Navigating Forest, Land, and Agriculture (FLAG) Emissions

Exploratory Research on FLAG Emissions
for Apparel & Footwear Companies

Cascale

worldly

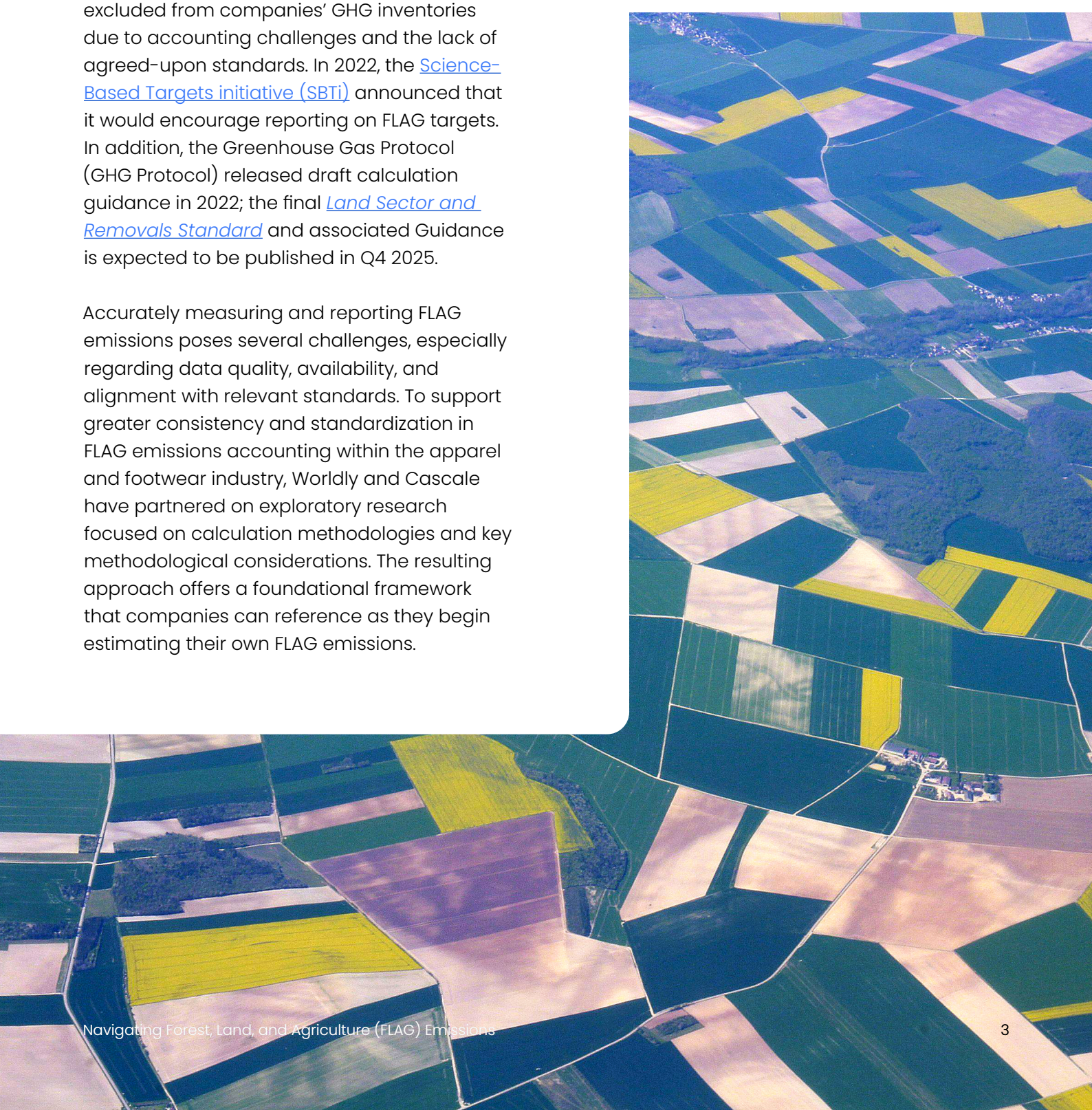
Summary

- To set Science Based Targets, brands must set separate targets of their forest, land-use, and agriculture (FLAG) emissions if these account for more than 20% of their total emissions.
- Greenhouse gas (GHG) reporting standards are moving toward increased reporting requirements for FLAG emissions, requiring apparel and footwear companies to better understand these emissions.
- The Higg Materials Sustainability Index (Higg MSI) already includes major elements of FLAG emissions, notably land management emissions. However, even where these emissions are aggregated with non-FLAG GHG emissions, they must be separated to calculate a FLAG baseline.
- While land-use change (LUC) emissions are sometimes reported in various LCA datasets, the data quality and consistency is highly variable, making it difficult to assess with confidence.
- This document provides a method with standardized assumptions (both base and conservative case) for both separating FLAG emissions from existing Higg MSI data and for including LUC emissions, enabling companies using the Higg MSI to calculate a FLAG emission baseline with more confidence and standardization.
- The percentage of FLAG emissions from an overall apparel and footwear industry GHG total are well below proposed mandatory reporting thresholds; however, this can vary significantly at the company level depending on the raw material mix of their product portfolio.

Introduction

According to the Intergovernmental Panel on Climate Change (IPCC)'s Sixth Assessment Report (2023), 22% of global greenhouse gas (GHG) emissions in 2019 came from forest, land-use, and agriculture (FLAG) sources. Historically, many of these emissions have been excluded from companies' GHG inventories due to accounting challenges and the lack of agreed-upon standards. In 2022, the Science-Based Targets initiative (SBTi) announced that it would encourage reporting on FLAG targets. In addition, the Greenhouse Gas Protocol (GHG Protocol) released draft calculation guidance in 2022; the final *Land Sector and Removals Standard* and associated Guidance is expected to be published in Q4 2025.

Accurately measuring and reporting FLAG emissions poses several challenges, especially regarding data quality, availability, and alignment with relevant standards. To support greater consistency and standardization in FLAG emissions accounting within the apparel and footwear industry, Worldly and Cascale have partnered on exploratory research focused on calculation methodologies and key methodological considerations. The resulting approach offers a foundational framework that companies can reference as they begin estimating their own FLAG emissions.



Understanding FLAG Emissions

What are FLAG emissions?

FLAG emissions apply to a company's GHG emissions from Agriculture, Forestry and Other Land Use (AFOLU) "up to the farm gate", including emissions associated with:

1. Land use change (LUC)—biomass and soil carbon losses from deforestation, conversion of coastal wetlands, conversion/draining and burning of peatlands, conversion of savannas and natural grasslands;

2. Emissions from land management (LM)—nitrous oxide and methane from enteric fermentation, biomass burning, nutrient management, fertilizer use, manure management and on-farm vehicles; and

3. Biogenic removals—forest restoration, silvopasture, improved forest management, agroforestry and soil carbon sequestration.

According to SBTi, separate FLAG targets should be set for science-based targets within six months of the release of the final version of the GHG Protocol Land Sector and Removals Guidance (expected in Q4 2025). These targets are separate from other fossil/industrial or non-FLAG targets. Removals can only be accounted for in FLAG targets and cannot be used in non-FLAG targets.

Who needs to set FLAG targets?

According to SBTi, certain companies will be required to set FLAG targets, including:

- Certain sectors:
  - Forest and paper products: forestry, timber, pulp and paper, rubber
  - Food production: agricultural production, animal source
  - Food and beverage processing
  - Food and staples retailing
  - Tobacco

- Companies with FLAG emissions that total 20% or more of overall emissions across scopes. The SBTi guidance list of other sectors includes: textile; manufacturing, spinning, weaving and apparel textile, apparel, footwear and luxury goods, and retailing.

It is recommended that companies below the 20% threshold also set a FLAG target, although not required. It is possible that some apparel brands using primarily natural fibers could exceed the 20% threshold and would need to report on FLAG emissions. Even if a company is below this threshold, it is recommended to monitor the contribution of FLAG emissions.

How are FLAG emissions calculated?

Companies must calculate FLAG emissions and LUC emissions in accordance with GHG Protocol Land Sector and Removals Guidance. Currently this guidance is in DRAFT/PILOT only (published in 2022) and not yet final (delayed to Q4 2025).

According to the draft guidance, companies must report emissions; reporting removals is optional. The GHG Protocol has provided a draft template for reporting, including the individual reporting categories. Some metrics can be calculated using secondary data while others require primary data. The following top level reporting categories are used for reporting:

- Emissions—required
  - Emissions (non-land)
  - Emissions (land)
    - Land use change emissions
    - Land management (net CO2)
    - Land management (non-CO2)
- Removals—optional (primary data required)
- Gross emissions and removals
- Land tracking—optional (primary data required)
- Reversals (of previously reported removals)—optional (primary data required)

Navigating Uncertainty: Data Quality & Availability

Before discussing the research to estimate FLAG emissions for apparel and footwear companies, the topic of data quality and availability needs to be addressed. Not only because this aspect contextualizes the results of the research, but also because apparel and footwear companies need to be aware of the current limitations associated with the assessment of FLAG emissions.

Limited inventory data

Though the GHG Protocol's draft *Land Sector and Removals Guidance* offers a pathway to account for FLAG emissions, collecting the required information can be challenging. New datasets that report high-quality FLAG emissions separately from other emission factors, as required by the guidance, take time to be published. Similarly, while an impact assessment method (methodology for quantifying impact) may be available, this doesn't always mean that the inventory data within the datasets has been updated. This is especially true if the original dataset was created before the methodology was defined. The necessary data may not have been collected at the time of dataset development, and updating the datasets to align with new methodologies requires significant time and resources. A similar situation exists with the newly developed methodology for the impact assessment of microplastics, where it is taking time for the inventory to catch up with this newly developed methodology. While there is a clear framework for reporting FLAG emissions, it can be difficult to apply in practice because the necessary data may not align, and updating it to match new methods requires both time and resources.

Restructuring of Life Cycle Assessment (LCA) datasets

Most LCA databases currently offer LCA datasets that include land management (LM) emissions alongside fossil-based emissions[1]. However, the draft GHG Protocol Land Sector and Removals Guidance requires the separate reporting of LM emissions and non-land (fossil) emissions because only the former should be included in the FLAG target. Separating these emissions can be challenging as the existing LCA model structure might not (easily) allow for this. In some LCA datasets, the detailed activity data is not disclosed in the LCA data models (also known as "black box" or "system level" models). Instead, only the aggregated impact results are available. In these cases, it is especially difficult to separate different inventory flows. Additionally, background datasets that are connected to the foreground LCA data are not always prepared with detailed data regarding land use change, which can lead to false confidence when using the resulting impact figures.

1 Please note that this document often refers to FLAG and non-FLAG emissions as non-fossil and fossil emissions for simplicity. In reality, some emissions from fossil sources are considered FLAG emissions, as explained on page 5.

Limited availability

Due to these challenges for both new and existing datasets, only a limited number of LCA databases offer datasets with FLAG emissions separated out from fossil-based emissions, and the quality of these datasets remains an area of concern. We expect this field to evolve in the near future.

Estimating FLAG Emissions for Apparel & Footwear Companies

Cascale and Worldly conducted exploratory research on the FLAG emissions for the apparel industry to provide guidance to apparel and footwear companies for their assessment of the relevance of FLAG emissions to their organizations. A key indicator of the relevance is whether or not an organization's FLAG emissions exceed the 20% threshold. This is because SBTi only requires organizations for which more than 20% of total emissions are from FLAG-related sources to set a FLAG target (although it also recommends FLAG targets when this threshold is not met).

As part of this research, we analyzed multiple scenarios since an organization's raw materials, product portfolio, and supply chain strongly determine if a company will exceed the 20% threshold. The significance of FLAG emissions was estimated for different levels of FLAG emissions and different material mixes.

Higg Materials Sustainability Index (Higg MSI) today

The Higg MSI includes both non-land emissions and LM emissions, both of which are accounted for in the existing Global Warming Potential (GWP) metric. However, land use change (LUC) is not included in Higg MSI GWP metrics at this stage. As discussed in the sections above, land use change data is dependent on the quality and availability of datasets. This analysis is part of a broader effort to develop some guidance for estimating FLAG emissions within the SBTi framework, using the Higg MSI and other relevant datasets. Furthermore, this analysis will help inform the future approach for the Higg MSI methodology.

Figure 1: FLAG emission reporting categories

Research set-up

To assess the relevance of FLAG emissions for the apparel and footwear industry, FLAG emissions were determined for materials relevant to the industry. Based on discussions with Worldly customers, Cascale members, and research into third party databases such as EF 3.1, base estimates of land use change (LUC) emissions as a percentage of total emissions were determined. A conservative case was also included in the analysis to simulate how sensitive the analysis' conclusions are to input variable changes (i.e. different levels of FLAG emissions). The percentages of LUC and LM emissions assigned to each material can be found in Table 1 of Appendix A. The often large difference between the base case and the conservative case reflects the significant variations that can occur across different supply chains and the lack of consistent data in the LCA datasets currently available.

The Higg MSI material emission factors are broken into the associated production tier, which is consistent with annual industry footprint conducted for Apparel impact institute (Aii). The Tiers are defined in Figure 2 below.

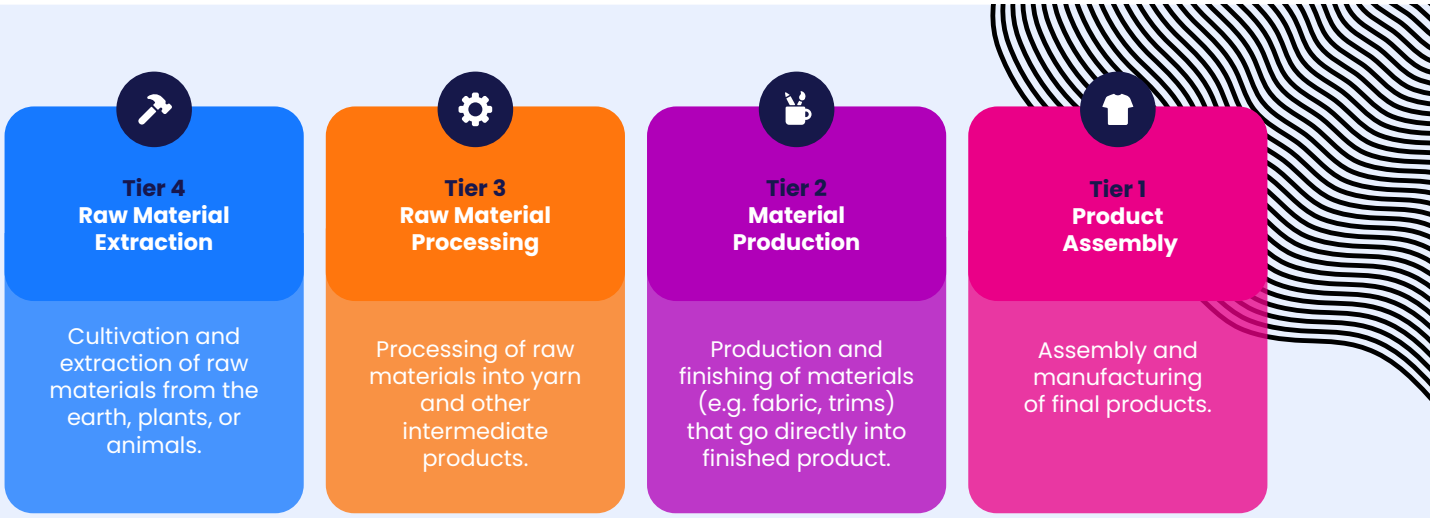


Figure 2: Apparel Industry Tiers

FLAG emissions are most relevant at Tier 4 (raw material extraction) as Tiers 3, 2, and 1 occur inside facilities. Emission factors for Tiers 3 through 1 are held constant and the focus of this paper is the Tier 4 portion of the emission factor. While Tier 1-3 facilities can use biomass as a thermal energy source (which would have FLAG-related emissions), the overall use of biomass across the sector is low and does not change the conclusions of this research.

Using available Life Cycle Assessment (LCA) databases (LCA for Experts, EF 3.1, ecoinvent), LUC was analyzed as a proportion of total raw material emissions. Fiber types were grouped into the following categories: natural fibers, synthetic fibers, man-made cellulosic fibers (MMCF), recycled fibers, biobased fibers, and others. Due to the high variability in current databases and datasets as discussed above, individual data points were not directly applied. Rather, a broader review of a range of datasets and databases across a fiber category was used to establish baseline estimates without relying on any singular, specific data points. Expert judgment was applied to estimate the percentage contributions based on

fiber classification. The Higg MSI GWP emission factors are multiplied by these percentages to estimate a LUC footprint for each material.

While LM emissions are included in the Higg MSI emission factors already, these also need to be separated for the calculation of emissions from FLAG. To account for this, additional assumptions were added. Simple and conservative estimates were chosen: for natural materials, 100% of the raw material impact is estimated as LM, 50% for MMCF, and 0% for synthetics.[2] While actual LM impacts likely vary across fiber types, these simplified estimates provide a precautionary baseline. These assumptions can be revised in the future as more high-quality, fiber-specific data becomes available.

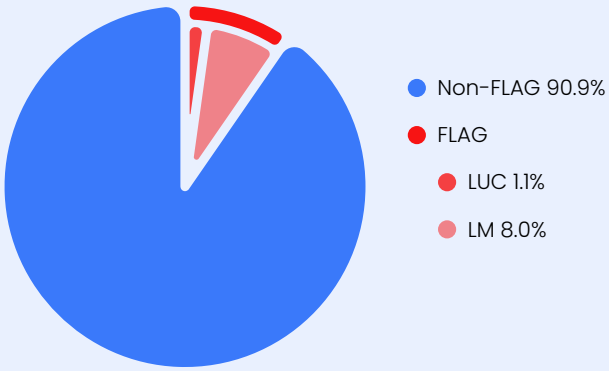
Aii's Taking Stock of Progress Against the Roadmap to Net Zero was used as a foundation to provide a basic understanding of the relevance of FLAG emissions for the apparel industry as a whole. For the past several years, Worldly and Cascale have provided emission factors from the Higg MSI to combine with fiber volumes from Textile Exchange to support the calculation of the industry's overall footprint.

As part of our analysis, leather production volumes from Textile Exchange were added to the existing material scenarios presented in the Aii apparel sector industry footprint to provide a more complete analysis of the apparel and footwear sectors, especially given the significance of FLAG emissions to leather. Both the base case and conservative case of FLAG emissions were applied to the resulting apparel and footwear industry footprint to understand what percentage of the industry's impact is estimated to come from FLAG emissions.

Results

Based on the total apparel and footwear industry footprint and the percentages of LUC and LM emissions assigned to each material category, total FLAG emissions could account for 9% in the base case and 12% in the conservative case scenario. The scope of this analysis includes the full product footprint, from Raw Material Extraction (Tier 4) through to Final Product Assembly (Tier 1). The pie charts below illustrates the contributions of LUC and LM emissions to these percentages.

% A&F Industry Emissions from FLAG (Base Case)



% A&F Industry Emissions from FLAG (Conservative Case)

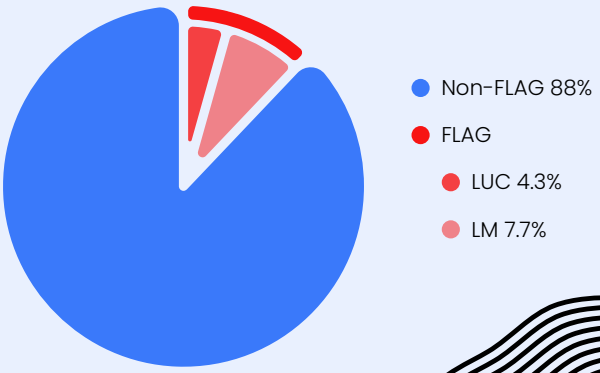


Figure 3: Breakdown of Estimated FLAG Emissions in Apparel and Footwear Industry

2 Based on the literature, silk did not fit into one of these categories and was therefore evaluated separately

This indicates that the industry's FLAG emissions fall short of the 20% threshold, meaning setting FLAG targets under the SBTi would not be required. The reduced significance of FLAG, despite the conservative LM percentages assigned to (natural) fibers, is due to the energy-intensive manufacturing processes that occur further downstream. FLAG emissions from the raw material phase are "diluted" in this sense, making up a smaller portion of total emissions as more stages of the value chain are considered. Figures 3 & 4 in Appendix A highlight this effect for all materials with (significant) FLAG emissions assigned to them.

Example assessments

In this section, two example assessments are provided to showcase the importance of the product portfolio when determining the relevance of FLAG emissions. Two contrasting product portfolios are described to complement the previous analysis of FLAG emissions across the apparel and footwear industry as a whole.

CASE 1

Natural Fiber-Heavy Portfolio

Product portfolio:

- 40% Cotton (conventional)
- 20% Leather
- 20% Wool
- 20% Lyocell

Base case FLAG emissions: 45.8%

Conservative case FLAG emissions: 49.8%

CASE 2

Synthetic Fiber-Heavy Portfolio

Product portfolio:

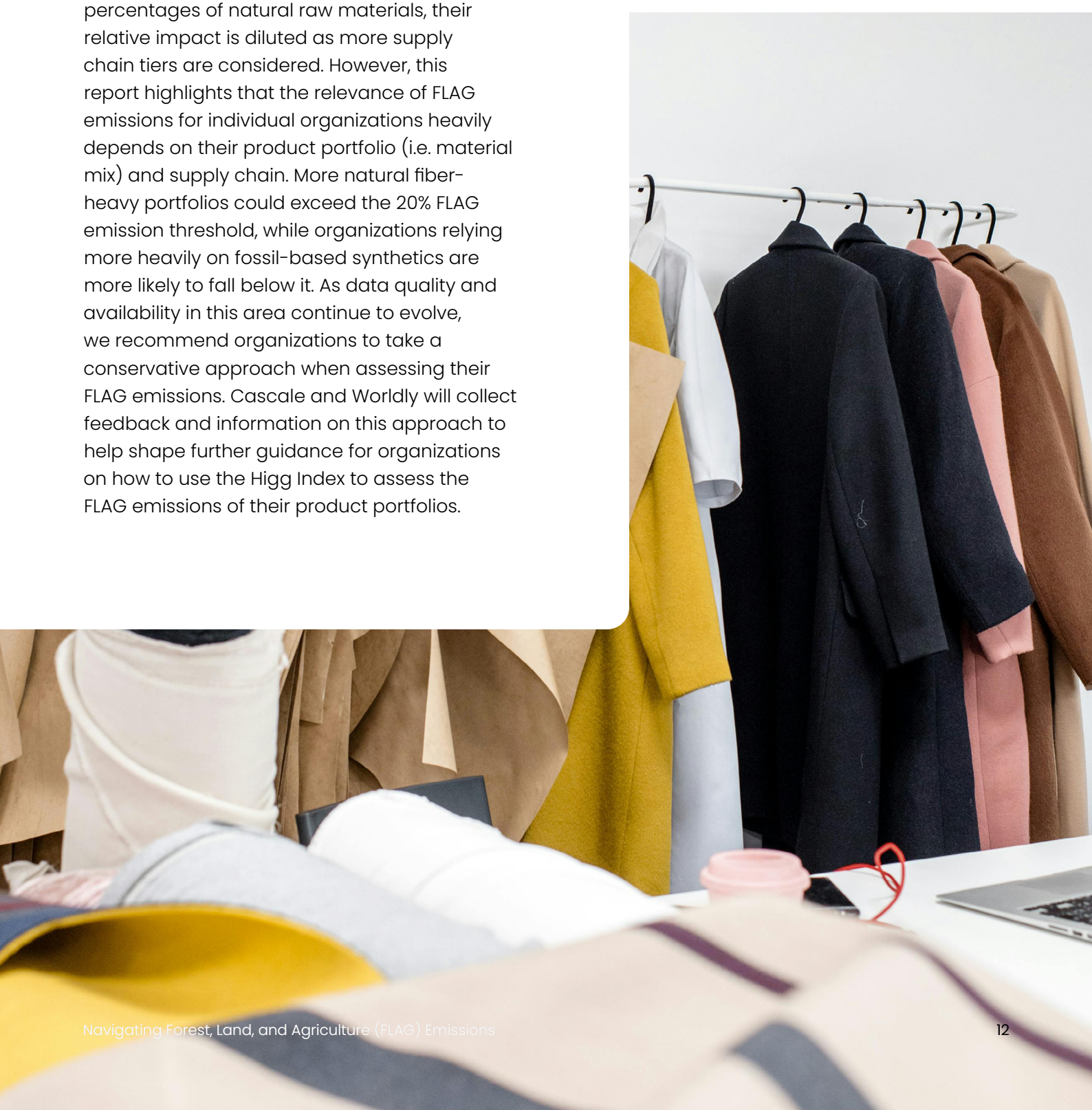
- 50% Polyester
- 20% Nylon
- 15% Viscose
- 10% Elastane
- 5% Cotton (conventional)

Base case FLAG emissions: 5.0%

Conservative case FLAG emissions: 6.4%

Conclusions

Our research indicates that FLAG emissions for most companies in the apparel and footwear industry are likely to be below the mandatory reporting threshold. Despite FLAG emissions potentially accounting for large percentages of natural raw materials, their relative impact is diluted as more supply chain tiers are considered. However, this report highlights that the relevance of FLAG emissions for individual organizations heavily depends on their product portfolio (i.e. material mix) and supply chain. More natural fiber-heavy portfolios could exceed the 20% FLAG emission threshold, while organizations relying more heavily on fossil-based synthetics are more likely to fall below it. As data quality and availability in this area continue to evolve, we recommend organizations to take a conservative approach when assessing their FLAG emissions. Cascale and Worldly will collect feedback and information on this approach to help shape further guidance for organizations on how to use the Higg Index to assess the FLAG emissions of their product portfolios.

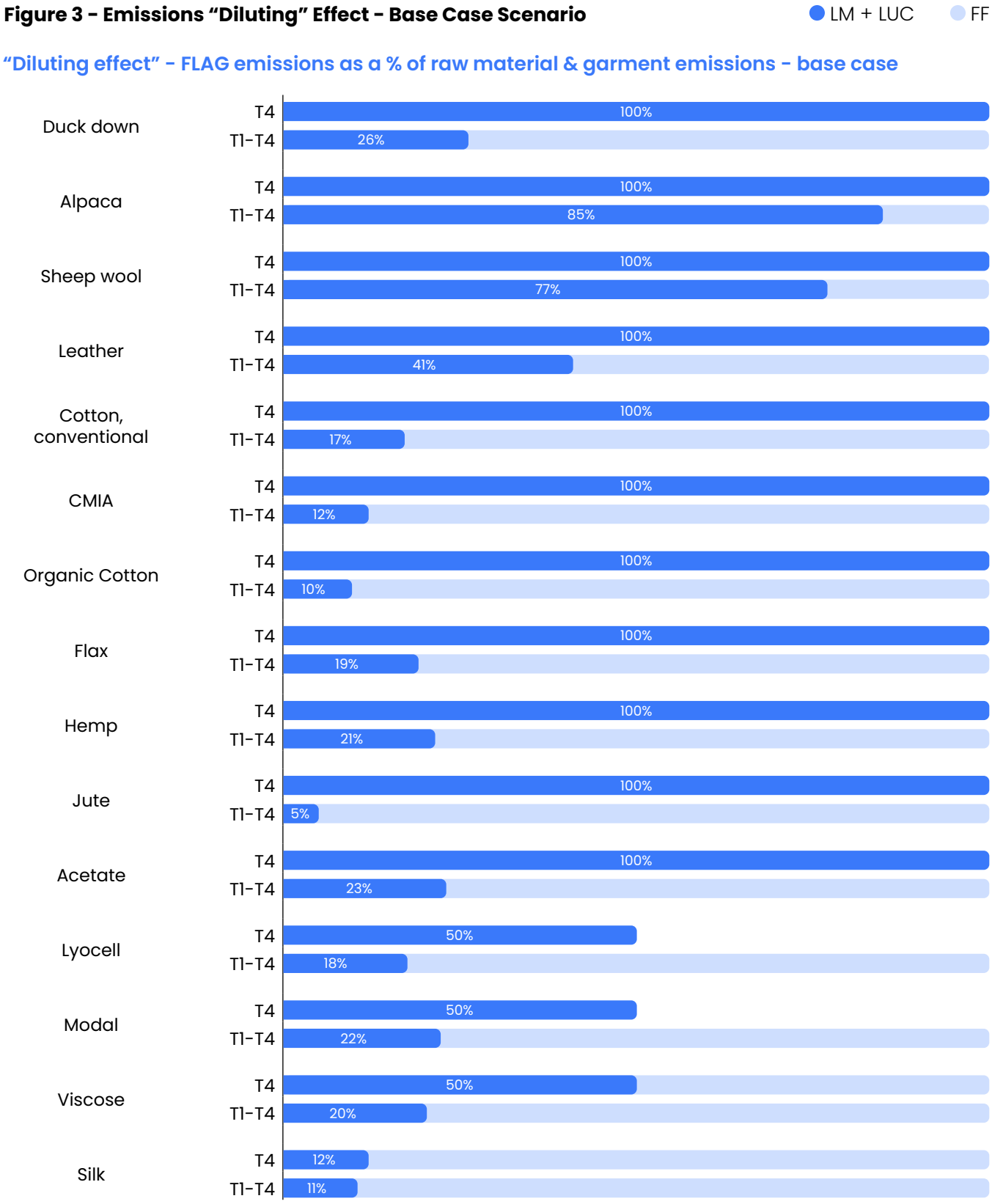


Appendix A

Table 1 - Percentage of LUC & LM Emissions Assigned to Material Categories

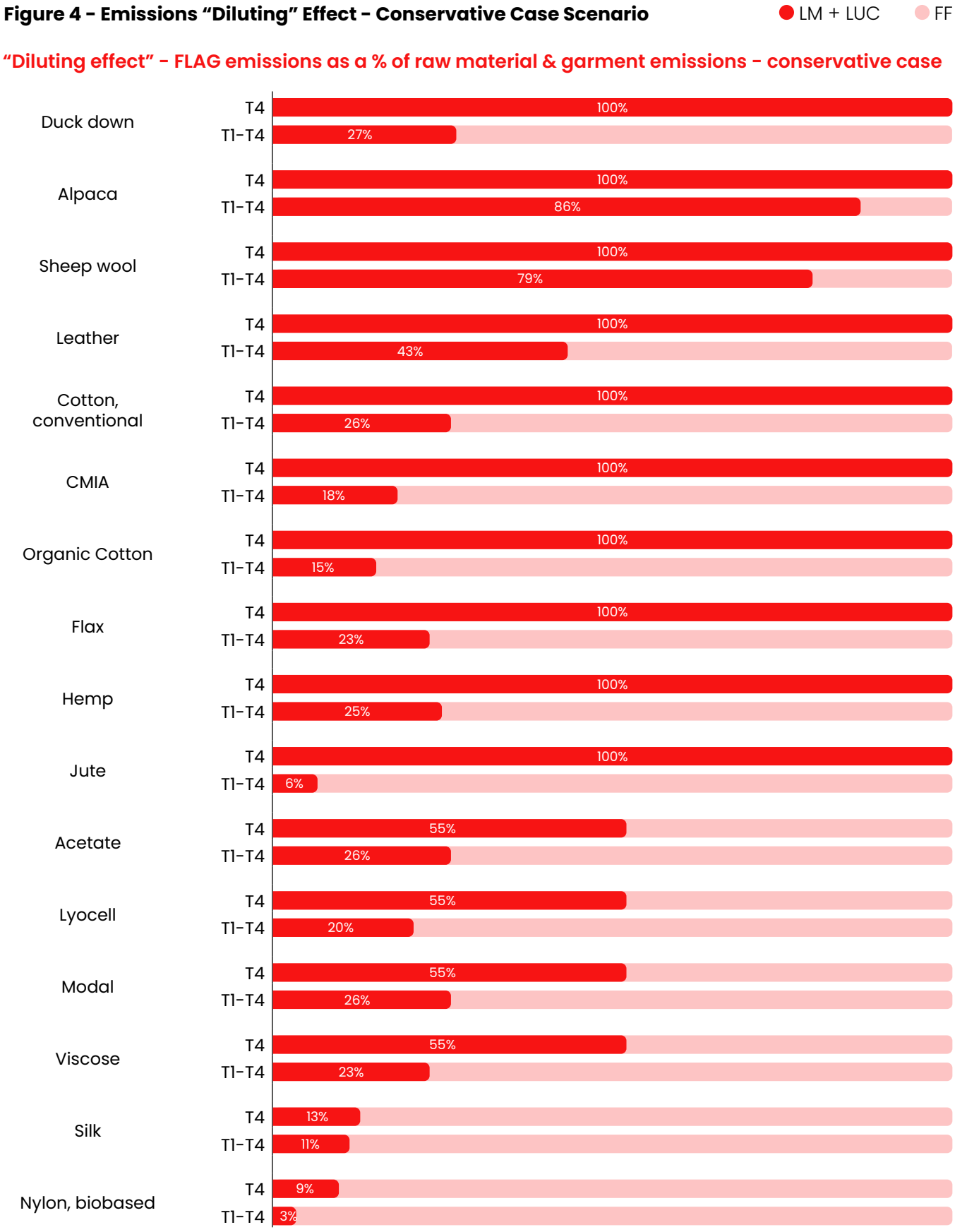
Material	LUC % - base	LUC % - conservative	fossil-based impact %	LM impact %
Acetate	0.3%	10%	50%	50%
Acrylic	0.1%	1%	100%	0%
Alpaca	12.5%	25%	0%	100%
Cotton, conventional	20%	100%	0%	100%
CMIA	20%	100%	0%	100%
Duck down	1.6%	10%	0%	100%
Elastane	0.1%	1%	100%	0%
Flax	20%	50%	0%	100%
Hemp	20%	50%	0%	100%
Jute	20%	50%	0%	100%
Lyocell	0.3%	10%	50%	50%
Modal	0.3%	10%	50%	50%
Nylon, biobased	1%	10%	100%	0%
Nylon	0.1%	1%	100%	0%
Organic Cotton	20%	100%	0%	100%
Polyester	0.1%	1%	100%	0%
Polypropylene	0.1%	1%	100%	0%
Recycled cotton	0.1%	1%	100%	0%
Recycled down	0.1%	1%	100%	0%
Nylon, recycled	0.1%	1%	100%	0%
Polyester, recycled	0.1%	1%	100%	0%
Polypropylene, recycled	0.1%	1%	100%	0%
Sheep wool	12.5%	25%	0%	100%
Silk	0.3%	1%	88%	12%
Viscose	0.3%	10%	50%	50%
Wool, recycled	0.1%	1%	100%	0%
Leather	12.5%	25%	0%	100%

Figure 3 - Emissions "Diluting" Effect - Base Case Scenario



LM + LUC = Land Management + Land Use Change, FF = Fossil Fuels
Fossil-based synthetic materials and recycled materials are not included in this chart as less than 1% LUC and LM emissions were assigned to these materials in the base case.

Figure 4 - Emissions "Diluting" Effect - Conservative Case Scenario



Fossil-based synthetic materials and recycled materials are not included in this chart as nearly all (>99%) emissions from these materials are considered non-FLAG.

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