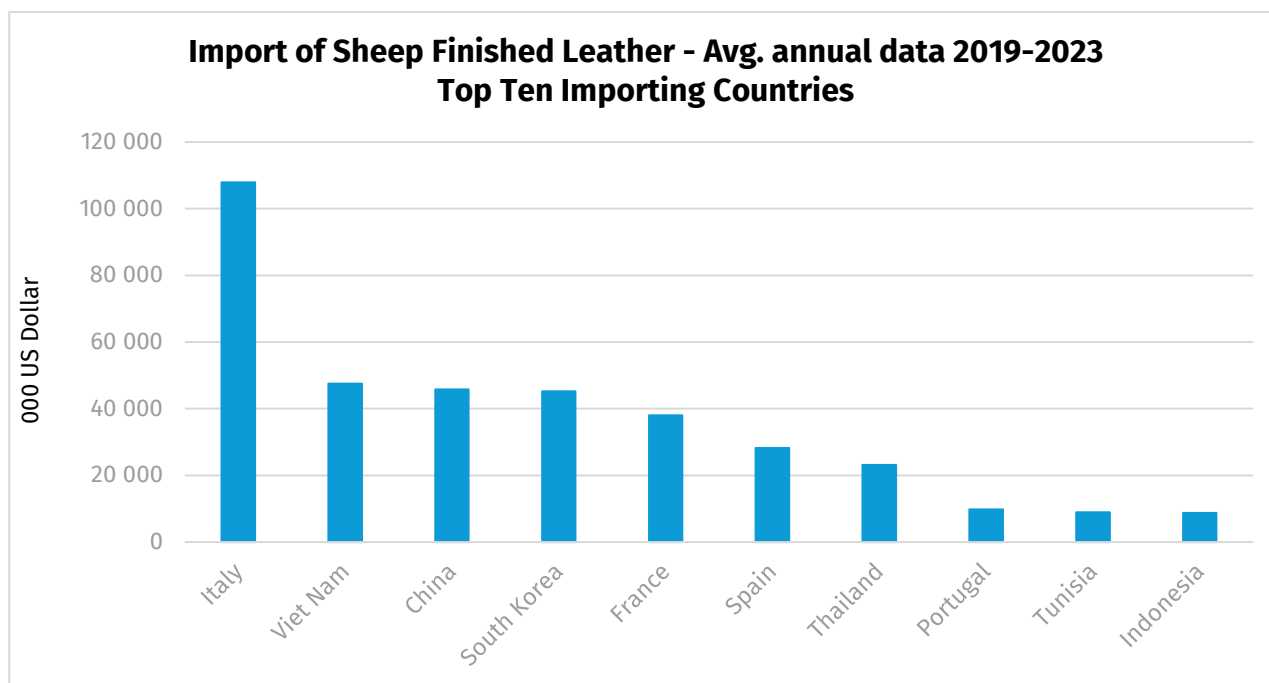


Figure A2.4: Finished Leather International Trade: import of bovine finished leather (UN/WTO Data)

⁷⁰ World Trade Organization, "World Trade Statistical Review 2023", WTO, 2023

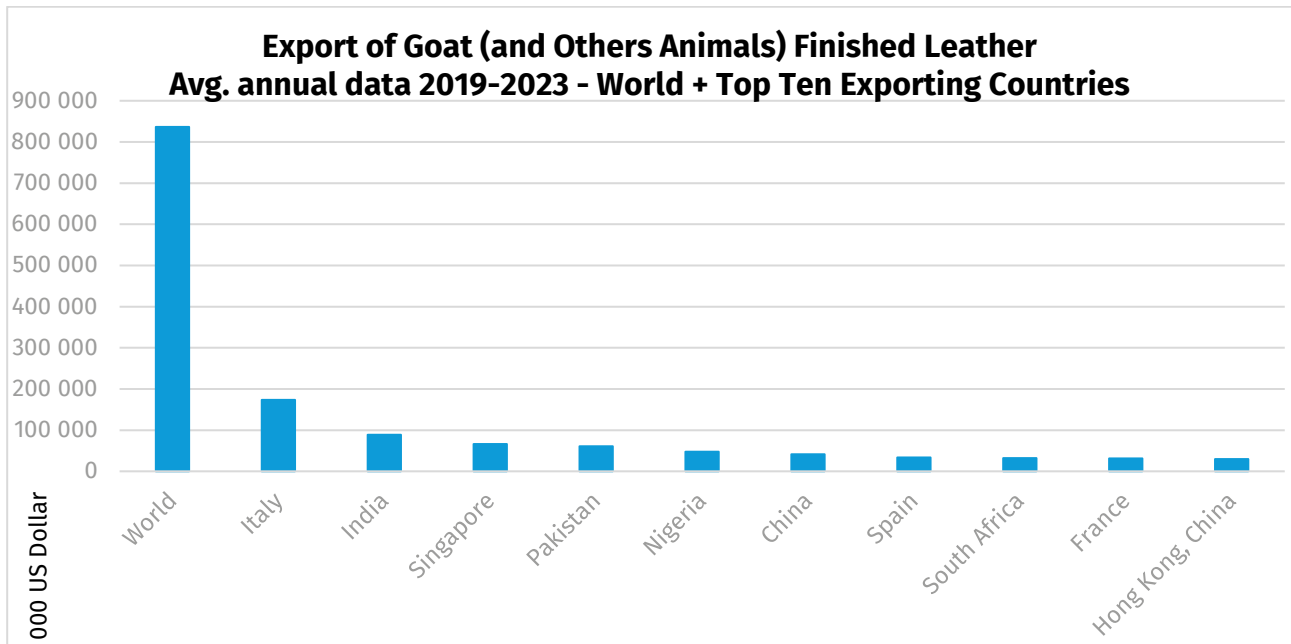


Figure A2.5: Finished Leather International Trade: export of goat and other animals finished leather (UN/WTO Data)

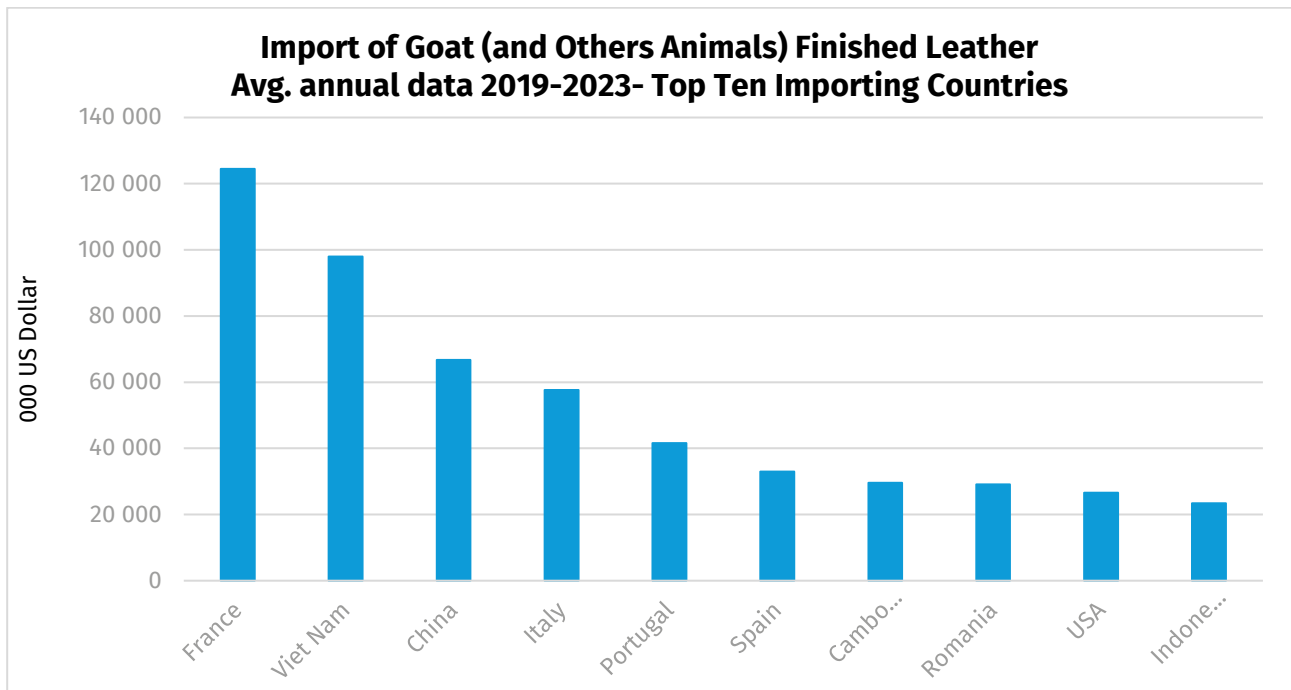


Figure A2.6: Finished Leather International Trade: import of goat and other animals finished leather (UN/WTO Data)

ANNEX 3 POSSIBLE ENTRIES FOR LEATHER PRODUCTS DEFINITION

The following table provides guidance on sources and additional examples of working, for all the 10 elements above:

ELEMENTS FOR PRODUCT SPECIFICATION	
1) PRODUCT NAME	<p>POSSIBLE ENTRIES Description of the name given by each company to the products under study</p>
2) PRODUCT TYPE	<p>POSSIBLE ENTRIES FULL SUBSTANCE, GRAIN SPLIT, FLESH SPLIT</p> <p>EN15987:2022 AVAILABLE DEFINITIONS 3.1.2 split leather: layer from a hide or skin made from a flesh split or a middle split, without any grain structure, tanned to be imputrescible <i>Note 1 to entry:</i> A split is a layer of hide or skin obtained by dividing it horizontally (splitting) to obtain at least two separate layers; the top layer is called top- grain split, and the bottom layer is called flesh split; for heavy hides also a middle split can be obtained. <i>Note 2 to entry:</i> If the name of the animal whence it originates, or the part of the animal whence it comes, is included in the description, the term "split leather" will be used as a noun, e.g., pig split leather.</p>
3) PROCESS STAGE	<p>POSSIBLE ENTRIES PICKLED, TANNED, WET BLUE, WET WHITE, CRUST, DYED CRUST, FINISHED</p> <p>EN15987:2022 AVAILABLE DEFINITIONS 3.1.5 pickled pelt: pelt treated with acid and brine, to be preserved or to be prepared for tanning 3.1.3 crust: leather which is tanned, fatliquored and dried, before finishing 3.1.3.1 dyed crust: leather tanned, dyed, fatliquored and dried, before finishing</p>
4) ANIMAL TYPE	<p>POSSIBLE ENTRIES (EXAMPLES) BOVINE; CALF; CAPRINE; LAMB; OVINE; OSTRICHS, PIGS, DEERS</p> <p>EN15987:2022 AVAILABLE DEFINITIONS NN</p>
5) INTENDED USE	<p>POSSIBLE ENTRIES⁷¹ AUTOMOTIVE & TRANSPORTATION, UPHOLSTERY & INTERIOR FURNISHINGS, FOOTWEAR, LEATHER GOODS, GARMENT AND GLOVES, WATCHSTRAPS, SADDLERY SOLE LEATHER</p>
6) THICKNESS RANGE	<p>POSSIBLE ENTRIES <0,9; 0,9 – 1,1; 1,11 – 1,3;...</p>

⁷¹ If the material has been designed and produced for other intended uses, alternative entries can be selected, provided that they are clear and unambiguous

<p>7) RAW MATERIAL TYPE</p>	<p>POSSIBLE ENTRIES FRESH, DRY, WET SALTED</p> <p>EN15987:2022 AVAILABLE DEFINITIONS NN</p>
<p>8) TYPE OF TANNING</p>	<p>POSSIBLE ENTRIES CHROME, CHROME-FREE, METAL FREE, ORGANIC, VEGETABLE, OTHERS (TO BE DEFINED AND DESCRIBED)</p> <p>EN15987:2022 AVAILABLE DEFINITIONS</p> <p>3.2.2.1 chrome-tanned leather: hide or skin converted to leather either by treatment solely with chromium salts or with chromium salts together with a small amount of some other tanning agent, used merely to assist the chromium tanning process, and not in sufficient amount to alter the essential chromium tanned character of the leather</p> <p>3.2.2.2 chrome-free: leather: hide or skin converted to leather by a tanning agent free of chromium salts, where the total content of chromium in the tanned leather is less than or equal to 0,1 % (mass of chromium/total dry weight of leather)</p> <p>3.2.2.3 metal-free-tanned leather: hide or skin converted to leather, where the total content of all tanning metals (Cr, Al, Ti, Zr, Fe) in the leather is less than or equal to 0,1 % (mass of all metals/total dry weight of leather)</p> <p>3.2.2.4 organic-tanned leather: hide or skin converted to leather by natural or synthetic organic tanning agents, where the total content of tanning metals (Cr, Al, Ti, Zr, Fe) is less than or equal to 0,3 % (mass of all metals/total dry weight of leather)</p> <p>3.2.2.5 vegetable-tanned leather hide or skin converted to leather by vegetable tanning agents, where the total content of tanning metals (Cr, Al, Ti, Zr, Fe) is less than or equal to 0,3 % (mass of all metals/total dry weight of leather)</p>
<p>9) TYPE OF RE-TANNING</p>	<p>POSSIBLE ENTRIES CHROME, CHROME-FREE, METAL FREE, ORGANIC, VEGETABLE, OTHERS (TO BE DEFINED AND DESCRIBED)</p> <p>EN15987:2022 AVAILABLE DEFINITIONS</p> <p>3.2.2.1 chrome-tanned leather: hide or skin converted to leather either by treatment solely with chromium salts or with chromium salts together with a small amount of some other tanning agent, used merely to assist the chromium tanning process, and not in sufficient amount to alter the essential chromium tanned character of the leather</p> <p>3.2.2.2 chrome-free: leather: hide or skin converted to leather by a tanning agent free of chromium salts, where the total content of chromium in the tanned leather is less than or equal to 0,1 % (mass of chromium/total dry weight of leather)</p> <p>3.2.2.3 metal-free-tanned leather: hide or skin converted to leather, where the total content of all tanning metals (Cr, Al, Ti, Zr, Fe) in the leather is less than or equal to 0,1 % (mass of all metals/total dry weight of leather)</p> <p>3.2.2.4 organic-tanned leather: hide or skin converted to leather by natural or synthetic organic tanning agents, where the total content of tanning metals (Cr, Al, Ti, Zr, Fe) is less than or equal to 0,3 % (mass of all metals/total dry weight of leather)</p> <p>3.2.2.5 vegetable-tanned leather hide or skin converted to leather by vegetable tanning agents, where the total content of tanning metals (Cr, Al, Ti, Zr, Fe) is less than or equal to 0,3 % (mass of all metals/total dry weight of leather)</p>
<p>10) TYPE OF FINISHING</p>	<p>POSSIBLE ENTRIES FREE TEXT</p>

**ANNEX 4:
LEATHER TECHNICAL PERFORMANCE – NON EXHAUSTIVE LIST OF REFERENCE
STANDARDS**

DOCUMENT TYPE: STANDARDS TO MEASURE LEATHER CHARACTERISTICS AND PERFORMANCE		
YEAR	ORGANIZATION	General LCA Theory and Rules
2000	UNI - Italian National Unification	<i>UNI 10886, Characteristics and requirements of leather used for the manufacture of gloves</i>
2005	CEN - European Committee for Standardization	<i>CEN Technical Standard 14906, Automotive Leathers</i>
2008	UNI - Italian National Unification	<i>UNI/Technical Standard 11268, Leather - Characteristics and requirements for leather upholstery</i>
2008	UNI - Italian National Unification	<i>UNI 10740, Leather - Suede for drying - Classification and requirements</i>
2010	UNI - Italian National Unification	<i>UNI 10594, Leather - Features of leathers for the footwear industry</i>
2012	ISO - International Organization for Standardization	<i>ISO 14930, Leather - Leather for dress gloves – Specification</i>
2012	ISO - International Organization for Standardization	<i>ISO 16131, Leather - Upholstery leather characteristics - Selection of leather for furniture</i>
2012	CEN - European Committee for Standardization	<i>EN 13336, Leather - Upholstery leather characteristics - Guide for selection of leather for furniture</i>
2012	CEN - European Committee for Standardization	<i>EN 16223, Leather - Requirements for the designation and description of leather in upholstery and automotive interior applications</i>
2012	UNI - Italian National Unification	<i>UNI 10826, Leather - Features of leathers intended for leather goods and accessories industry</i>
2012	UNI - Italian National Unification	<i>UNI 10885, Vegetable tanned leather - definition, characteristics and requirements</i>
2013	ISO - International Organization for Standardization	<i>ISO 14931, Apparel leather – excluding Furs</i>
2013	ISO - International Organization for Standardization	<i>ISO 5431, Leather - Wet blue goat skins - Specification</i>
2013	ISO - International Organization for Standardization	<i>ISO 5432, Leather - Wet blue sheep skins – Specification</i>
2013	ISO - International Organization for Standardization	<i>ISO 5433, Leather - Bovine wet blue - Specification</i>
2014	CEN - European Committee for Standardization	<i>EN 16419, Leather - Chamois leather for cleaning purposes - Classification and requirements</i>
2015	ISO - International Organization for Standardization	<i>ISO 14931, Leather - Guide to the selection of leather for apparel (excluding furs)</i>
2016	ISO - International Organization for Standardization	<i>EN ISO 2589, Leather — Physical and mechanical tests — Determination of thickness (ISO 2589)</i>
2023	CEN - European Committee for Standardization	<i>EN 17900:2023-10. Leather - Standard data for the calculation of leather density</i>

ANNEX 5 LEATHER SYSTEM BOUNDARIES: EXAMPLES AND TERMINOLOGY

ELEMENTS FOR SPECIFICATION OF SYSTEM BOUNDARIES SYSTEM BOUNDARIES	
PRODUCT SYSTEM DEFINITION	ISO 14040, DEF 3.28: PRODUCT SYSTEM: collection of unit processes with elementary and product flows, performing one or more defined functions, and which models the life cycle of a product
LIFE CYCLE STAGES	<p>The product system of leather can be represented as divided into three different life cycle stages:</p> <ul style="list-style-type: none"> • UPSTREAM PROCESSES, are the ones producing the Input to the Tannery (from cradle to entry gate of the tannery) • CORE PROCESSES, are the ones carried out in the tannery (from gate to gate of the tannery) • DOWNSTREAM PROCESSES, are the ones using/managing the outputs of the tannery (from gate to grave)
UPSTREAM PROCESSES	<p>The following attributional processes are classified as UPSTREAM PROCESSES:</p> <ul style="list-style-type: none"> • ANIMAL FARMING, with a subdivision into different processes, such as for example: <ul style="list-style-type: none"> • Breeding • Rearing • Fattening • SLAUGHTERING • RAW HIDES AND SKINS PRESERVATION • PRODUCTION OF CHEMICALS and auxiliary products • ENERGY PRODUCTION • WATER EXTRACTION AND DELIVERY • MANUFACTURING OF PACKAGING • All TRANSPORTS required to carry out these processes
CORE PROCESSES	<p>The following attributional processes are classified as CORE PROCESSES:</p> <ul style="list-style-type: none"> • PRODUCTION PROCESSES carried out in the tannery, divided in the 4 categories identified by the JRC BREF document⁷². <ul style="list-style-type: none"> • Beamhouse Processes, such as for example: <ul style="list-style-type: none"> ○ <i>Trimming</i> ○ <i>Soaking</i> ○ <i>Unhairing and liming</i> ○ <i>Fleshing</i> ○ <i>Lime Splitting</i> • Tanyard Processes, such as for example: <ul style="list-style-type: none"> ○ <i>Deliming</i> ○ <i>Bating</i> ○ <i>Degreasing</i> ○ <i>Pickling</i> ○ <i>Tanning</i> ○ <i>Draining</i> ○ <i>Samming</i> ○ <i>Shaving</i> ○ <i>Splitting</i> • Post-Tanning (Wet Finishing) processes, such as for example: <ul style="list-style-type: none"> ○ <i>Splitting</i> ○ <i>Neutralising</i> ○ <i>Bleaching</i> ○ <i>Retanning</i> ○ <i>Dyeing</i>

⁷² Best Available Techniques (BAT) Reference Document for the Tanning of Hides and Skins Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control JOINT RESEARCH CENTRE Institute for Prospective Technological Studies Sustainable Production and Consumption Unit European IPPC Bureau 2013

	<ul style="list-style-type: none"> ○ <i>Fatliquoring</i> ○ <i>Drying</i> ● Dry Finishing processes, such as for example: <ul style="list-style-type: none"> ○ <i>Roller Coating</i> ○ <i>Spraying</i> ○ <i>Conditioning</i> ○ <i>Staking</i> ○ <i>Buffing</i> ○ <i>Dry milling</i> ○ <i>Polishing</i> ○ <i>Embossing</i> ○ <i>Measuring</i> ● All TRANSPORTS to and from the tannery, and in particular those referring to: <ul style="list-style-type: none"> ● Hides ● Semi-processed leather ● Chemicals ● Packaging ● Waste ● Co-products ● WASTE MANAGEMENT ● WASTEWATER TREATMENT
<p>DOWNSTREAM PROCESSES</p>	<ul style="list-style-type: none"> ● LEATHER USE, INCLUDING TRANSPORT ● END OF LIFE OF LEATHER SCRAPS ● USE OF CO-PRODUCTS, INCLUDING TRANSPORT ● MANUFACTURING OF CONSUMER PRODUCTS ● USE OF CONSUMER PRODUCTS ● END-OF-LIFE OF CONSUMER PRODUCTS