Life Cycle Assessment of Grass Fiber Interior Products

Commissioner: Mørkegaard A/S in collaboration with Salling Group A/S

Product brand: Nord Harmony

LCA practitioner: Better Green ApS

Critical reviewer: Bureau Veritas Solutions Denmark A/S

Date and version: 2026-04-28 (v1.1)

LIFE CYCLE ASSESSMENT (LCA) INFORMATION	
Commissioner	Mørkegaard A/S in collaboration with Salling Group A/S
Product brand	Nord Harmony
LCA practitioner	Better Green ApS Julie Kathrine Lyager & Marie Astrid Steenberg Holm
Independent critical reviewer	Bureau Veritas Solutions Denmark A/S Julie M. V. Larsen, LCA & EPD Consultant
LCA standard	DS/EN ISO 14040:2008 DS/EN ISO 14044:2008
Products	Oval placemat 53x33 cm Round placemat Ø37 cm Round deep bowl 30x10 cm Laundry basket – small 32x40 cm Laundry basket – large 42x50 cm Oval floor rug 140 x 170
Life cycle scope	Cradle-to-grave
Temporal scope	Production data collected covers 2025
Geographical scope	Raw materials: India Production: India Use and end-of-life: Denmark
Background database	ecoinvent v3.11 (cut-off)
Software	SimaPro 10.2.0.3
Modeling/allocation approach	Attributional LCA and physical allocation in phase 3 (production)
LCIA method	Environmental Footprint 3.1
Impact categories	Climate change; Ecotoxicity, freshwater; Particulate matter; Eutrophication, marine; Eutrophication, freshwater; Eutrophication, terrestrial; Human toxicity, cancer; Human toxicity, non-cancer; Ionising radiation; Land use; Ozone depletion; Photochemical ozone formation; Resource use, fossils; Resource use, minerals and metals; Water use
Date and version:	2026-04-28 (v1.1)

1 Summary

Goal and scope: A life cycle assessment (LCA) was carried out to investigate the environmental impacts arising in the full life cycle of a range of grass fiber interior products from the fall 2026 line of Nord Harmony. The life cycle phases included in the LCA are:

1) Raw materials: Production of grass rope and cotton yarn
2) Raw material transport: Transport of raw materials to the factory
3) Production: Transformation of grass rope and cotton yarn into final interior products incl. packaging
4) Distribution: Transport to Denmark, warehouse, retail, disposal of transport packaging, and transport to the consumer home
5) Use phase: Disposal of consumer packaging
6) End-of-life: Disposal of the products through incineration

The goal of the assessment was to get a deeper understanding of the environmental impacts of the products and to label the product packaging with the climate change impact.

Data collection and data quality: Data was collected to represent the six life cycle phases of the LCA. Primary data was collected from the factory in India to fully represent the production phase, and additional information about the supply chain of the raw materials was also collected from the factory. The life cycle phases before and after production generally rely on secondary data. The data quality in the study is generally good, although a significant limitation is the lack of data for cultivation of the specific type of grass fiber used in the products. Instead, a dataset for cultivation of jute plant was used as a proxy.

Results and conclusions: The environmental impact of the products was evaluated across 16 impact categories according to the EF3.1 LCIA method. The climate change impact of the product is shown in Table 1.

Table 1 – Climate change impact of the products evaluated in the life cycle assessment (LCA)

ID	Product type	Climate change impact (kg CO_2e/product)	
		Cradle-to-consumer*	Cradle-to-grave**
OPM	Oval placemat 53x33 cm	1,68	1,73
RPM	Round placemat Ø37 cm	1,29	1,32
RDB	Round deep bowl 30x10 cm	1,77	1,80
LBS	Laundry basket – small 32x40 cm	6,85	6,98
LBL	Laundry basket – large 42x50 cm	13,45	13,69
OFR	Oval floor rug 140 x 170	11,84	12,11

*Cradle-to consumer covers: phase 1 – raw materials, phase 2 – raw material transport, phase 3 – production and phase 4 – distribution. **Cradle-to-grave covers: phase 1 – raw materials, phase 2 – raw material transport, phase 3 – production, phase 4 – distribution, phase 5 – use of product and phase 6 – end-of-life of product (all life cycle phases).

In a contribution analysis (see Figure 1), it was found that:

1) 'Phase 1 –Raw materials' is the most contributing life cycle phase to climate change, contributing with 52-70% depending on the product.
2) 'Phase 4 – distribution' is the second most contributing phase to climate change, contributing with 11-35% depending on the product.
3) 'Phase 3 – Production' is the third most contributing phase to climate change, contributing with 7-12% depending on the product.

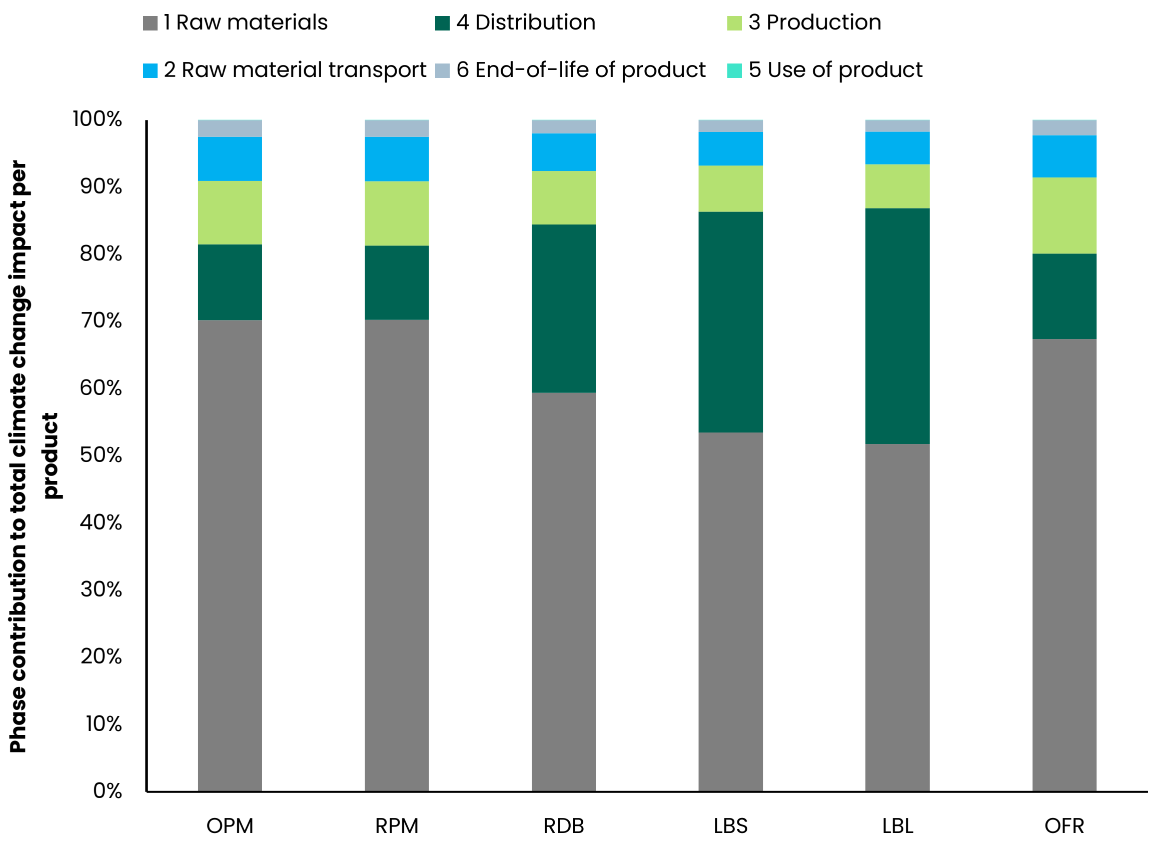

Figure 1 – Contribution analysis for the climate change impact

Critical review: The LCA study was carried out by Better Green ApS and critically reviewed by Julie M. V. Larsen, LCA & EPD Consultant from Bureau Veritas Solutions Denmark A/S. The review took place post-study and the LCA study was updated to accommodate suggestions and comments for improvement from the third-party reviewer. The review took place in April 2026.

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Product IDs

ID	Product type and line
OPM	Oval placemat 53x33 cm
RPM	Round placemat Ø37 cm
RDB	Round deep bowl 30x10 cm
LBS	Laundry basket – small 32x40 cm
LBL	Laundry basket – large 42x50 cm
OFR	Oval floor rug 140 x 170

List of abbreviations

Abbreviation	Full expression
DK	Denmark
DPP	Digital product passport
DQR	Data quality rating
DST	Statistics Denmark
EF	Environmental Footprint
ESPR	Ecodesign for Sustainable Products Regulation
EU	European Union
GLO	Global
IN	India
LCA	Life cycle assessment
LCI	Life cycle inventory
LCIA	Life cycle impact assessment
N.D.	No date
PEF	Product Environmental Footprint
PEFCR	Product Environmental Footprint Category Rules
RER	Europe
RoW	Rest of World

3 Goal of the study

3.1 Reasons for carrying out the study

Mørkegaard A/S is preparing for the expected future requirements related to the EU Ecodesign for Sustainable Products Regulation (ESPR), which entered into force on July 18, 2024. One of the planned requirements of the ESPR is the digital product passport (DPP) - a digital identity card for products, components, and materials - which will store relevant information to support product sustainability, circularity, and compliance. The DPP requirements are still being developed for various product categories.

Mørkegaard A/S is carrying out a DPP pilot project aiming at providing transparent product information to the consumer. The DPP pilot project focuses on the product line, *Nord Harmony*, which is being continuously developed with the aim of improving the environmental footprint and circularity of the products.

The aim of this LCA study is to evaluate the environmental footprint of range of grass fiber interior products from the fall 2026 line of Nord Harmony.

An equally important goal of the LCA study is to give Mørkegaard A/S a deep understanding of the environmental impact drivers in the life cycle of the assessed products. This will inform future product design and operational decisions for Mørkegaard A/S aiming to further minimize the environmental impact of their products and business.

3.2 Intended applications

The results of this LCA study are intended to be communicated to the business partners of Mørkegaard A/S (i.e., retail partners). Furthermore, the results will be communicated to the consumer of interior products by:

1) labelling the products with their climate change impact (kg CO_2e per product)
2) labelling the products with a QR code which links to a simplified digital product passport containing a summary of the findings in this LCA including the LCIA results and the external review statement.

3.3 Target audience

The target audience of this LCA study is the business partners of Mørkegaard A/S (retail partners) and the end consumer of the products. The LCA report will be shared with relevant business partners of Mørkegaard A/S as well as the end consumer.

3.4 Comparative claims

The products in this LCA study are not intended to be compared.

4 Scope of the study

4.1 Description of the products

This study assesses a range of grass fiber interior products from the Nord Harmony fall 2026 line. See Figure 2 for illustrations of the products.

Figure 2 – Illustrations of grass fiber interior products in the Nord Harmony fall 2026 line. The pictures are only for illustrative purposes in this LCA and may vary from the actual products. OPM = Oval placemat, RPM = round placemat, RDB = round deep bowl, LBS = laundry basket – small, LBL = laundry basket – large, OFR = oval floor rug.

The products are produced at a factory in India. Due to confidentiality the factory is not named in this LCA. An overview of the products assessed in this LCA is given in Table 2. There are six products assessed in the LCA represented by six sets of LCA results.

Table 2 – Products assessed in the LCA study incl. size variations and LCA ID.

LCA ID	Product name	Grass rope content	Cotton thread content	Color
OPM	Oval placemat 53x33 cm	85%	15%	Natural
RPM	Round placemat Ø37 cm			
RDB	Round deep bowl 30x10 cm			
LBS	Laundry basket – small 32x40 cm			
LBL	Laundry basket – large 42x50 cm			
OFR	Oval floor rug 140 x 170			

4.2 Functional unit

In line with the purpose of the LCA, which is to inform the consumer of the environmental impact of the product they are purchasing, the LCA results will be declared based on the product package that the consumer will see in the store. The reference flow and declared unit are listed in Table 3.

Table 3 – Reference flow and declared unit per product in the LCA. * The product packaging consists of a hangtag (cardboard and jute rope).

LCA ID	Product name	Declared unit
OPM	Oval placemat 53x33 cm	1 product incl. packaging*
RPM	Round placemat Ø37 cm	1 product incl. packaging*
RDB	Round deep bowl 30x10 cm	1 product incl. packaging*
LBS	Laundry basket – small 32x40 cm	1 product incl. packaging*
LBL	Laundry basket – large 42x50 cm	1 product incl. packaging*
OFR	Oval floor rug 140 x 170	1 product incl. packaging*

4.3 System boundary

The life cycle of this LCA is cradle-to-grave and has been divided into the following life cycle phases: (1) Raw materials, (2) Transport of raw materials, (3) Production, (4) Distribution, (5) Use of product, and (6) End-of-life of product. In Table 4 the activities included in each life cycle phase are presented.

Table 4 – Life cycle phases declared in this LCA, and the activities included per life cycle phase.

Life cycle phase	Activities included:
1) Raw materials	• Grass rope supply chain • Cotton thread supply chain
2) Transport of raw materials	• Transport of raw materials to the grass product factory
3) Production	• Energy consumption • Other material inputs • Waste treatment • Packaging for products
4) Distribution	• Transport of product to warehouse • Warehouse energy consumption • Transport of product from warehouse to retail • Retail energy consumption • Waste treatment of freight packaging • Transport to consumer home
5) Use	• Waste treatment of consumer packaging
6) End-of-life	• Waste treatment of products after end-of-life

A flow diagram for the life cycle phases in this LCA is shown in Figure 3.

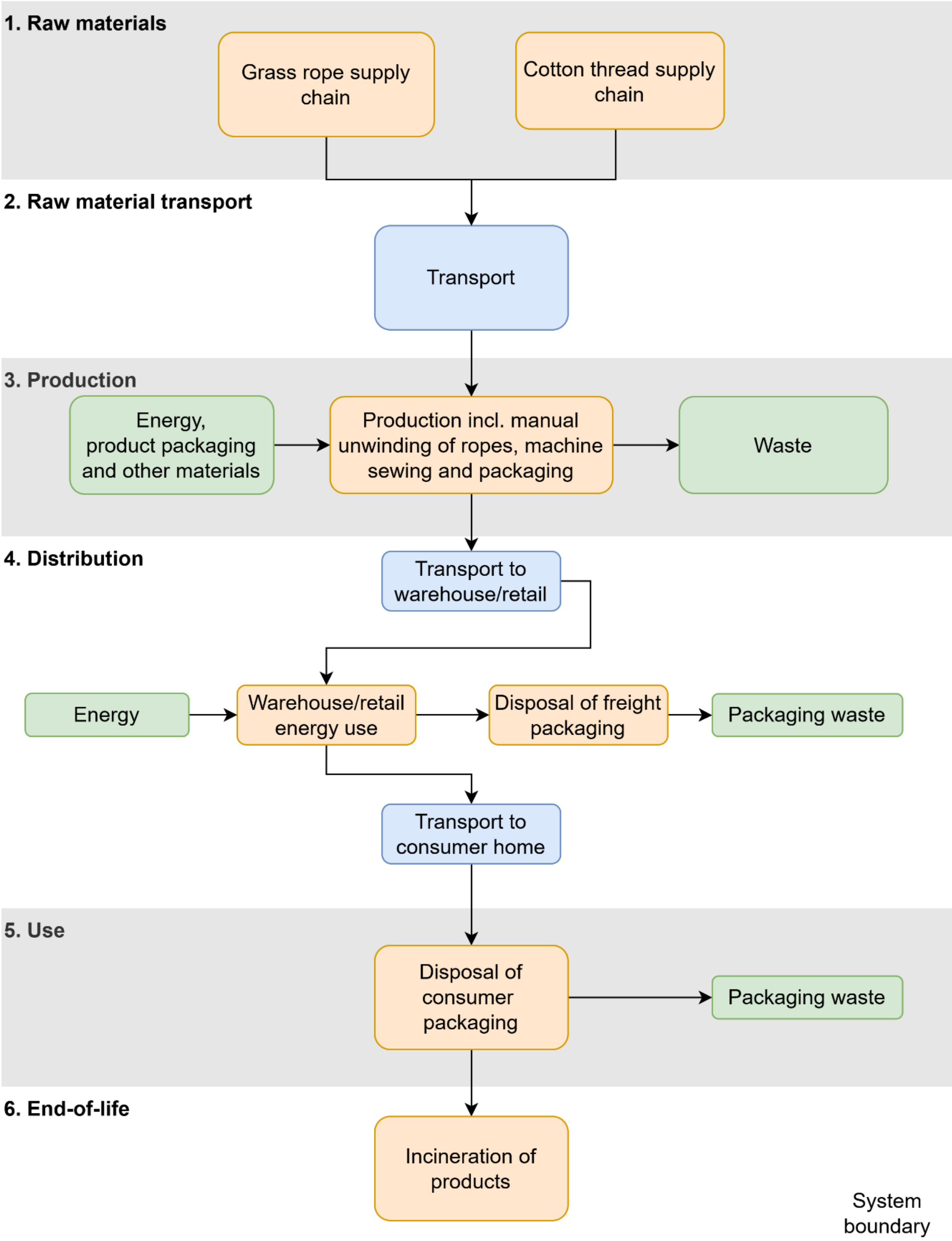

Figure 3 – Flow diagram for life cycle phases in this LCA.

4.4 Modelling approach

4.4.1 LCA standard

This LCA follows the DS/EN ISO 14040:2008 and DS/EN ISO 14044:2008 standards for life cycle assessment. ISO 14040 provides the principles and framework for conducting a Life Cycle Assessment (LCA), while ISO 14044 specifies the requirements and guidelines for carrying out each phase of an LCA, including goal definition, inventory analysis, impact assessment, and interpretation. These LCA standards were followed since they are widely recognized international standards. For assumptions the study has been inspired by the Product Environmental Footprint (PEF) Method (PEF, 2021).

4.4.2 Database and software

The ecoinvent 3.11 database ("cut-off by classification") has been used for background LCI datasets. The software SimaPro 10.2.0.3 and Microsoft Excel have been used for LCA modelling.

4.4.3 LCA method

This is an attributional LCA, meaning the LCA models the environmental impacts of the activities included in the life cycle of the product. This LCA method is commonly adopted for LCA of single products and is the LCA method adopted by the European Union "Product Environmental Footprint". In this type of LCA the background system uses "average" processes.

4.4.4 Handling of multifunctional processes

According to ISO 14044 allocation should be avoided wherever possible by (1) dividing multifunctional processes into multiple sub-processes and collecting input and output data for these sub-processes, or (2) by system expansion. If not avoidable ISO 14040/44 prioritizes physical allocation, and economic allocation if a physical relationship is not established.

In this LCA, for the foreground system (Phase 3: Production) the data is collected as far as possible for single processes in the factory (i.e., using submeters) and if that is not possible the data is collected for the whole factory. Data at the process or factory level is distributed to each product by means of mass allocation (kg).

For the background system, the ecoinvent 3.11 system model "cut-off by classification" was used. This system model handles multifunctionality by economic allocation (i.e., allocation based on price) with few exceptions, such as for energy, for which allocation is based on exergy.

4.4.5 Cut-off criteria

In this LCA, a cut-off threshold is set at a maximum of 5%, meaning that the cumulative exclusion of mass inputs (kg) and energy inputs (MJ) must not exceed this limit across the whole life cycle. For each life cycle stage, the cut-off limit is set at 1% of mass and energy. This approach ensures that all significant inputs are considered while allowing minor contributions to be omitted to streamline the analysis. Furthermore, any processes which are known to have a high environmental impact intensity per kg or MJ shall not be excluded.

4.5 Temporal and geographical scope

The temporal and geographical scope of this LCA is presented in Table 5.

The products studied in this LCA have been produced throughout multiple campaigns in the recent years. Data for the production is collected for the most recent whole year (2025), which is considered representative. The LCA results from this LCA will be printed on the packaging of a batch of products from the same production line, which will be produced in 2026.

Table 5 – Temporal and geographical scope of this LCA per life cycle phase

Scope	Raw materials	Transport of raw materials	Production	Distribution	Use of product	End-of-life of product
Temporal	2025/2026	2026	2026	2026	2026-2031	2027-2031
Geographical	India	India	India	Denmark	Denmark	Denmark

4.6 Data quality requirements

4.6.1 Temporal representativeness

Data collected for the LCA should reflect the temporal scope of the LCA as far as possible. For upstream processes the background datasets should be as recent and up-to-date as possible. For the production process, primary data should be collected for the most recently completed year (2025). For the distribution phase the background datasets should be as recent and up-to-date as possible. For the use phase and end-of-life phase that may take place until 2-5 years in the future, it is assumed that no major differences to current practices will occur, meaning the background datasets should be as recent and up-to-date as possible.

4.6.2 Geographical representativeness

Data collected for the LCA should reflect the geographical scope of the LCA as far as possible. Country-specific background datasets should be prioritized over regional and global datasets, when they are available. If they are not available, the geographical representativeness can be improved by adapting the datasets, i.e. by exchanging the electricity mix.

4.6.3 Technological representativeness

Data collected for the LCA should reflect the technologies used in the value chain of the products. For the production phase, this is ensured through collection of primary data. For upstream processes it is ensured by collecting information about the different technologies used in the supply chain, i.e. farming method. The downstream processes can vary a lot based on the consumer behavior. The most commonly used technologies should be assumed downstream.

4.6.4 Other data quality requirements

The data quality requirements are applied uniformly to ensure consistency throughout the study. Furthermore, the methodology and assumptions are reported as transparently as possible regarding sources of the data, modelling choices and uncertainty.

4.7 Critical review

This LCA has undergone a critical review by an independent expert from Bureau Veritas Solutions Denmark A/S, Julie M. V. Larsen, LCA & EPD Consultant. The critical review took place in April 2026 and included written feedback and a review meeting. The study was adapted based on the comments from the reviewer. See dialogue between the reviewer and the LCA practitioner during the review process in section 10.3 (appendix).

5 Life cycle inventory analysis (LCI)

5.1 Phase 1: Raw materials

The products consist solely of grass rope and cotton thread. The cotton thread is used to sew the grass rope together into the desired shape. In Table 6 the composition of the products can be seen. In this table the product composition is shown and the figures do not include the material losses occurring in the life cycle.

Table 6 – Product composition

LCA ID	Product name	Grass rope (grams)	Cotton thread (grams)	Total (grams)
OPM	Oval placemat 53x33 cm	255	45	300
RPM	Round placemat Ø37 cm	196	34	230
RDB	Round deep bowl 30x10 cm	213	37	250
LBS	Laundry basket – small 32x40 cm	740	130	870
LBL	Laundry basket – large 42x50 cm	1403	247	1650
OFR	Oval floor rug 140 x 170	1615	285	1900

For modelling of phase 1 and 2 the amount of raw material used per product considers the losses in the grass product factory. According to the manufacturer, for OPM and RPM there is a 15% loss in the production, while for RDB, LBS, LBL and OFR there is a 20% loss in the production (see Table 7).

Table 7 – Material consumption per product (incl. losses in production)

LCA ID	Product name	Loss %	Grass rope incl. losses (grams)	Cotton thread incl. losses (grams)	Total incl. losses (grams)
OPM	Oval placemat 53x33 cm	15%	300	53	353
RPM	Round placemat Ø37 cm	15%	231	40	271
RDB	Round deep bowl 30x10 cm	20%	266	46	313
LBS	Laundry basket – small 32x40 cm	20%	925	163	1088
LBL	Laundry basket – large 42x50 cm	20%	1754	309	2063
OFR	Oval floor rug 140 x 170	20%	2019	356	2375

Relevant supply chain information regarding the product is summarized in Table 8. The activity data, background data and data quality are described further in the following sections.

Table 8 – Supply chain information for raw materials.

Material	Parameter	Supply chain information
Grass rope	Grass cultivation location	West Bengal, India
	Grass cultivation method	Conventional
	Grass rope processing location	Jhargram, West Bengal, India
Cotton thread	Cotton origin	Surat, Gujarat, India
	Cotton cultivation method	Conventional
	Cotton spinning mill	Surat, Gujarat, India

5.1.1 Grass cultivation and processing

5.1.1.1 Activity data

The grass used for the products is of the species *Eulaliopsis binata* – also commonly known as Sabai grass. It is grown and processed into rope in West Bengal, India. It is a perennial plant and is commonly grown on degraded farmlands due to its resistance to drought and ability to grow in low-nutrient soil (Sahu et al., 2010). According to the grass product manufacturer, the grass cultivation requires minimal input. It is harvested manually using sickle and dried in the sun. The processing of the grass into a rope is carried out in several steps including twisting by hand and tightening of the rope using a hand-operated rotator. Furthermore, the rope is manually rubbed against tree bark to smoothen it. Finally, the rope is packed in bundles.

5.1.1.2 Background data

No specific life cycle inventory data for Sabai grass (*Eulaliopsis binata*) cultivation was available in ecoinvent or other LCI databases. Therefore, a dataset for jute cultivation was selected as a proxy, since this crop is evaluated to be the closest agronomic analogue available in the ecoinvent database. Sabai grass and jute are both lignocellulosic natural fibers that are grown in West Bengal.

Sabai grass is a rain-fed crop (Sahu et al. 2010; Tripathy and Mohapatra, 2017) while jute is grown in both rain-fed and irrigated systems. An ecoinvent dataset for a rain-fed jute cultivation system in Bangladesh was selected as a proxy for Sabai grass cultivation in this LCA (Jute plant, harvested {BD}| jute production, rainfed | Cut-off, U). This dataset had the most similar conditions to Sabai grass cultivation since it was rainfed and reports a relatively low yield, which is comparable with Sabai grass. The dataset reports a yield of

2680 kg/hectare/year, while Sabai grass has a reported yield of 3912 kg/hectare/year[1,2]. A dataset for an irrigated jute cultivation system in India was also available in the ecoinvent database, but this dataset was not selected since the reported yield per hectare was 10 times higher than that of Sabai grass according to Sahu et al. (2010).

After harvest the Sabai grass is left to dry in the sun (Tripathy and Mohapatra, 2017). The dry matter content in harvested Sabai grass is not known. Instead, the dry matter content in harvested jute (0,18 kg/kg) was used to calculate the amount of harvested green plant required per kg of dry plant material (1/0,18=5,56 kg green plant/kg dry plant).

After drying, all the processing is carried out manually (Sahu et al. 2010; Tripathy and Mohapatra, 2017). During processing into rope, there will likely be a loss of dry plant material. It has not been possible to find literature sources quantifying or estimating these loss rates. Nonetheless, to conservatively account for loss of material in the twisting process, it is assumed that 2 kg of dry Sabai grass is required to produce 1 kg of Sabai grass rope. This means that the following amount of harvested Sabai grass is required to produce 1 kg of rope:

5,56 kg green plant/kg dry plant x 2 kg dry plant/kg rope
= 11,11 kg green plant/kg rope

This conversion rate from green plant to final rope material is comparable with the conversion rate from green jute to jute yarn according to the ecoinvent datasets representing retting and yarn spinning from jute.

5.1.1.3 Data quality

The data quality is rated as 'Fair' for accuracy and technological representativeness, since proxy data for jute cultivation has been applied. The geographical representativeness is rated as 'Good' for cultivation since the dataset represents Bangladesh, which boarders with the region of West Bengal, where the Sabai grass in this LCA is grown. See Table 9 for data quality rating (DQR).

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[1] Sahu et al. (2010) reports that Sabai grass can produce 190 quintals/acre in a 12-year period, which equals to 46950 kg/hectare in a 12-year period or 3912 kg/hectare/year (1 quintal = 100 kg and 1 acre = 0,405 hectares).

[2] The yield for the jute in the applied dataset is slightly lower (2680 kg/ha) than the calculated yield for Sabai grass (3912 kg/ha). Nonetheless, the dataset is applied on a basis of 1 kg harvested jute to 1 kg harvested Sabai grass. This is a conservative estimate for Sabai grass considering that a dataset based on a lower yield has higher land impacts per kg than a dataset with higher yield.

Table 9 – Data quality rating (DQR) for grass rope*.

Activity	Accuracy	Geography	Time	Technology
Grass cultivation	Fair	Good	Very good	Fair
Grass rope production	Fair	Very good	Very good	Good

*Accuracy is rated for the activity data. Geographical, temporal and technological representativeness is rated for the secondary data used to represent the activity data. DQR based on UN Environment Global Guidance on LCA database development with the following scale: 'very good', 'good', 'fair', 'poor', and 'very poor'. Temporal representativeness is rated as follows: Very good = data is no more than 3 years old, Good = data is no more than 6 years old, Fair = data is no more than 10 years old, Poor = data is no more than 15 years old, Very poor = data is older than 15 years old or unknown.

5.1.2 Cotton thread production

5.1.2.1 Activity data

The cotton thread is sourced from Surat, Gujarat, India and the origin of the cotton is Surat, Gujarat, India. The cotton cultivation is conventional.

5.1.2.2 Background data

The cotton thread is modelled with an ecoinvent 3.11 dataset for ring-spun cotton yarn in India (Yarn, cotton {IN}| yarn production, cotton, ring spinning | Cut-off, U – adapted with cotton from India). This dataset has an input of cotton fiber from Bangladesh, India and 'Rest of World' (RoW). Since the cotton in this LCA originates in India, the ecoinvent dataset was adapted by changing the input of cotton fibers to be exclusively from India. The dataset accounts for losses in each processing step. I.e. seed-cotton loss in the ginning process and cotton fiber loss in the spinning process.

5.1.2.3 Data quality

The data quality is rated as 'Good-Very good' for accuracy, geographical, temporal and technological representativeness. See Table 10 for data quality rating (DQR).

Table 10 – Data quality rating (DQR) for cotton yarn*.

Activity	Accuracy	Geography	Time	Technology
Cotton yarn	Good	Very good	Very good	Very good

*Accuracy is rated for the activity data. Geographical, temporal and technological representativeness is rated for the secondary data used to represent the activity data. DQR based on UN Environment Global Guidance on LCA database development with the following scale: 'very good', 'good', 'fair', 'poor', and 'very poor'. Temporal representativeness is rated as follows: Very good = data is no more than 3 years old, Good = data is no more than 6 years old, Fair = data is no more than 10 years old, Poor = data is no more than 15 years old, Very poor = data is older than 15 years old or unknown.

Phase 1 – unit process overview

Table 11 – Unit processes in phase 1 – raw materials.

Unit process name	Unit process unit	Input	Input unit	ecoinvent dataset	Comment
1.1 Grass rope	kg	11,11	kg	Jute plant, harvested {BD}| jute production, rainfed | Cut-off, U	The input of 11,11 kg/kg rope accounts for the conversion from green plant material to dry plant material and the estimated losses in the rope making process. The processing into rope is entirely manual, which means that no other inputs or outputs are required.
1.2 Cotton thread	kg	1	kg	Yarn, cotton {IN}| yarn production, cotton, ring spinning | Cut-off, U – adapted to only have input from IN	Background dataset adapted by exchanging input of fiber (from average fiber consumption mix to 100% fiber input from India)

Table 12 – Amount of unit processes per product in phase 1 – raw materials. The amount of raw materials included in phase 1 accounts for the losses in the production step.

Unit process name	Unit	OPM	RPM	RDB	LBS	LBL	OFR
1.1 Grass rope	kg/product	0,300	0,231	0,266	0,925	1,754	2,019
1.2 Cotton thread	kg/product	0,053	0,040	0,046	0,163	0,309	0,356

5.2 Phase 2: Transport of raw materials

Phase 2 "Raw materials" includes the transport of grass ropes from the grass cultivation/processing location to the grass product factory and the transport of cotton thread from the cotton thread supplier to the grass product factory. The activity data, background data and data quality are described further in the following sections. See Table 13 for relevant supply chain information for phase 2 – transport.

Table 13 – Information about the transport routes from the suppliers to the factory.

Parameter	Transport information
Grass products factory location	Moradabad, Uttar Pradesh, India
Grass cultivation/processing location	Jhargram, West Bengal, India
Grass wholesaler location	Odisha, India (city in Odisha unknown)
Transport of grass	Leg 1: From cultivation/processing in Jhargram, West Bengal to wholesaler in Odisha by truck (distance estimated at 600 km). Leg 2: From wholesaler in Odisha to grass product factory in Moradabad, Uttar Pradesh, India by truck (distance estimated at 1500 km).
Cotton thread supplier location	Surat, Gujarat, India
Transport of cotton thread	Leg 1: From supplier in Surat, Gujarat to grass product factory in Jhargram, West Bengal, India by truck (distance estimated at 1400 km).

5.2.1 Activity data

The grass product factory is located in Moradabad, Uttar Pradesh, India. The exact address of the factory has been used for estimation of transport distances. The grass is cultivated and processed in Jhargram, West Bengal, India. The grass rope is transported via a wholesaler that is located in the state of Odisha, India. The exact location of the wholesaler is unknown, so a central location in the state of Odisha has been selected for the purpose of estimating the transport distance. The first transport leg from Jhargram, West Bengal to Odisha by truck is estimated at 600 km. The second transport leg from Odisha to the grass product factory by truck is estimated at 1500 km.

The cotton thread supplier is located in Surat, Gujarat, India. The transport from the supplier to the grass product factory by truck is estimated at 1400 km.

All transport distances by truck have been estimated by using Google Maps.

The weight of grass rope and cotton thread transported accounts for the losses in the grass product factory – see Table 7.

5.2.2 Background data

The truck transport in India was modelled with an ecoinvent 3.11 dataset for unspecified truck in the 'Rest of World' (RoW) geography (Transport, freight, lorry, diesel, unspecified {RoW}| market for transport, freight, lorry, unspecified | Cut-off, U).

See overview of LCI data for phase 2 (Transport of raw materials) in Table 15 and Table 16.

5.2.3 Data quality

The activity data is of good quality because the factory knows the details of the grass rope and cotton supply chains. See Table 14 for data quality rating (DQR).

Table 14 – Data quality rating (DQR) for transport of raw materials*.

Activity	Accuracy	Geography	Time	Technology
Transport by truck	Good	Fair	Very good	Good

*Accuracy is rated for the activity data. Geographical, temporal and technological representativeness is rated for the secondary data used to represent the activity data. DQR based on UN Environment Global Guidance on LCA database development with the following scale: 'very good', 'good', 'fair', 'poor', and 'very poor'. Temporal representativeness is rated as follows: Very good = data is no more than 3 years old, Good = data is no more than 6 years old, Fair = data is no more than 10 years old, Poor = data is no more than 15 years old, Very poor = data is older than 15 years old or unknown.

5.2.4 Phase 2 – unit process overview

Table 15 – Unit processes in phase 2 – transport of raw materials.

Unit process name	Unit process unit	Input	Input unit	ecoinvent dataset	Comment
2.1 Truck transport to factory	tkm	1	tkm	Transport, freight, lorry, diesel, unspecified {RoW}| market for transport, freight, lorry, unspecified | Cut-off, U	

Table 16 – Amount of unit processes per product in phase 2 – transport of raw materials. The transported weight of raw materials used to calculate the ton-km accounts for the losses in the production step.

Unit process name	Unit	OPM	RPM	RDB	LBS	LBL	OFR
2.1 Truck transport to factory	tkm/product	0,704	0,540	0,624	2,170	4,115	4,738

5.3 Phase 3: Production

5.3.1 Production inputs and outputs

5.3.1.1 Activity data

The products included in this LCA undergo the following processes in the factory:

1) Manual unwinding of ropes
2) Machine sewing
3) Packaging

Based on data from the factory, there is a loss of 15-20% of the material input during the production, which varies by product type – see Table 17. These losses are based on conservative estimates by the artisans producing the products and include both discarded raw materials that do not meet the quality standards and cut-off in the sewing process. The production losses are mainly related to the grass rope, while there is very little loss on the cotton thread. Nonetheless, as a conservative estimate the loss rates are applied to both the grass rope and the cotton thread.

Table 17 – Production losses

LCA ID	Product name	Loss %	Raw material consumption
OPM	Oval placemat 53x33 cm	15%	1/(1-0,15)=117,6% of the product weight
RPM	Round placemat Ø37 cm	15%	1/(1-0,15)=117,6% of the product weight
RDB	Round deep bowl 30x10 cm	20%	1/(1-0,20)=125% of the product weight
LBS	Laundry basket – small 32x40 cm	20%	1/(1-0,20)=125% of the product weight
LBL	Laundry basket – large 42x50 cm	20%	1/(1-0,20)=125% of the product weight
OFR	Oval floor rug 140 x 170	20%	1/(1-0,20)=125% of the product weight

The manual unwinding of the ropes carries no environmental impacts.

The sewing machine power during operation has been measured by the factory. The power was measured in the interval 8-32 W during sewing. As a conservative approach it is assumed that the machines operate at 32 W constantly during production of each product. The power (W) is multiplied by the time it takes to produce each product, which is shown in Table 18 along with the calculated power consumption per product.

Table 18 – Sewing machine power consumption per product

LCA ID	Product name	Sewing time (hrs)	Sewing energy consumption
OPM	Oval placemat 53x33 cm	0,4	32 W x 0,4 hrs = 12,8 Wh = 0,0128 kWh
RPM	Round placemat Ø37 cm	0,3	32 W x 0,3 hrs = 9,6 Wh = 0,0096 kWh
RDB	Round deep bowl 30x10 cm	0,5	32 W x 0,5 hrs = 16,0 Wh = 0,0160 kWh
LBS	Laundry basket – small 32x40 cm	1,6	32 W x 1,6 hrs = 51,2 Wh = 0,0512 kWh

LCA ID	Product name	Sewing time (hrs)	Sewing energy consumption
LBL	Laundry basket – large 42x50 cm	2,5	32 W x 2,5 hrs = 80,0 Wh = 0,0800 kWh
OFR	Oval floor rug 140 x 170	2,5	32 W x 2,5 hrs = 80,0 Wh = 0,0800 kWh

It has not been possible to measure the overhead energy consumption (non-sewing machine consumption) in the factory due to a lack of metering and due to co-metering with a much larger factory complex that produces metalware. Instead, the overhead energy consumption has been estimated. The sewing machines are the only energy-consuming equipment in the grass product factory, aside from lighting and ventilation. As a conservative estimate, it is assumed that the sewing machines use 50% of the electricity in the factory, with 50% of the electricity being consumed by lighting and ventilation. This yields an overhead factor of 2 which is multiplied onto the sewing machine energy consumption. A conservative approach is taken due to a relatively low production volume, which can lead to a significant overhead consumption per product. See the overall estimated energy consumption per product in Table 19.

Table 19 – Overall estimated energy consumption per product

LCA ID	Product name	Sewing energy (kWh)	Overhead energy (kWh)	Total energy (kWh)
OPM	Oval placemat 53x33 cm	0,0128	0,0128	0,0256
RPM	Round placemat Ø37 cm	0,0096	0,0096	0,0192
RDB	Round deep bowl 30x10 cm	0,0160	0,0160	0,0320
LBS	Laundry basket – small 32x40 cm	0,0512	0,0512	0,1024
LBL	Laundry basket – large 42x50 cm	0,0800	0,0800	0,1600
OFR	Oval floor rug 140 x 170	0,0800	0,0800	0,1600

The grass product factory mainly relies on energy from its own solar roof installations. The solar installations are not connected to the grid meaning that only the grass product factory consumes the energy from the solar panels. When there is not enough solar power produced to cover the factory consumption, the factory manually switches to the grid. When neither the solar power nor the grid is available, the factory has an emergency generator running on diesel. It has not been possible for the factory to measure the kWh consumption for each energy source in 2025. This is due to a lack of meters and due to co-metering with a much larger factory complex that produces metalware. Instead, the distribution of energy sources consumed in 2025 has been estimated. In 2025, the factory ran on solar power 89% of the time, on the grid 9% of the time and on the diesel generator 2% of the time. These percentages have been estimated based on the number of days each energy source was used in 2025. The grass product factory confirms that the metalware factory - that it shares grid meter with - does not consume power from the solar installations and neither does it claim any of the renewable attributes of this energy.

The factory has some plastic and paper waste, which is collected by municipal waste collection services. The plastic waste stems mainly from packaging materials and is assumed to be LDPE. This waste stems mainly from raw material packaging, i.e. cotton thread spools etc. The production of this plastic and paper is also accounted for in this LCA to maintain a mass balance of material inputs and outputs from the factory.

Inputs and outputs from the factory are listed in Table 20.

Table 20 – Energy, consumables and waste per product

Input	Unit	Value	Comment
Electricity from grid	kWh/product	0,0017-0,0144	Electricity use varies by product (see Table 19). 9% of energy comes from the grid.
Electricity from solar	kWh/product	0,0171-0,1424	Electricity use varies by product (see Table 19). 89% of energy comes from solar.
Electricity from diesel generator	kWh/product	0,0004-0,0032	Electricity use varies by product (see Table 19). 2% of energy comes from diesel generator.
Plastic input	kg/kg product	0,015	Assumed equal to the plastic waste
Plastic waste	kg/kg product	0,015	Total waste (kg) split by production volume (kg)
Paper input	kg/kg product	0,010	Assumed equal to the paper waste
Paper waste	kg/kg product	0,010	Total waste (kg) split by production volume (kg)
Cotton waste	kg/kg product	0,026-0,038	Waste % varies by product (see Table 17).
Grass rope waste	kg/kg product	0,150-0,213	Waste % varies by product (see Table 17).

5.3.1.2 Background data

The electricity consumption from the grid was modelled with an ecoinvent 3.11 dataset for electricity from the Northern Grid in India (IN-Northern grid) (Electricity, medium voltage {IN-Northern grid}| market for electricity, medium voltage | Cut-off, U).

The electricity consumption from solar energy was modelled with an ecoinvent 3.11 dataset for solar electricity in the geography 'Rest of World' (RoW) (Electricity, low voltage {RoW}| electricity production, photovoltaic, 3kWp flat-roof installation, multi-Si | Cut-off, U).

The electricity consumption from diesel generator was modelled with an ecoinvent 3.11 dataset for diesel burned in a generator in the geography 'Global' (GLO) (Diesel, burned in diesel-electric generating set, 18.5kW {GLO}| diesel, burned in diesel-electric generating set, 18.5kW | Cut-off, U). The unit for this ecoinvent dataset is the lower heating value of the diesel burned in the generator. This means that the dataset does not account for the efficiency of the generator. The dataset documentation does propose an efficiency of 35%, which has been used in this LCA. This means that for each kWh electricity consumed, 1/0,35=2,85 kWh diesel is consumed.

The input of plastics to the factory was modelled with an ecoinvent 3.11 dataset for LDPE film in the geography 'Global' (GLO) (Packaging film, low density polyethylene {GLO}| market for packaging film, low density polyethylene | Cut-off, U).

The input of paper to the factory was modelled with an ecoinvent 3.11 dataset for woodfree paper in the geography 'Rest of World' (RoW) (Paper, woodfree, uncoated {RoW}| market for paper, woodfree, uncoated | Cut-off, U).

The disposal of plastic waste was modelled with an ecoinvent 3.11 dataset for disposal of waste polyethylene in the geography 'Rest of World' (RoW) (Waste polyethylene {RoW}| market for waste polyethylene | Cut-off, U).

The disposal of paper waste was modelled with an ecoinvent 3.11 dataset for disposal of paperboard in the geography 'Rest of World' (RoW) (Waste paperboard {RoW}| market for waste paperboard | Cut-off, U).

The disposal of textile (cotton) waste was modelled with an ecoinvent 3.11 dataset for disposal of soiled textile in the geography 'Rest of World' (RoW) (Waste textile, soiled {RoW}| market for waste textile, soiled | Cut-off, U).

The disposal of grass rope waste was modelled with an ecoinvent 3.11 dataset for disposal of biowaste in the geography 'Rest of World' (RoW) (Biowaste {RoW}| market for biowaste | Cut-off, U).

See overview of LCI data for phase 3 (production) in Table 24 and Table 25.

5.3.1.3 Data quality

The data quality rating for the production phase can be seen in Table 21. Overall, the data accuracy is good, and the temporal and technological representativeness of the background data is 'good-very good' except for grass rope waste which has a fair technological representativeness. The geographical representativeness is rated 'poor'-'fair' except for electricity from grid in Northern India which is geographically very representative for the factory.

Table 21 – Data quality rating (DQR) for production inputs and outputs*.

Activity	Accuracy	Geography	Time	Technology
Electricity from grid	Good	Very good	Very good	Very good
Electricity from solar	Good	Fair	Very good	Very good
Electricity from diesel	Good	Poor	Very good	Very good
Plastic input	Fair	Poor	Very good	Good
Plastic waste	Good	Fair	Very good	Good
Paper input	Fair	Fair	Very good	Good
Paper waste	Good	Fair	Very good	Good
Cotton waste	Good	Fair	Very good	Good
Grass rope waste	Good	Fair	Very good	Fair

*Accuracy is rated for the activity data. Geographical, temporal and technological representativeness is rated for the secondary data used to represent the activity data. DQR based on UN Environment Global Guidance on LCA database development with the following scale: 'very good', 'good', 'fair', 'poor', and 'very poor'. Temporal representativeness is rated as follows: Very good = data is no more than 3 years old, Good = data is no more than 6 years old, Fair = data is no more than 10 years old, Poor = data is no more than 15 years old, Very poor = data is older than 15 years old or unknown.

5.3.2 Product packaging

5.3.2.1 Activity data

The amount of packaging per product can be seen in Table 22. The only packaging that reaches the consumer is a hang-tag, which is printed cardboard attached to the product by a jute rope. The freight packaging consists of a cardboard box and LDPE polybags. The freight packaging per product is calculated based on the weight of packaging materials divided by the total weight of shipped products per box multiplied by the weight of each product.

Table 22 Product packaging composition

LCA ID	Consumer packaging (grams/product)		Freight packaging (grams/product)	
	Jute rope	Printed cardboard	LDPE polybag	Unprinted cardboard box
OPM	2	4	4	66
RPM	2	4	3	51
RDB	2	4	4	55
LBS	2	4	13	192
LBL	2	4	24	365
OFR	2	4	30	680

5.3.2.2 Background data

Jute rope was modelled with an ecoinvent 3.11 dataset for jute yarn in the 'India' (IN) geography (Yarn, jute {IN}| yarn production, jute | Cut-off, U).

The printed cardboard tag was modelled with an ecoinvent 3.11 dataset for printed carton board in the 'Global' (GLO) geography (Carton board box production, with offset printing {GLO}| market for carton board box production, with offset printing | Cut-off, U).

The LDPE polybag was modelled with an ecoinvent 3.11 dataset for LDPE packaging film in the 'Global' (GLO) geography (Packaging film, low density polyethylene {GLO}| market for packaging film, low density polyethylene | Cut-off, U).

The freight box was modelled with an ecoinvent 3.11 dataset for cardboard box in the 'Rest of World' (RoW) geography (Corrugated board box {RoW}| market for corrugated board box | Cut-off, U).

See overview of LCI data for phase 3 (production) in Table 24 and Table 25.

5.3.2.3 Data quality

The accuracy of the activity data is very good. For jute the geographical, temporal and technological representativeness is very good. For the other materials, the geographical representativeness is 'poor'-'fair', while the technological representativeness is 'good'. See Table 23 for data quality rating (DQR).

Table 23 – Data quality rating (DQR) for product packaging*.

Activity	Accuracy	Geography	Time	Technology
Jute rope	Very good	Very good	Very good	Very good
Printed cardboard	Very good	Poor	Very good	Good
Unprinted cardboard	Very good	Fair	Very good	Good
LDPE bag	Very good	Poor	Very good	Good

*Accuracy is rated for the activity data. Geographical, temporal and technological representativeness is rated for the secondary data used to represent the activity data. DQR based on UN Environment Global Guidance on LCA database development with the following scale: 'very good', 'good', 'fair', 'poor', and 'very poor'. Temporal representativeness is rated as follows: Very good = data is no more than 3 years old, Good = data is no more than 6 years old, Fair = data is no more than 10 years old, Poor = data is no more than 15 years old, Very poor = data is older than 15 years old or unknown.

5.3.3 Phase 3 – unit process overview

Table 24 – Unit processes in phase 3 – production.

Unit process name	Unit process unit	Input	Input unit	ecoinvent dataset	Comment
3.1.1 Electricity from grid	kWh	1	kWh	Electricity, medium voltage {IN-Northern grid}| market for electricity, medium voltage | Cut-off, U	
3.1.2 Electricity from solar	kWh	1	kWh	Electricity, low voltage {RoW}| electricity production, photovoltaic, 3kWp flat-roof installation, multi-Si | Cut-off, U	
3.1.3 Electricity from diesel generator	kWh	2,86	kWh	Diesel, burned in diesel-electric generating set, 18.5kW {GLO}| diesel, burned in diesel-electric generating set, 18.5kW | Cut-off, U	2,86 kWh of the dataset per kWh of electricity consumed. The ecoinvent dataset unit is kWh of LHV of the diesel input. A generator electric efficiency of 35% has been assumed: 1/0,35=2,86 kWh
3.2.1 Inputs - plastic	kg	1	kg	Packaging film, low density polyethylene {GLO}| market for packaging film, low density polyethylene | Cut-off, U	
3.2.2 Inputs - paper	kg	1	kg	Paper, woodfree, uncoated {RoW}| market for paper, woodfree, uncoated | Cut-off, U	
3.3.1 Waste - plastic	kg	1	kg	Waste polyethylene {RoW}| market for waste polyethylene | Cut-off, U	
3.3.2 Waste - paper	kg	1	kg	Waste paperboard {RoW}| market for waste paperboard | Cut-off, U	
3.4.1 Loss - cotton waste	kg	1	kg	Waste textile, soiled {RoW}| market for waste textile, soiled | Cut-off, U	
3.4.2 Loss - Grass rope waste	kg	1	kg	Biowaste {RoW}| market for biowaste | Cut-off, U	
3.5.1 Packaging - jute rope	kg	1	kg	Yarn, jute {IN}| yarn production, jute | Cut-off, U	
3.5.2 Packaging - printed cardboard	kg	1	kg	Carton board box production, with offset printing {GLO}| market for carton board box production, with offset printing | Cut-off, U	

Unit process name	Unit process unit	Input	Input unit	ecoinvent dataset	Comment
3.5.3 Packaging - unprinted cardboard	kg	1	kg	Corrugated board box {RoW}| market for corrugated board box | Cut-off, U	
3.5.4 Packaging - LDPE	kg	1	kg	Packaging film, low density polyethylene {GLO}| market for packaging film, low density polyethylene | Cut-off, U	

Table 25 – Amount of unit processes per product in phase 3 – production.

Unit process name	Unit	OPM	RPM	RDB	LBS	LBL	OFR
3.1.1 Electricity from grid	kWh/product	0,002	0,002	0,003	0,009	0,014	0,014
3.1.2 Electricity from solar	kWh/product	0,023	0,017	0,028	0,091	0,142	0,142
3.1.3 Electricity from diesel generator	kWh/product	0,001	0,000	0,001	0,002	0,003	0,003
3.2.1 Inputs - plastic	kg/product	0,005	0,003	0,004	0,013	0,025	0,029
3.2.2 Inputs - paper	kg/product	0,003	0,002	0,003	0,009	0,017	0,019
3.3.1 Waste - plastic	kg/product	0,005	0,003	0,004	0,013	0,025	0,029
3.3.2 Waste - paper	kg/product	0,003	0,002	0,003	0,009	0,017	0,019
3.4.1 Loss - cotton waste	kg/product	0,008	0,006	0,009	0,033	0,062	0,071
3.4.2 Loss - Grass rope waste	kg/product	0,045	0,035	0,053	0,185	0,351	0,404
3.5.1 Packaging - jute rope	kg/product	0,002	0,002	0,002	0,002	0,002	0,002
3.5.2 Packaging - printed cardboard	kg/product	0,004	0,004	0,004	0,004	0,004	0,004
3.5.3 Packaging - unprinted cardboard	kg/product	0,066	0,051	0,055	0,192	0,365	0,680
3.5.4 Packaging - LDPE	kg/product	0,004	0,003	0,004	0,013	0,024	0,030

5.4 Phase 4: Distribution

Phase 4 “Distribution” is divided into four sections:

1) Transport to retail in Denmark
2) Warehouse and retail
3) Disposal of freight packaging
4) Transport to consumer

The products are sold in stores all over Denmark. The distribution phase is based on a representative scenario, where the products are sold at a retail store in Odense, Denmark. Odense was selected because the city has a central location in Denmark. Odense was selected because it is a larger city located more or less midway between the two retail stores located the furthest away from each other (Skagen and Nexø). The distance from Odense to Skagen and Nexø is 352 km and 358 km, respectively.

Relevant information regarding distribution is summarized in Table 26. The activity data, background data and data quality are described further in the following sections.

Table 26 Relevant information regarding distribution of products

Parameter	Information
Transport from factory to retail in Denmark	Leg 1: 10 km by truck from factory to Inland Container Depot in Moradabad, Uttar Pradesh, India. Leg 2: 1900 km by electric train from Inland Container Depot in Moradabad, Uttar Pradesh, India to port in Mundra, Gujarat, India. Leg 3: 14150 km by ship from port in Mundra, Gujarat, India to port in Aarhus (Denmark). Leg 4: 270 km truck transport from port in Aarhus, Denmark to warehouse in Køge, Denmark. Leg 5: 140 km truck transport from warehouse in Køge, Denmark, to retail in Odense, Denmark.
Warehouse	Ambient storage in warehouse located in Køge. The products are assumed to take up four times the space of their actual volume. The products are expected to spend 4 weeks in the warehouse. Total warehouse capacity in ‘m^3-weeks’ is estimated based on PEF standard scenarios. Electricity and heating included based on the capacity taken up by each product.
Retail	Ambient storage in retail store located in Odense. The products are assumed to take up four times the space of their actual volume. The products are expected to spend 5 weeks in the retail store. Total retail store capacity in ‘m^3-weeks’ is estimated based on PEF standard scenarios. Electricity included based on the capacity taken up by each product.
Transport to consumer	5 km by small passenger car assumed

5.4.1 Transport to retail in Denmark

5.4.1.1 Activity data

The products are transported from the factory in Moradabad, Uttar Pradesh, India to the Inland Container Depot in Moradabad, Uttar Pradesh, India by truck (10 km). From the Inland Container Depot to the port in Mundra, Gujarat, India the products are transported by electric train (1900 km). From the port in Mundra the products are transported by container ship to Denmark (14150 km). The destination port in Denmark was unknown at the time of performing this LCA. As an estimate the port in Aarhus, Denmark, was selected. From the port in Aarhus, the products are transported by truck to the warehouse in Køge (270 km). From the warehouse in Køge, the products are transported to a retail store in Odense, Denmark (140 km). The transport distances are estimated using the EcoTransit online tool.

The weight of packaging is included in the transported weight when calculating the ton-kilometers for each mode of transport.

5.4.1.2 Background data

The truck transport in India was modelled with an ecoinvent 3.11 dataset for unspecified truck in the 'Rest of World' (RoW) geography (Transport, freight, lorry, diesel, unspecified {RoW}| market for transport, freight, lorry, unspecified | Cut-off, U).

The electric train transport in India was modelled with an ecoinvent 3.11 dataset for electric train in India (IN) (Transport, freight, train, fleet average {IN}| transport, freight, train, electric | Cut-off, U).

The ship transport was modelled with an ecoinvent 3.11 dataset for global container shipping (Transport, freight, sea, container ship, heavy fuel oil {GLO}| transport, freight, sea, container ship, heavy fuel oil | Cut-off, U).

The truck transport in Denmark was modelled with an ecoinvent 3.11 dataset for >32 ton, EURO 6 truck in the 'Rest of Europe' (RER) geography (Transport, freight, lorry, >32 metric ton, diesel, EURO 6 {RER}| transport, freight, lorry, >32 metric ton, diesel, EURO 6 | Cut-off, U).

See overview of LCI data for phase 4 (distribution) in Table 32 and Table 33.

5.4.1.3 Data quality

The accuracy of activity data is very good since Mørkegaard knows the locations of each distribution step until the selected retail store. The geographical representativeness is 'fair'-'very good', with the datasets representing either the specific country (India) or larger regions, where the exact locations fall under (i.e. European transport representing transport in Denmark). The temporal representativeness is rated as very good. The technological representativeness is rated as good-very good. See Table 14 for data quality rating (DQR).

Table 27 – Data quality rating (DQR) for product transport to Denmark*.

Activity	Accuracy	Geography	Time	Technology
Truck transport India	Very good	Fair	Very good	Good
Electric train transport India	Very good	Very good	Very good	Very good
Ship transport	Very good	Fair	Very good	Good
Truck transport Denmark	Very good	Good	Very good	Good

*Accuracy is rated for the activity data. Geographical, temporal and technological representativeness is rated for the secondary data used to represent the activity data. DQR based on UN Environment Global Guidance on LCA database development with the following scale: 'very good', 'good', 'fair', 'poor', and 'very poor'. Temporal representativeness is rated as follows: Very good = data is no more than 3 years old, Good = data is no more than 6 years old, Fair = data is no more than 10 years old, Poor = data is no more than 15 years old, Very poor = data is older than 15 years old or unknown.

5.4.2 Warehouse and retail

5.4.2.1 Activity data

Energy consumption for warehousing and retail is included in the LCA based on standard scenarios defined in the Product Environmental Footprint (PEF) Method (PEF, 2021).

Warehousing: According to PEF (2021) the electricity consumption for an average distribution center is 30 kWh/m^2/yr, while the heating consumption is 360 MJ/m^2/yr. The heating is assumed to come from natural gas. An average distribution center has a size of 30.000 m^2 and a storage volume of 60.000 m^3. The total electricity consumption for a year is calculated as 900.000 kWh, and the total heating consumption for a year is calculated as 10.800.000 MJ. The specific storage volume is calculated to be 3.120.000 m^3-weeks. The specific electricity consumption is calculated as 0,29 kWh/m^3-week, and the specific heating consumption is calculated as 3,46 MJ/m^3-week.

Retail: According to PEF (2021) the electricity consumption for an average retail store is 150 kWh/m^2/yr. An average retail store center has a size of 2.000 m^2 and a storage volume of 2.000 m^3. The total electricity consumption for a year is calculated as 300.000 kWh. The specific storage volume is calculated to be 104.000 m^3-weeks. The specific electricity consumption is calculated as 2,88 kWh/m^3-week.

The storage occupancy of each product is determined based on its actual volume times four based on PEFCR (2018) guidelines. The specific storage occupancy in m^3-weeks is then calculated based on the average time the product spends in storage, which is expected to be four weeks in warehouse and five weeks in the retail store. See specific occupancy of each product in Table 28 for warehousing and retail, respectively. RDB, LBS and LBL are bowl-shaped products which have a higher volume relative to the weight compared to the other products. The products are stackable, but since it cannot be guaranteed that the products are stacked in the store, their full volume is considered. Some stores may receive only a few pieces of each product, and therefore it is considered a conservative estimate to account for the full volume.

Table 28 – Occupancy rates for the product in the LCA for warehouse.

LCA ID	Storage occupancy* (m^3)	Storage time warehouse (weeks)	Storage time retail (weeks)	Specific storage occupancy warehouse (m^3-weeks)	Specific storage occupancy retail (m^3-weeks)
OPM	0,003	4	5	0,011	0,014
RPM	0,002	4	5	0,007	0,009
RDB	0,028	4	5	0,113	0,141
LBS	0,164	4	5	0,655	0,819
LBL	0,353	4	5	1,411	1,764
OFR	0,038	4	5	0,152	0,190

* Estimated as four times the actual volume of the products

5.4.2.2 Background data

The electricity consumed at the warehouse and the retail store was modelled with an ecoinvent 3.11 dataset for Danish residual electricity mix (Electricity, low voltage {DK}| electricity, low voltage, residual mix | Cut-off, U).

The heating consumed at the warehouse was modelled with an ecoinvent 3.11 dataset for heating from natural gas in Denmark (Heat, district or industrial, natural gas {DK}| heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical | Cut-off, U).

See overview of LCI data for phase 4 (distribution) in Table 32 and Table 33.

5.4.2.3 Data quality

The activity data is of fair quality because this phase is based on a standard scenario, meaning no data was collected for the actual warehouse and retail store that the products go to. The geographical representativeness of the secondary data is rated as very good, since they are representative for Denmark. See Table 29 for data quality rating (DQR).

Table 29 – Data quality rating (DQR) for warehouse and retail energy consumption*.

Activity	Accuracy	Geography	Time	Technology
Electricity for warehouse	Fair	Very good	Very good	Very good
Heating for warehouse	Fair	Very good	Very good	Good
Electricity for retail	Fair	Very good	Very good	Very good

*Accuracy is rated for the activity data. Geographical, temporal and technological representativeness is rated for the secondary data used to represent the activity data. DQR based on UN Environment Global Guidance on LCA database development with the following scale: 'very good', 'good', 'fair', 'poor', and 'very poor'. Temporal representativeness is rated as follows: Very good = data is no more than 3 years old, Good = data is no more than 6 years old, Fair = data is no more than 10 years old, Poor = data is no more than 15 years old, Very poor = data is older than 15 years old or unknown.

5.4.3 Disposal of freight packaging

5.4.3.1 Activity data

The freight packaging is disposed of after distribution. The amount of freight packaging (cardboard box and LDPE polybag) per product can be seen in Table 22.

5.4.3.2 Background data

The disposal of cardboard box was modelled with an ecoinvent 3.11 dataset for waste paperboard disposal in Denmark (Waste paperboard {DK}| market for waste paperboard | Cut-off, U).

The disposal of LDPE polybag was modelled with an ecoinvent 3.11 dataset for waste polyethylene disposal in Denmark (Waste polyethylene {DK}| market for waste polyethylene | Cut-off, U).

See overview of LCI data for phase 4 (distribution) in Table 32 and Table 33.

5.4.3.3 Data quality

The activity data is of very good quality because the packaging weight is based on the actual packaging designs. The secondary datasets are geographically representative of Denmark and waste fractions very similar to the packaging materials. See

Table 30 for data quality rating (DQR).

Table 30 – Data quality rating (DQR) for disposal of freight packaging*.

Activity	Accuracy	Geography	Time	Technology
Cardboard disposal	Very good	Very good	Very good	Good
LDPE disposal	Very good	Very good	Very good	Good

*Accuracy is rated for the activity data. Geographical, temporal and technological representativeness is rated for the secondary data used to represent the activity data. DQR based on UN Environment Global Guidance on LCA database development with the following scale: 'very good', 'good', 'fair', 'poor', and 'very poor'. Temporal representativeness is rated as follows: Very good = data is no more than 3 years old, Good = data is no more than 6 years old, Fair = data is no more than 10 years old, Poor = data is no more than 15 years old, Very poor = data is older than 15 years old or unknown.

5.4.4 Transport to consumer

5.4.4.1 Activity data

Transport to the consumer is based on a 5 km round trip in a personal car. It was assumed that the consumer purchased 10 kg of goods, so the 5 km round trip was distributed across that amount of goods.

5.4.4.2 Background data

The transport to consumer home was modelled with an ecoinvent 3.11 dataset for a small petrol car in Europe (Transport, passenger car, small size, petrol, EURO 5 {RER}| transport, passenger car, small size, petrol, EURO 5 | Cut-off, U). See overview of LCI data for phase 4 (distribution) in Table 32 and Table 33.

5.4.4.3 Data quality

The activity data for this process is of very poor quality since the distances travelled, and the amount of goods purchased per trip is highly variable. Therefore, it is based on an estimated scenario. See Table 31 for data quality rating (DQR).

Table 31 – Data quality rating (DQR) for product transport to consumer home*.

Activity	Accuracy	Geography	Time	Technology
Car transport	Very poor	Good	Very good	Fair

*Accuracy is rated for the activity data. Geographical, temporal and technological representativeness is rated for the secondary data used to represent the activity data. DQR based on UN Environment Global Guidance on LCA database development with the following scale: 'very good', 'good', 'fair', 'poor', and 'very poor'. Temporal representativeness is rated as follows: Very good = data is no more than 3 years old, Good = data is no more than 6 years old, Fair = data is no more than 10 years old, Poor = data is no more than 15 years old, Very poor = data is older than 15 years old or unknown.

5.4.5 Phase 4 – unit process overview

Table 32 – Unit processes in phase 4 – distribution.

Unit process name	Unit process unit	Input	Input unit	ecoinvent dataset	Comment
4.1 Distribution by truck IN	tkm	1	tkm	Transport, freight, lorry, diesel, unspecified {RoW}| market for transport, freight, lorry, unspecified | Cut-off, U	
4.2 Distribution by train IN	tkm	1	tkm	Transport, freight, train, fleet average {IN}| transport, freight, train, electric | Cut-off, U	
4.3 Distribution by ship	tkm	1	tkm	Transport, freight, sea, container ship, heavy fuel oil {GLO}| transport, freight, sea, container ship, heavy fuel oil | Cut-off, U	
4.4 Distribution by truck EU	tkm	1	tkm	Transport, freight, lorry, >32 metric ton, diesel, EURO 6 {RER}| transport, freight, lorry, >32 metric ton, diesel, EURO 6 | Cut-off, U	
4.5 Warehouse	m3-weeks	0,288	kWh	Electricity, low voltage {DK}| electricity, low voltage, residual mix | Cut-off, U	
		3,46	MJ	Heat, district or industrial, natural gas {DK}| heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical | Cut-off, U	
4.6 Retail	m3-weeks	2,88	kWh	Electricity, low voltage {DK}| electricity, low voltage, residual mix | Cut-off, U	
4.7 Freight packaging disposal LDPE	kg	1	kg	Waste polyethylene {DK}| market for waste polyethylene | Cut-off, U	
4.8 Freight packaging disposal cardboard	kg	1	kg	Waste paperboard {DK}| market for waste paperboard | Cut-off, U	
4.9 Transport to consumer home	km	1	km	Transport, passenger, car, petrol, small size, EURO 5 {RER}| transport, passenger, car, petrol, small size, EURO 5 | Cut-off, U	

Table 33 – Amount of unit processes per product in phase 4 – distribution.

Unit process name	Unit	OPM	RPM	RDB	LBS	LBL	OFR
4.1 Distribution by truck IN	tkm/product	0,004	0,003	0,003	0,011	0,020	0,026
4.2 Distribution by train IN	tkm/product	0,716	0,551	0,598	2,054	3,885	4,970
4.3 Distribution by ship	tkm/product	5,330	4,106	4,456	15,296	28,934	37,016
4.4 Distribution by truck EU	tkm/product	0,154	0,119	0,129	0,443	0,838	1,073

Unit process name	Unit	OPM	RPM	RDB	LBS	LBL	OFR
4.5 Warehouse	m3-weeks	0,011	0,007	0,113	0,655	1,411	0,152
4.6 Retail	m3-weeks	0,014	0,009	0,141	0,819	1,764	0,190
4.7 Freight packaging disposal LDPE	kg/product	0,004	0,003	0,004	0,013	0,024	0,030
4.8 Freight packaging disposal cardboard	kg/product	0,066	0,051	0,055	0,192	0,365	0,680
4.9 Transport to consumer home	km	0,153	0,118	0,128	0,438	0,828	0,953

5.5 Phase 5: Use of product

Phase 5 "Use of product" includes the disposal of consumer packaging. No other activities are included in the use phase of the product. The products can be wiped with a wet cloth for cleaning during their lifetime, which is not estimated in this LCA, as it is evaluated to have a negligible environmental impact.

5.5.1 Disposal of consumer packaging

5.5.1.1 Activity data

The consumer packaging is disposed of by the consumer. The amount of consumer packaging per product can be seen in Table 22.

5.5.1.2 Background data

The disposal of cardboard was modelled with an ecoinvent 3.11 dataset for waste paperboard disposal in Denmark (Waste paperboard {DK}| market for waste paperboard | Cut-off, U).

The disposal of jute rope was modelled witn an ecoinvent 3.11 dataset for biowaste disposal in Switzerland (CH) (Biowaste {CH}| treatment of biowaste, municipal incineration FAE | Cut-off, U).

See overview of LCI data for phase 5 (use of product) in Table 35 and Table 36.

5.5.1.3 Data quality

The activity data is of very good quality because the packaging weight is based on the actual packaging designs. The geographical representativeness is fair for jute rope, and very good for cardboard. See Table 34 for data quality rating (DQR).

Table 34 – Data quality rating (DQR) for disposal of consumer packaging*.

Activity	Accuracy	Geography	Time	Technology
Cardboard disposal	Very good	Very good	Very good	Good
Jute rope disposal	Very good	Fair	Very good	Good

*Accuracy is rated for the activity data. Geographical, temporal and technological representativeness is rated for the secondary data used to represent the activity data. DQR based on UN Environment Global Guidance on LCA database development with the following scale: 'very good', 'good', 'fair', 'poor', and 'very poor'. Temporal representativeness is rated as follows: Very good = data is no more than 3 years old, Good = data is no more than 6 years old, Fair = data is no more than 10 years old, Poor = data is no more than 15 years old, Very poor = data is older than 15 years old or unknown.

5.5.2 Phase 5 – unit process overview

Table 35 – Unit processes in phase 5 – use of product.

Unit process name	Unit process unit	Input	Input unit	ecoinvent dataset	Comment
5.1 Consumer packaging jute disposal	kg	1	kg	Biowaste {CH}| treatment of biowaste, municipal incineration FAE | Cut-off, U	
5.2 Consumer packaging cardboard disposal	kg	1	kg	Waste paperboard {DK}| market for waste paperboard | Cut-off, U	

Table 36 – Amount of unit processes per product in phase 5 – use of product.

Unit process name	Unit	OPM	RPM	RDB	LBS	LBL	OFR
5.1 Consumer packaging jute disposal	kg/product	0,002	0,002	0,002	0,002	0,002	0,002
5.2 Consumer packaging cardboard disposal	kg/product	0,004	0,004	0,004	0,004	0,004	0,004

5.6 Phase 6: End-of-life of product

5.6.1 Activity data

In this phase the products are disposed of. Although the products are made of natural fibers (cotton and grass) and could potentially be treated through composting, it has been evaluated that the most probable fate of the products is incineration with energy recovery. This is also in line with public sorting guidance from several Danish municipalities and waste management companies (Københavns Kommune, N.D.; Odense Renovation, N.D.)

The distance to the incineration plant in Denmark is estimated to be 41,5 km (0,0415 tkm/kg waste) based on data from Eurostat included in the ecoinvent dataset for mixed municipal waste in Denmark.

5.6.2 Background data

For waste transport to the incineration plant an ecoinvent 3.11 dataset for truck transport in Europe is applied (Transport, freight, lorry, diesel, unspecified {RER}| market for transport, freight, lorry, unspecified | Cut-off, U).

For incineration of the products two ecoinvent 3.11 datasets are used:

- for the cotton fraction a dataset for waste textile incineration in Switzerland (Waste textile, soiled {CH}| treatment of waste textile, soiled, municipal incineration FAE | Cut-off, U).
- For the grass rope fraction a dataset for biowaste incineration in Switzerland (Biowaste {CH}| treatment of biowaste, municipal incineration FAE | Cut-off, U).

Although two separate datasets are used for the incineration, it is not considered that the product is taken apart before incineration. Two datasets are used to more accurately represent the direct emissions related to incinerating the two materials that the products consist of.

Switzerland is considered to have a technology level in waste incineration similar to that of Denmark.

See overview of LCI data for phase 6 (end-of-life) in Table 38 and Table 39.

5.6.3 Data quality

See Table 34 for data quality rating (DQR).

Table 37 – Data quality rating (DQR) for EOL of textile products*.

Activity	Accuracy	Geography	Time	Technology
Cotton to incineration	Very good	Fair	Very good	Very good
Grass to incineration	Very good	Fair	Very good	Good

*Accuracy is rated for the activity data. Geographical, temporal and technological representativeness is rated for the secondary data used to represent the activity data. DQR based on UN Environment Global Guidance on LCA database development with the following scale: 'very good', 'good', 'fair', 'poor', and 'very poor'. Temporal representativeness is rated as follows: Very good = data is no more than 3 years old, Good = data is no more than 6 years old, Fair = data is no more than 10 years old, Poor = data is no more than 15 years old, Very poor = data is older than 15 years old or unknown.

5.6.4 Phase 6 – unit process overview

Table 38 – Unit processes in phase 6 – end of life of product.

Unit process name	Unit process unit	Input	Input unit	ecoinvent dataset	Comment
6.1 End-of-life cotton	kg	1	kg	Waste textile, soiled {CH}| treatment of waste textile, soiled, municipal incineration FAE | Cut-off, U	
		0,0415	tkm	Transport, freight, lorry, unspecified {RER}| market for transport, freight, lorry, unspecified | Cut-off, U	41,5 km to incineration plant.
6.2 End-of-life grass rope	kg	1	kg	Biowaste {CH}| treatment of biowaste, municipal incineration FAE | Cut-off, U	
		0,0415	tkm	Transport, freight, lorry, diesel, unspecified {RER}| market for transport, freight, lorry, unspecified | Cut-off, U	41,5 km to incineration plant.

Table 39 – Amount of unit processes per product in phase 6 – end of life of product.

Unit process name	Unit	OPM	RPM	RDB	LBS	LBL	OFR
6.1 End-of-life cotton	kg/product	0,045	0,034	0,037	0,130	0,247	0,285
6.2 End-of-life grass rope	kg/product	0,255	0,196	0,213	0,740	1,403	1,615

6 Life cycle impact assessment (LCIA)

6.1 LCIA procedures and calculations

The LCIA method Environmental Footprint (EF) 3.1 was selected for this project. It is an internationally accepted LCIA method developed by the European Commission as part of the PEF initiative. EF 3.1 covers a broad range of environmental impact categories. No impact categories have been excluded from the study. All impact categories are listed below:

1. Climate change
2. Acidification
3. Ecotoxicity, freshwater
4. Particulate matter
5. Eutrophication, marine
6. Eutrophication, freshwater
7. Eutrophication, terrestrial
8. Human toxicity, cancer
9. Human toxicity, non-cancer
10. Ionising radiation
11. Land use
12. Ozone depletion
13. Photochemical ozone formation
14. Resource use, fossils
15. Resource use, minerals and metals
16. Water use

The impact category "climate change" is the sum of "climate change – biogenic", "climate change – fossil" and "climate change – land use and land use change". SimaPro v. 10.2.0.3 was used to conduct the calculations.

The LCA has been conducted according to this LCIA method to have a broad overview of environmental impacts, and to avoid burden shifting, when the results are used for minimizing the environmental impact of the products. Climate change is a particularly relevant impact category for Mørkegaard since this impact category is more well known by the average consumer and the impact category result will be printed on the product packaging. This impact category will also be the main focus of the contribution analysis and sensitivity analysis carried out in this study.

6.2 LCIA results

The LCIA results per product can be seen in Table 40.

Please note that the numbers have different units per impact category meaning that the impact categories cannot be compared to each other. The numbers are shown using scientific notation due to some very small numbers in certain impact categories (i.e., human toxicity). An example of how to read scientific notation is as follows: "1,2E+01" means 12, while "1,2E-01" means 0,12.

There are negative impact results in the categories 'human toxicity, cancer', and 'human toxicity, non-cancer'. This is due to an uptake of heavy metals from cultivation of jute. Nickel, mercury, and lead for human toxicity, cancer. Nickel, mercury, lead, zinc, copper, and chromium for human toxicity, non-cancer.

In Figure 4 the climate change impact (kg CO_2e) per product is presented visually.

Table 40 - LCIA results for the 19 impact categories.

Impact category	Unit	OPM	RPM	RDB	LBS	LBL	OFR
Climate change	kg CO2 eq	1,73E+00	1,32E+00	1,80E+00	6,98E+00	1,37E+01	1,21E+01
Acidification	mol H+ eq	4,50E-02	3,45E-02	4,07E-02	1,44E-01	2,74E-01	3,04E-01
Ecotoxicity, freshwater	CTUe	2,85E+01	2,17E+01	2,56E+01	9,01E+01	1,72E+02	1,93E+02
Particulate matter	disease inc.	3,16E-07	2,43E-07	2,83E-07	9,88E-07	1,88E-06	2,15E-06
Eutrophication, marine	kg N eq	2,66E-02	2,03E-02	2,36E-02	8,27E-02	1,57E-01	1,79E-01
Eutrophication, freshwater	kg P eq	1,07E-02	8,19E-03	9,60E-03	3,36E-02	6,40E-02	7,17E-02
Eutrophication, terrestrial	mol N eq	1,89E-01	1,45E-01	1,70E-01	5,93E-01	1,13E+00	1,28E+00
Human toxicity, cancer	CTUh	-2,06E-09	-1,59E-09	-1,80E-09	-6,12E-09	-1,15E-08	-1,36E-08
Human toxicity, non-cancer	CTUh	-1,39E-07	-1,07E-07	-1,21E-07	-4,13E-07	-7,78E-07	-9,23E-07
Ionising radiation	kBq U-235 eq	3,40E-02	2,56E-02	5,74E-02	2,69E-01	5,56E-01	2,63E-01
Land use	Pt	1,05E+02	8,02E+01	9,28E+01	3,23E+02	6,13E+02	7,19E+02
Ozone depletion	kg CFC11 eq	1,61E-08	1,23E-08	1,98E-08	8,26E-08	1,66E-07	1,20E-07
Photochemical ozone formation	kg NMVOC eq	7,93E-03	6,08E-03	7,51E-03	2,75E-02	5,29E-02	5,52E-02
Resource use, fossils	MJ	1,45E+01	1,11E+01	1,65E+01	6,72E+01	1,34E+02	1,04E+02
Resource use, minerals and metals	kg Sb eq	9,18E-06	7,01E-06	1,01E-05	4,02E-05	7,93E-05	6,38E-05
Water use	m3 depriv.	8,27E+00	6,26E+00	7,25E+00	2,54E+01	4,83E+01	5,56E+01

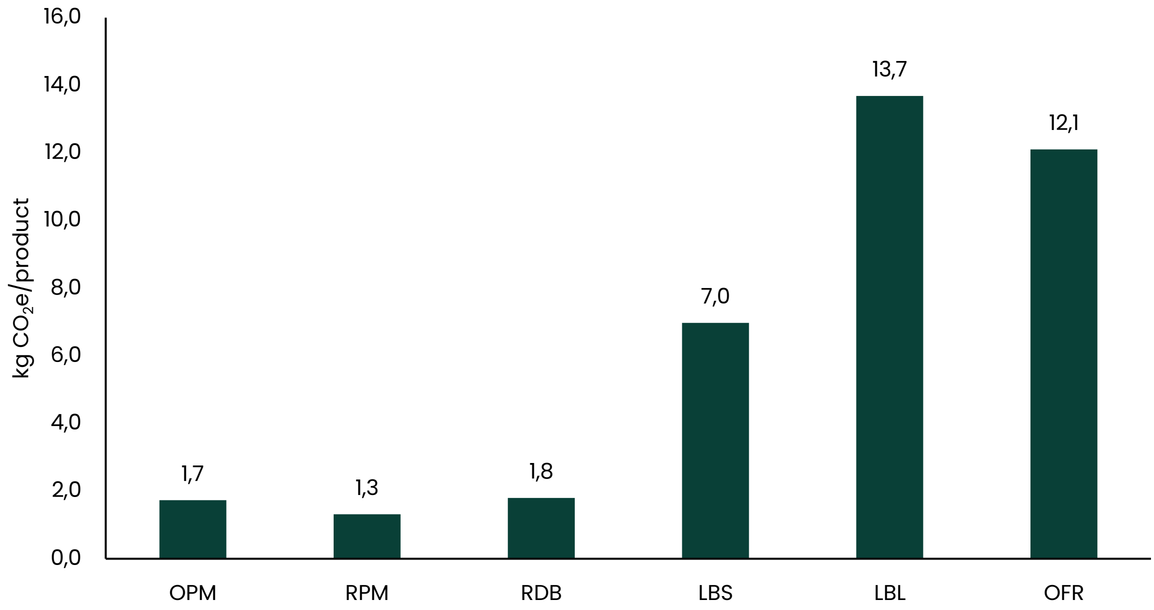

Figure 4 – Climate change impact of each product in the LCA across the whole life cycle

6.3 Contribution analysis

The % contribution of each life cycle phase to the climate change impact can be seen in Figure 5 for each product. 'Phase 1 – raw materials' is the most contributing life cycle phase contributing with 52-70% of the impact. The second most contributing life cycle phase is 'Phase 4 – distribution' contributing with 11-35% followed by 'Phase 3 – production' contributing with 7-12%.

Overall, 'Phase 1 – raw materials', 'Phase 3 – production', and 'Phase 4 - distribution' together account for approximately 91-93% of the total climate change impact, meaning that the life cycle phases 'Phase 2 – raw material transport', 'Phase 5 – use of product', and 'Phase 6 – end-of-life of product' contribute with 7-9% of the total climate change impact. The most contributing life cycle phases will be examined further.

For the other impact categories, the contribution analyses can be found in Section 10.2 (appendix).

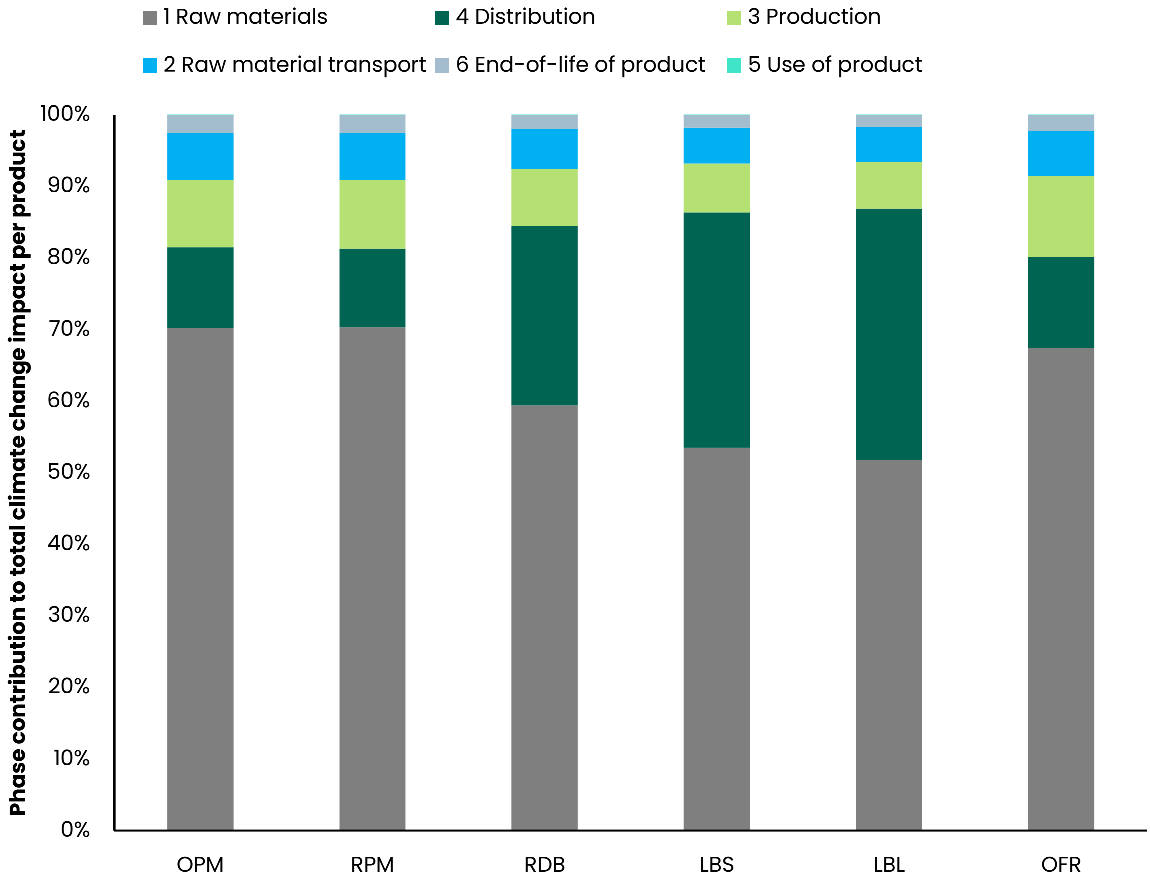

Figure 5 - Contribution of each life cycle phase to the ‘climate change’ impact category in the LCA.

6.3.1 Process contribution – phase 1 – climate change

In Figure 6 the contribution of processes in 'Phase 1 – raw materials' to the total climate change impact in phase 1 can be seen. It shows that grass rope production is the most contributing process to this phase, contributing with 67% of 'Phase 1 – raw materials' for all products.

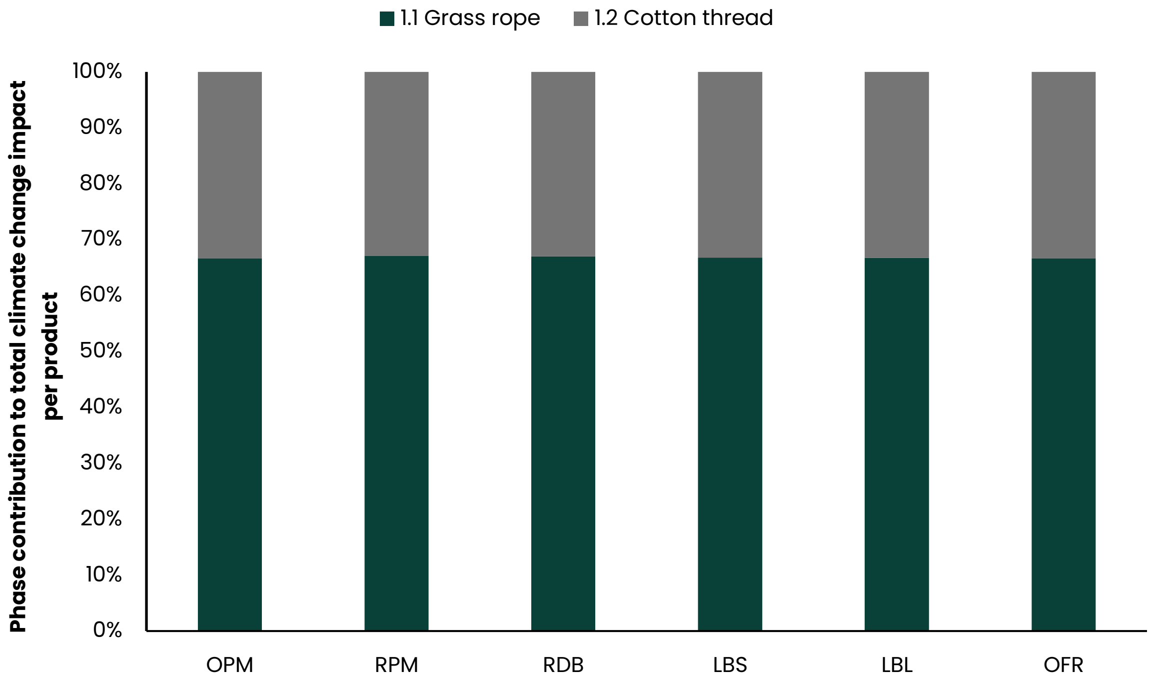

Figure 6 - Contribution of processes in 'phase 1 – raw materials' to the total 'climate change' impact category for 'phase 1 – raw materials'.

6.3.2 Process contribution – phase 3 - climate change

In Figure 7 the contribution of processes in 'Phase 3 – production' to the total climate change impact in phase 3 can be seen. It shows that packaging is the most contributing process followed by waste and wastewater and plastic input. Electricity consumption and paper input contributes very little. Here it should be noted that these processes may have a higher contribution to other environmental impact categories.

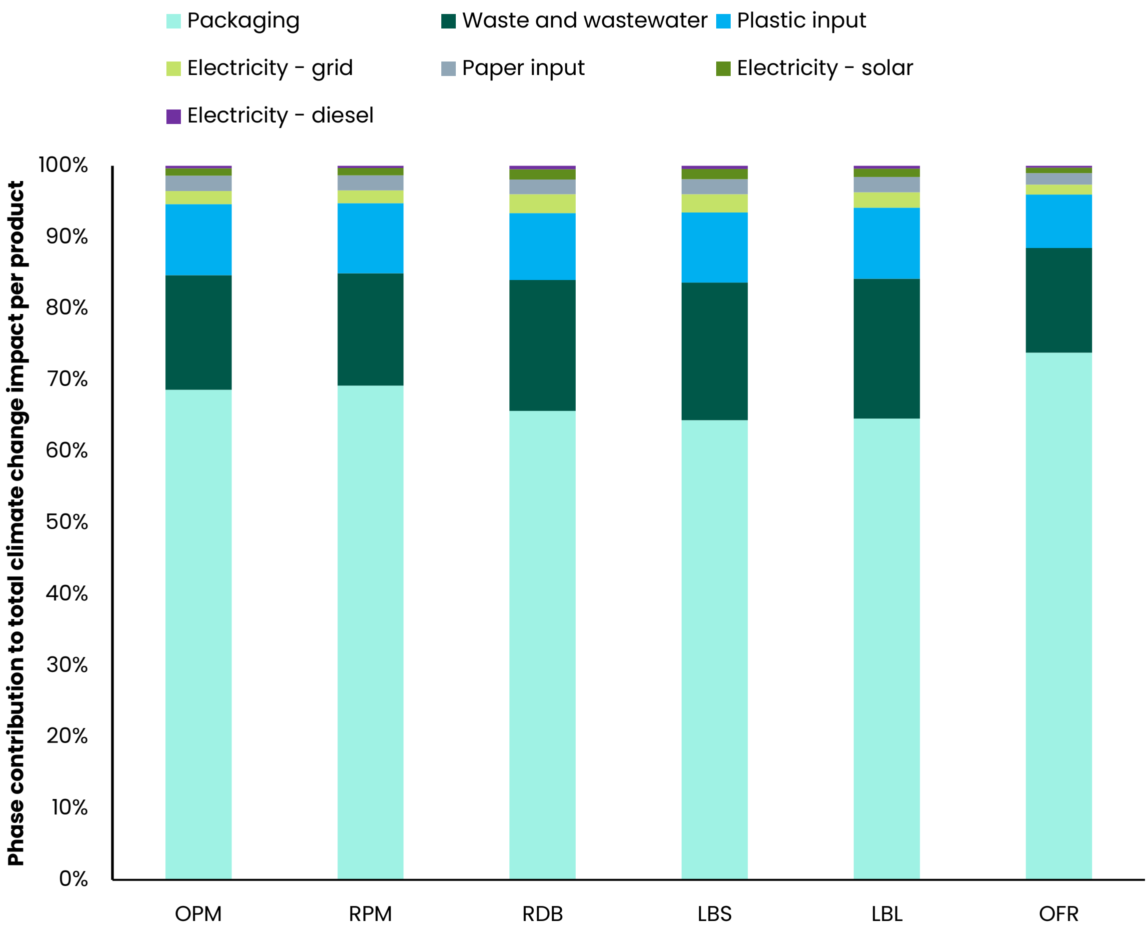

Figure 7 - Contribution of processes in 'phase 3 – production' to the total 'climate change' impact category for 'phase 3 – production'.

6.3.3 Process contribution – phase 4 – climate change

In Figure 8 the contribution of the processes in 'Phase 4 – distribution' to the total climate change impact in phase 4 can be seen. It shows that retail is the most contributing process for products RDB, LBS and LBL. For OFR retail and distribution by ship are the most contributing processes. Distribution by ship is the most contributing process for OPM and RPM. The retail energy contributes more to RDB, LBS and LBL because they take up more space in the store, because they are bowl-shaped, whereas the other products are flat.

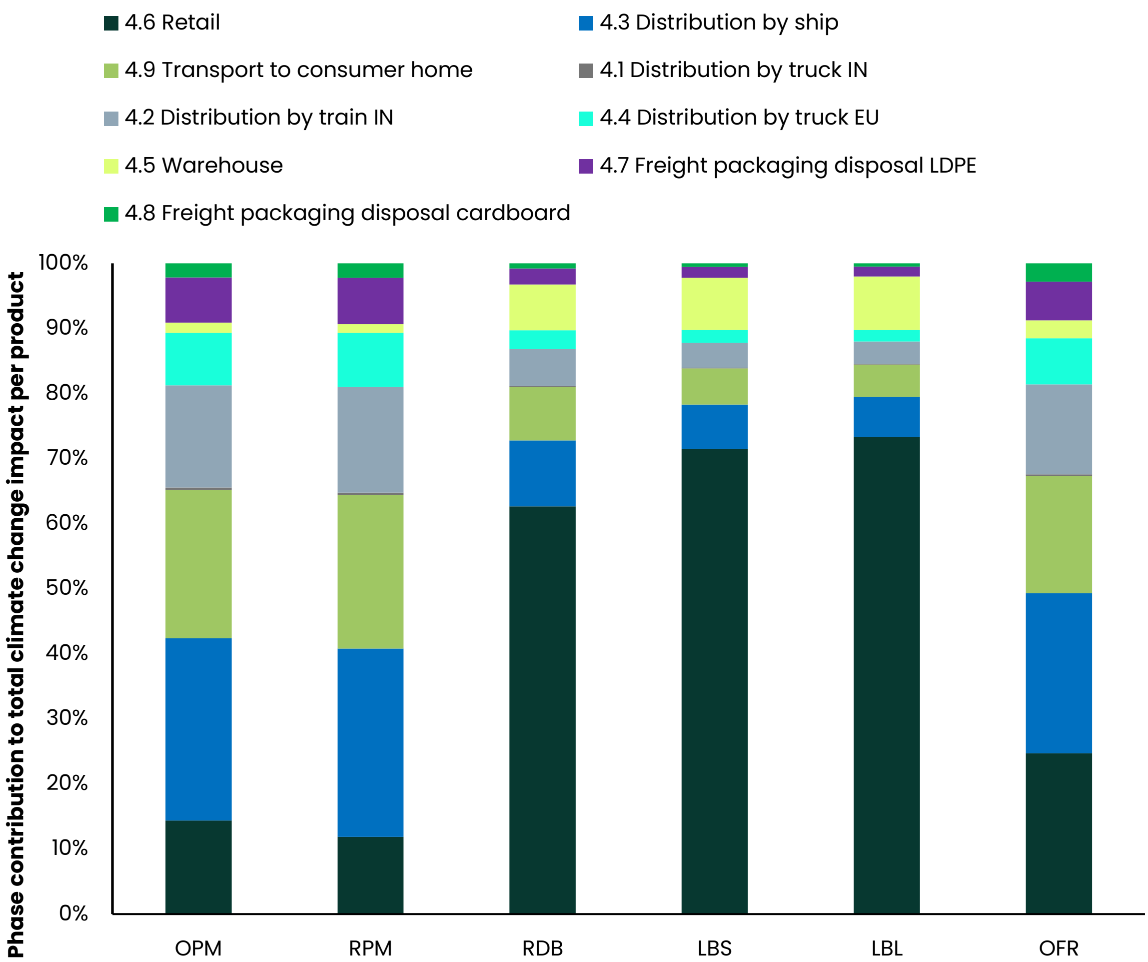

Figure 8 - Contribution of processes in in 'phase 4 – distribution' to the total 'climate change' impact category for 'phase 4 – distribution'

6.3.4 Contribution to other environmental impacts

The contribution of each life cycle stage to each of the environmental impact categories aside from climate change are shown in Section 10.2 (appendix).

The most contributing life cycle stage per impact category is described in Table 41. Overall, Phase 2 – Raw material transport, Phase 5 – Use of product and Phase 6 – End-of-life of product are not the most contributing life cycle stage for any impact categories.

Phase 1 or phase 3 are the most contributing life cycle stage across all impact categories for products OPM, RPM, and OFR. Phase 1 or phase 4 are the most contributing life cycle stage across all impact categories for products RDB, LBS, and LBL.

Table 41 – Most contributing life cycle stage per impact category evaluated in the LCA.

Impact category	Most contributing life cycle stage					
	OPM	RPM	RDB	LBS	LBL	OFR
Climate change	1 Raw materials					
Acidification	1 Raw materials					
Ecotoxicity, freshwater	1 Raw materials					
Particulate matter	1 Raw materials					
Eutrophication, marine	1 Raw materials					
Eutrophication, freshwater	1 Raw materials					
Eutrophication, terrestrial	1 Raw materials					
Human toxicity, cancer	3 Production		4 Distribution			3 Production
Human toxicity, non-cancer	3 Production		4 Distribution			3 Production
Ionising radiation	1 Raw materials		4 Distribution			1 Raw materials
Land use	1 Raw materials					
Ozone depletion	1 Raw materials		4 Distribution			1 Raw materials
Photochemical ozone formation	1 Raw materials					
Resource use, fossils	1 Raw materials		4 Distribution			1 Raw materials
Resource use, minerals and metals	1 Raw materials					
Water use	1 Raw materials					

7 Life cycle interpretation

7.1 Significant findings

Raw materials and distribution contribute highly to climate change impact

'Phase 1 – raw materials' is the most contributing life cycle phase to the climate change impact, contributing with 52-70% of the impact.

The second most contributing life cycle phase is 'Phase 4 – distribution' followed by 'Phase 3 – production'.

Raw material transport, use of product and end-of-life have little climate change contribution

Overall, 'Phase 1 – raw materials', 'Phase 3 – production', and 'Phase 4 - distribution' together account for 91-93% of the total climate change impact, meaning that the life cycle phases 'Phase 2 – raw material transport', 'Phase 5 – use of product', and 'Phase 6 – end-of-life of product' contribute with 7-9% of the total climate change impact per product.

Raw materials have the highest contribution to most impact categories

Raw materials have the highest contribution to climate change, acidification, ecotoxicity freshwater, particulate matter, eutrophication (marine, freshwater, and terrestrial), land use, photochemical ozone formation, resource use (minerals and metals), and water use for all products.

Production and distribution have the highest contribution to some impact categories

Production has the highest contribution to human toxicity (cancer and non-cancer) for products OPM, RPM and OFR. Distribution has the highest contribution to human toxicity (cancer and non-cancer), ozone depletion, and resource use (fossil) for products RDB, LBS, and LBL. This is mainly due to the fact that they take up more volume in the store, and therefore the impacts from retail are higher.

7.2 Sensitivity analysis

Sensitivity was evaluated by comparing baseline scenarios to alternative scenarios and calculating sensitivity coefficients. The sensitivity coefficient is defined as the ratio between relative change in results and relative change in input parameters. Parameters with coefficients below 0.1 were considered to have low influence on results, values between 0.1 and 0.5 moderate influence, and values above 0.5 high influence. For scenario analyses where multiple input parameters were changed simultaneously, and it was not possible to determine a single sensitivity coefficient, absolute changes below 10% were considered to have low influence on the results, absolute changes between 10-20% were considered to have moderate influence, and absolute changes above 20% were considered to have high influence.

The sensitivity analysis was focused on the change in climate change impact. This is chosen because the climate change impact will be used for communication to the end-consumer, which means that the influence of uncertain or variable parameters on this impact category is particularly important.

7.2.1 Sensitivity: Crop proxy in phase 1

In 'Phase 1 –Raw materials', a proxy dataset for rain-fed jute cultivation in Bangladesh was applied to represent the cultivation of Sabai grass in India, since no specific dataset was available for this crop. The effects of selecting other potential proxy datasets from the ecoinvent database are analyzed. The following other crops are evaluated, which are all irrigated and present higher yields than the applied dataset for rain-fed jute cultivation in Bangladesh: jute (India), flax (India), Kenaf (India) and Hemp (India). All of these crops can be used as raw material for rope-making. The same amount of green plant was applied for all datasets (11,11 kg green plant per kg rope).

The alternative scenarios can be seen compared to the baseline scenario in Figure 9. It was found that the alternative scenarios decreased the climate change impact of the total life cycle with 16-33%. Applying a dataset for jute from India led to the largest decrease, while applying a dataset for flax from India led to the smallest decrease. This shows that the selection of proxy dataset for the Sabai grass in phase 1 has a moderate-high influence on the results. Nonetheless, the sensitivity analysis also shows that the applied dataset for jute cultivation in Bangladesh leads to a conservative result, which is preferred in the case of data gaps.

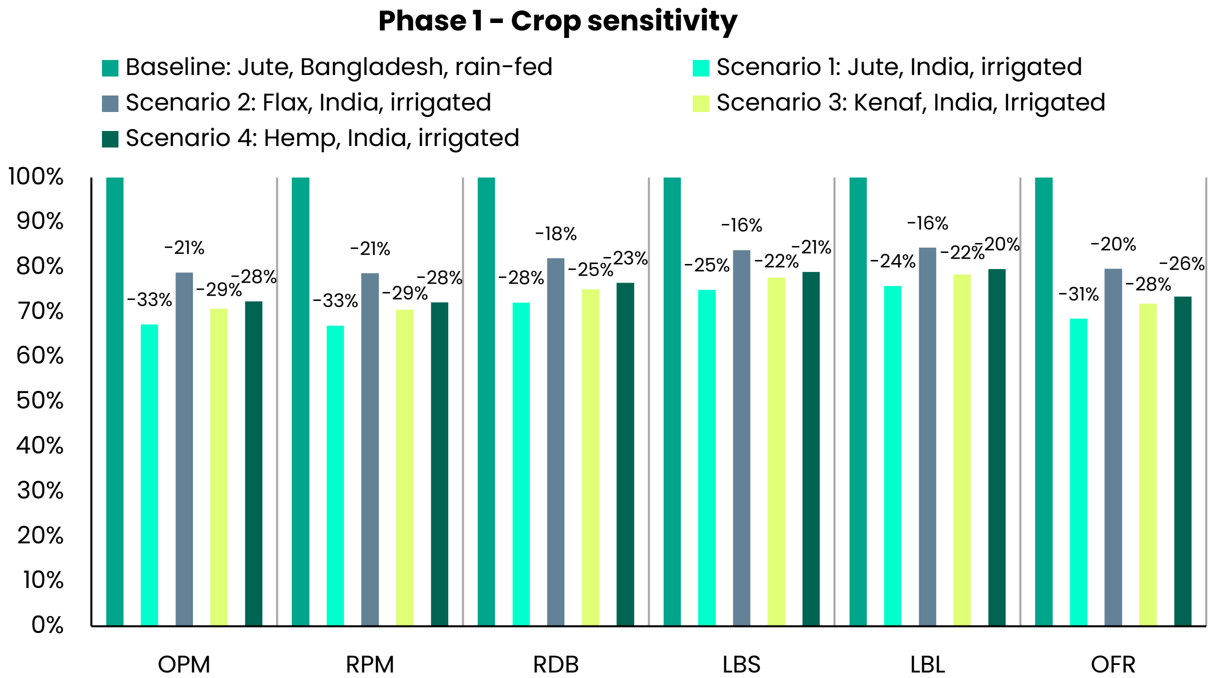

Figure 9 – Change in climate change impact across the whole life cycle from the baseline scenario (Rain-fed jute from Bangladesh) to the alternative scenarios (Irrigated jute, flax, kenaf and hemp from India)

7.2.2 Sensitivity: Green grass consumption

In 'Phase 1 – production', it was estimated that 11,11 kg of green grass is required produce 1 kg of rope. This was considering a dry matter content of 18% in the harvested green grass, which yields a green-to-dry ratio of 5,56 kg green grass pr. kg dry grass. Furthermore, it was assumed that 2 kg of dry grass is required to produce 1 kg of rope. In this scenario the effect of consuming 10% more green grass was analyzed. The alternative scenario can be seen compared to the baseline scenario in Figure 10. A 10% increase in the consumed green grass, results in an increase in the climate change impact between 4-6% across the products. This yields sensitivity coefficients in the range 0,4-0,6, which is considered a moderate-high sensitivity level.

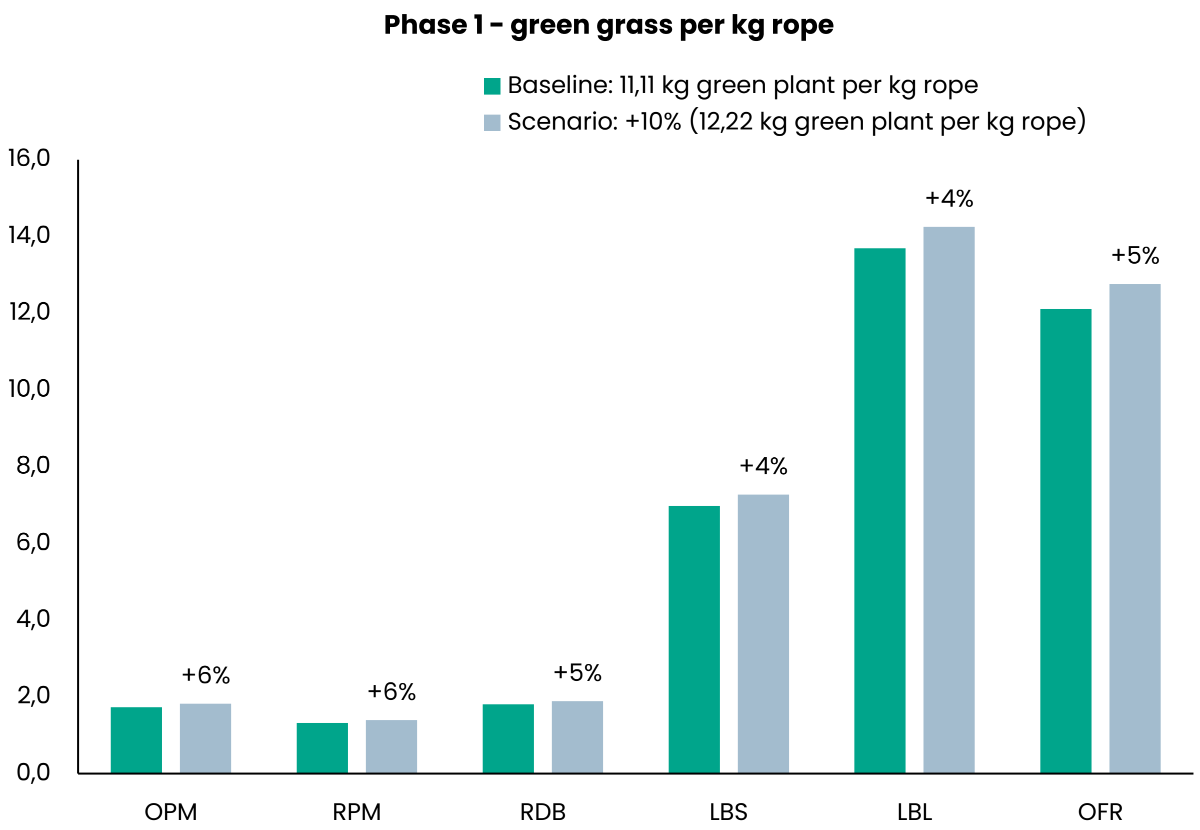

Figure 10 - Change in climate change impact across the whole life cycle from the baseline scenario (11,11 kg green grass per kg rope) to the alternative scenario (12,22 kg green grass per kg rope).

7.2.3 Sensitivity: Electricity source in phase 3

In 'Phase 3 – production', 89% of the electricity consumption is from solar power, 9% is electricity from the grid, and 2% is electricity from a diesel generator. The effects of consuming 100% of the electricity from the grid are analyzed. The alternative scenario can be seen compared to the baseline scenario in Figure 11. It was found that the alternative scenario increased the climate change impact of the total life cycle with 3-4%. Therefore, the source of electricity consumption in the production is considered to have low influence on the results.

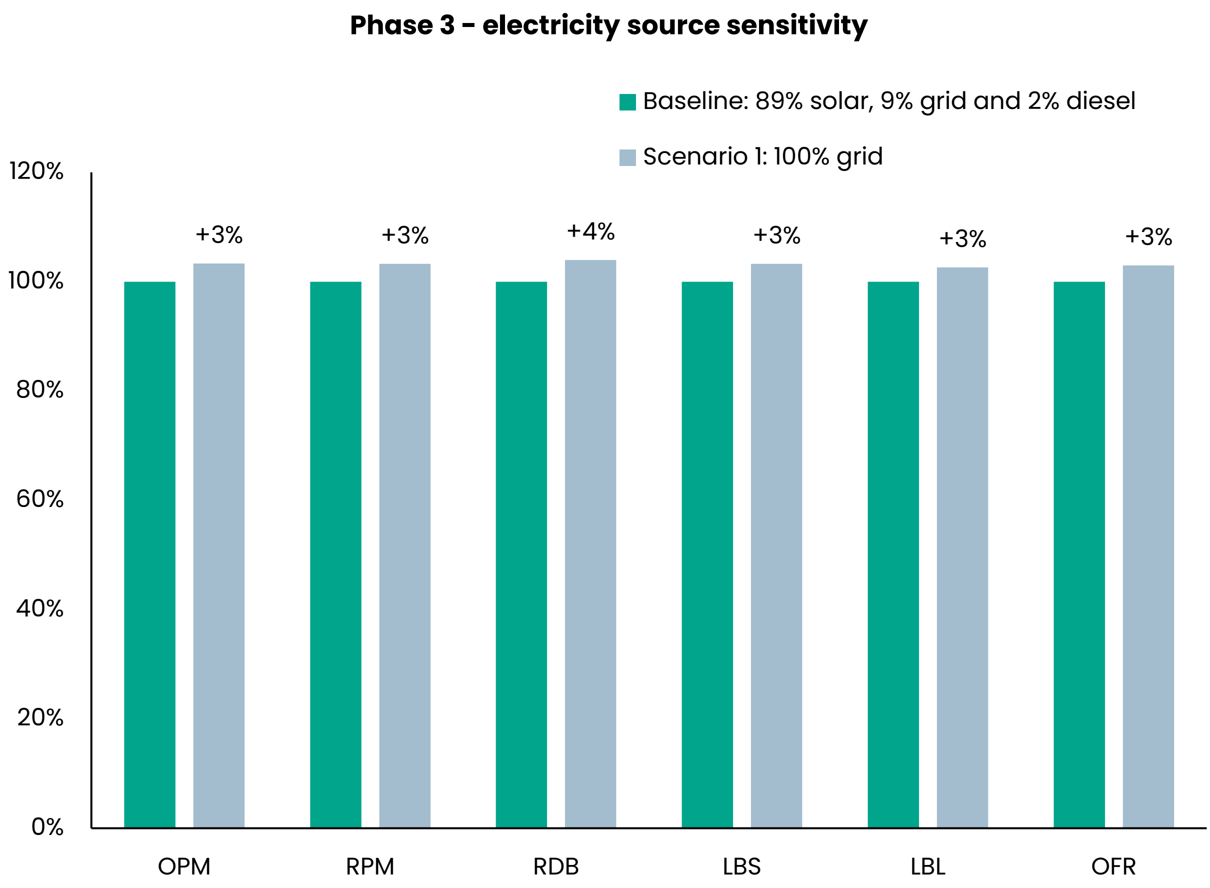

Figure 11 - Change in climate change impact across the whole life cycle from the baseline scenario (electricity from grid, solar energy, and diesel generator) to the alternative scenario (electricity only from grid)

7.2.4 Sensitivity: Train vs. truck transport in phase 4

In 'Phase 4 – distribution', the products are transported 10 km by truck from factory to Inland Container Depot in Moradabad, Uttar Pradesh, India and 1900 km by electric train from Inland Container Depot in Moradabad, Uttar Pradesh, India to port in Mundra, Gujarat, India. The effects of transporting the products from factory to port only by truck are analyzed (1910 km). The alternative scenario can be seen compared to the baseline scenario in Figure 12. It was found that the alternative scenario increased the climate change impact of the total life cycle by 3-5%. Therefore, switching from train transport to truck transport from factory to port is considered to have low influence on the results.

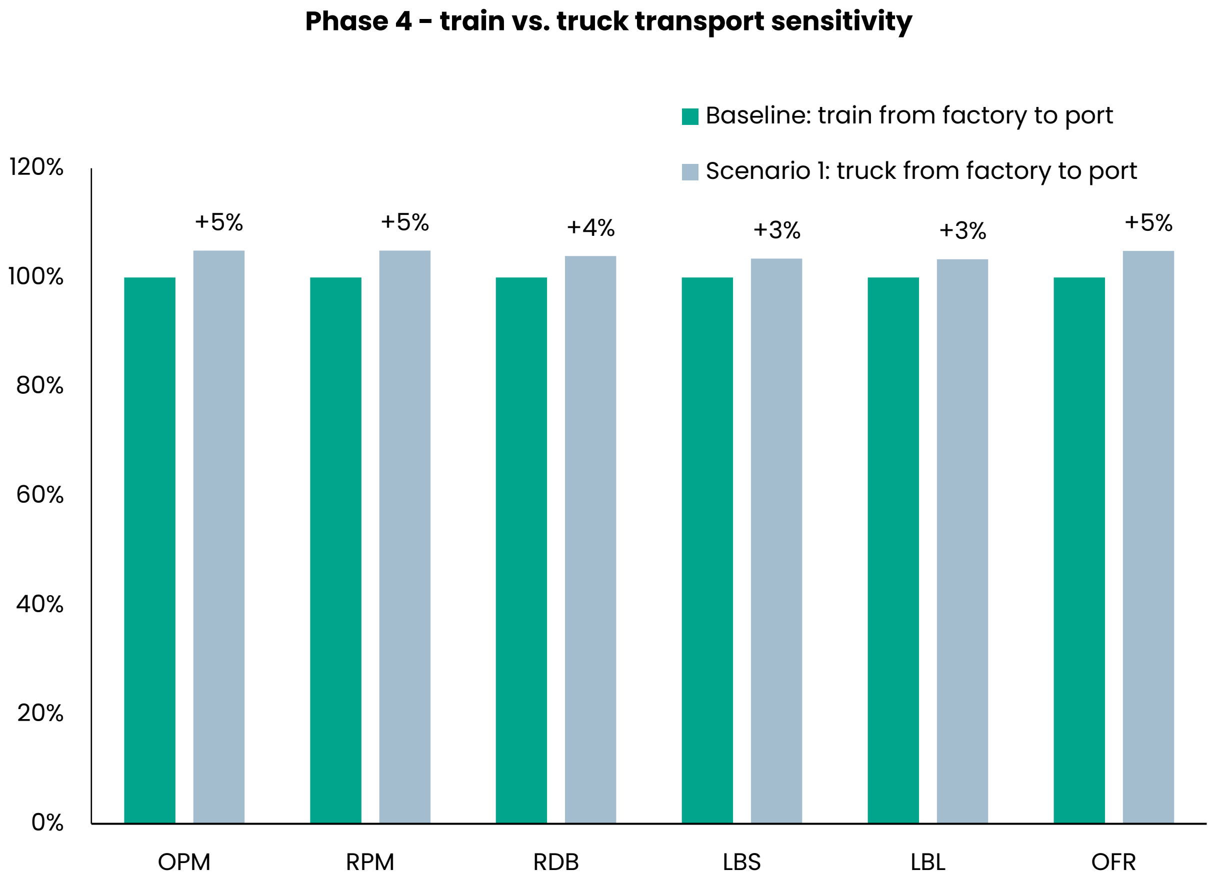

Figure 12 - Change in climate change impact across the whole life cycle from the baseline scenario (train from factory to port) to the alternative scenario (truck from factory to port)

7.2.5 Sensitivity: Retail volume in phase 4

Figure 13 – Illustration of stacking

In 'Phase 4 – distribution', it is assumed that the products are not stacked when calculating their volume in retail. This is due to the fact that some stores may receive only few pieces of each item. The effects of stacking five pieces of each product together in retail are analyzed. For the hollow, bowl-shaped products (RDB, LBS and LBL) it is assumed that five products stacked together are 50% taller than a single product (see Figure 13). The alternative scenario can be seen compared to the baseline scenario in Figure 14. It was found that the alternative scenario decreased the climate change impact of the total life cycle by 0-20%. Therefore, stacking five pieces of products together in retail is considered to have low influence on the results for products OPM, RPM, and OFR since they are 'flat' products. However, stacking five pieces of products together in retail is considered to have medium-high influence on the results for products RDB, LBS, and LBL.

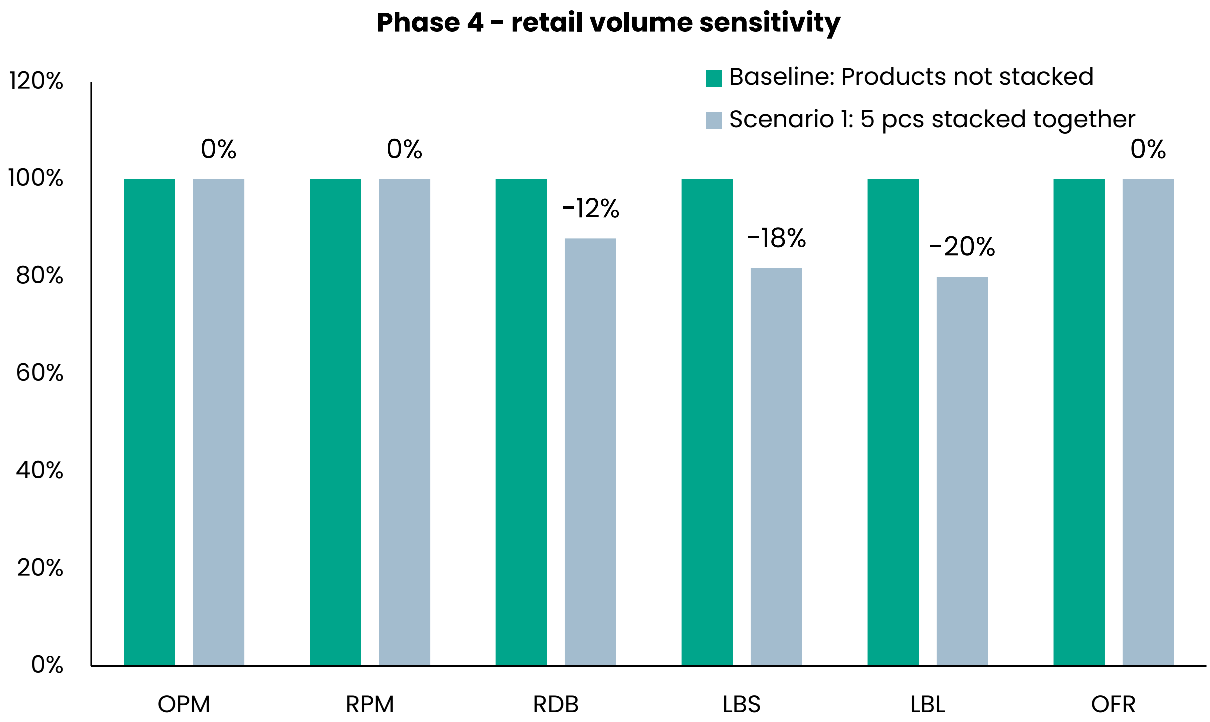

Figure 14 - Change in climate change impact across the whole life cycle from the baseline scenario (products not stacked) to the alternative scenario (5 pcs stacked together)

7.2.6 Sensitivity: Consumer transport in phase 4

In 'Phase 4 – Distribution', it was assumed that one trip to the retail store was a 5 km roundtrip and that the consumer purchases 10 kg of goods from the store. The impact of driving to the store was then allocated between the purchased goods based on the weight. In this scenario the effect of the consumer driving a 5 km roundtrip purchasing a single item from this LCA was analyzed. This means that the 5 km of transport are not allocated across 10 kg of products but are allocated 100% to the single purchased product. The alternative scenario can be seen compared to the baseline scenario in Figure 15. This results in an increase in the climate change impact between 9-19% for LBS, LBL and OFR (the heaviest products in the analysis) and an increase between 79-108% for OPM, RPM and RDB (the lightest products in the LCA). For LBS, LBL and OFR this means a low-moderate sensitivity level. For OPM, RPM and RDB the sensitivity is very high. This is related to the very low weight of the products, which yields a low climate change impact, and a much higher increase in the climate change impact when the product accounts for the whole 5 km roundtrip.

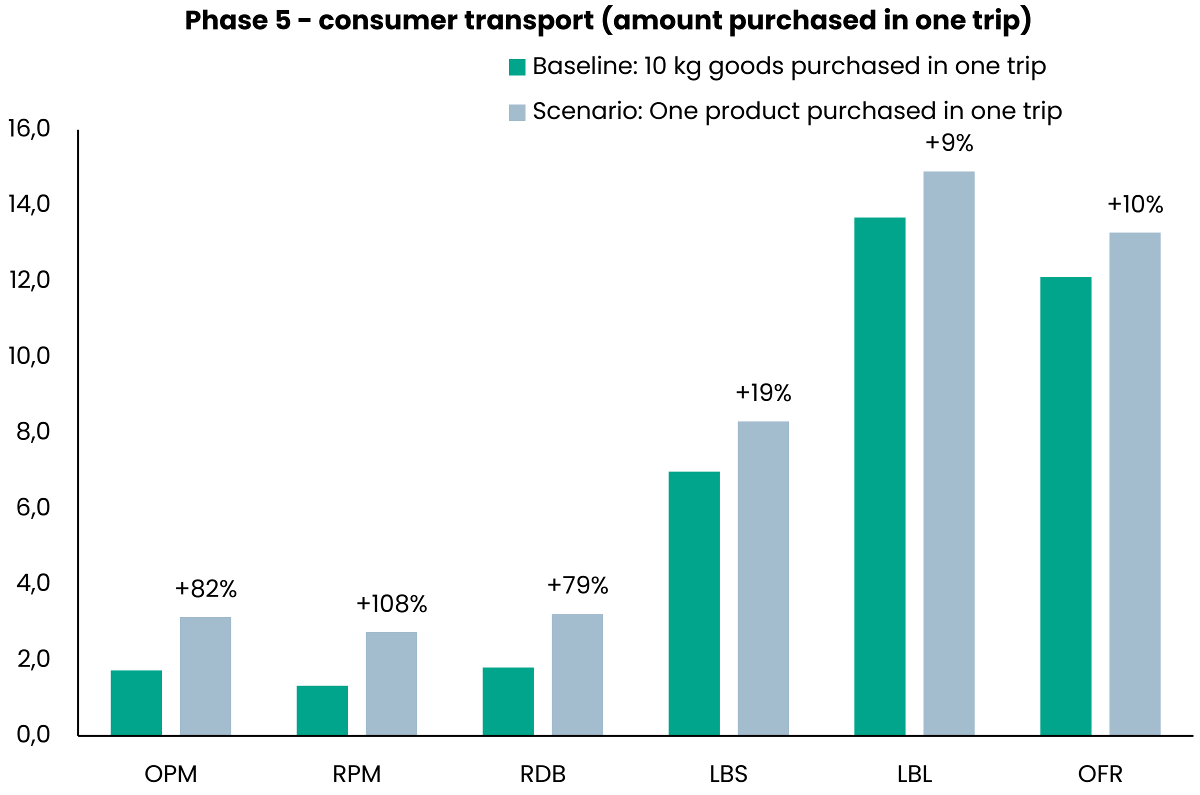

Figure 15 - Change in climate change impact across the whole life cycle from the baseline scenario (10 kg goods purchased in one trip) to the alternative scenario (one product purchased in one trip)

7.3 Data quality and uncertainty analysis

The uncertainty in the LCA has been evaluated both quantitatively and qualitatively.

The quantitative uncertainty analysis was performed by Monte Carlo analysis on one product (OPM). At 1000 Monte Carlo runs, it was found that the average climate change impact was 1,79 kg CO_2e and the 95% confidence interval was 1,54-1,96 kg CO_2e (this means that in 95% of the 1000 Monte Carlo runs, the climate change impact was within this range). This leads to a standard deviation of 0,102 kg CO2e, which equals a coefficient of variance of 5,9% (standard deviation divided by average). The Monte Carlo analysis evaluates the uncertainty in the background datasets applied in the LCA.

The uncertainty related to the primary data points was evaluated qualitatively by looking at the data quality rating for "accuracy" for the most contributing processes:

- Phase 1 – Raw materials: Grass rope (Fair)
- Phase 3 – Production - Packaging: Jute rope (Very good)
- Phase 3 – Production - Packaging: Printed cardboard (Very good)
- Phase 3 – Production - Packaging: Unprinted cardboard (Very good)
- Phase 3 – Production - Packaging: LDPE bag (Very good)
- Phase 4 – Distribution: Truck transport India (Very good)
- Phase 4 – Distribution: Electric train transport India (Very good)
- Phase 4 – Distribution: Ship transport (Very good)
- Phase 4 – Distribution: Truck transport Denmark (Very good)
- Phase 4 – Distribution: Electricity for retail (Fair)

Generally, the accuracy is rated as 'Very good' for the most contributing processes except for the grass rope and retail stages (rated as 'fair'). Furthermore, the grass rope and retail stages were both evaluated in a sensitivity analysis, where it was found that the results are sensitive to changes in these parameters. The uncertainty in the results can thus be reduced by collecting more accurate data for the grass rope and retail stages in the LCA. Consequently, a conservative approach is applied in this LCA for the grass rope and retail stages as shown in the sensitivity analysis.

The uncertainty related to matching the LCA processes to appropriate background datasets has been evaluated qualitatively by looking at the data quality rating for 'technological representativeness' for the most contributing processes:

- Phase 1 – Raw materials: Grass rope (Fair)
- Phase 3 – Production - Packaging: Jute rope (Very good)

- Phase 3 – Production - Packaging: Printed cardboard (Good)
- Phase 3 – Production - Packaging: Unprinted cardboard (Good)
- Phase 3 – Production - Packaging: LDPE bag (Good)
- Phase 4 – Distribution: Truck transport India (Good)
- Phase 4 – Distribution: Electric train transport India (Very good)
- Phase 4 – Distribution: Ship transport (Good)
- Phase 4 – Distribution: Truck transport Denmark (Good)
- Phase 4 – Distribution: Electricity for retail (Very good)

Generally, the technological representativeness is rated as ‘good-very good’ for the most contributing processes except for the grass rope stage (rated as ‘fair’). As previously mentioned, the grass rope stage was evaluated in a sensitivity study, which found that the results were sensitive to the modelling choices in this step. The modeling choices were also shown to be conservative, which means that they most likely overestimate the climate change impact of the products.

See Section 10.3 (Appendix) for an overview of the data quality rating. Overall, the data quality in the LCA is rated as ‘Good’.

7.4 Assumptions and limitations

Assumptions and limitations of this LCA can be seen in Table 42.

Table 42 Assumptions and limitations per life cycle phase in the LCA

Phase	Assumptions and limitations
1 Raw materials and 2 Raw material transport	• A proxy dataset for rain-fed jute cultivation in Bangladesh has been applied to represent cultivation of Sabai grass in India, since no specific datasets were available for Sabai grass. • The dry matter content in harvested Sabai grass was assumed to be the same as for harvested jute (18%). • The amount of dry Sabai grass required to produce 1 kg of grass rope was assumed to be 2 kg.
3 Production	• The power of the sewing machines during operation was measured in the interval 8-32 W, and for the LCA the upper level of the interval (32 W) was applied. • The overhead processes in the factory (lighting and ventilation) were estimated to consume 50% of the electricity in the factory, while the sewing machines were estimated to consume 50% of the electricity. The overhead electricity was then extrapolated from the measured sewing machine consumption. This was considered a conservative estimate. • The amount of electricity consumed from the grid, from solar and from diesel generator were estimated based on the number of days these energy sources were used in 2025 (9% from grid, 89% from solar and 2% from diesel generator). • The efficiency of the diesel generator was assumed to be 35% (efficiency when converting the lower heating value of diesel to electric energy). • The amount of plastic and paper waste collected from the factory was assumed to be plastic and paper packaging entering the factory.
4 Distribution	• The distribution scenario is based on distribution to a retail store in Odense, Denmark (selected for its central location within Denmark). • Energy consumption for warehouse and retail is estimated based on standard scenarios defined in PEF. • It was assumed that the products are not stacked when storing them in the retail store. • Transport to consumer home is assumed to be 5 km and in a small passenger car. It is assumed that the consumer buys 10 kg of products in the trip.
5 Use of products	• No cleaning or maintenance of the product has been included in the LCA. The products can be cleaned by wiping them with a wet cloth, which was evaluated not to have a significant environmental impact on the products and thus excluded from the LCA. This was based on the judgment of the LCA practitioner.
6 End-of-life of products	• It was assumed that the products are incinerated at the end of their useful life. Although alternative treatment routes, i.e. reuse, composting or recycling may be possible, it was evaluated by the LCA practitioner that incineration is the most likely fate.

8 Conclusions

A life cycle assessment (LCA) was carried out to investigate the environmental impacts arising in the full life cycle of a range of grass fiber interior products from the fall 2026 line of Nord Harmony. The assessed life cycle phases were (1) Raw materials, (2) Raw material transport, (3) Production, (4) Distribution, (5) Use of product, and (6) End-of-life of product.

The goal of the assessment was to get a deeper understanding of the environmental impacts of the products and to label the product packaging with the climate change impact of the products.

The environmental impact of the product was evaluated across 16 impact categories according to the EF3.1 LCIA method. The climate change impact of the product is shown in Table 43.

Table 43 – Climate change impact of the evaluated products in the life cycle assessment (LCA)

ID	Product type	Climate change impact (kg CO_2e/product)	
		Cradle-to-consumer*	Cradle-to-grave**
OPM	Oval placemat 53x33 cm	1,68	1,73
RPM	Round placemat Ø37 cm	1,29	1,32
RDB	Round deep bowl 30x10 cm	1,77	1,80
LBS	Laundry basket – small 32x40 cm	6,85	6,98
LBL	Laundry basket – large 42x50 cm	13,45	13,69
OFR	Oval floor rug 140 x 170	11,84	12,11

*Cradle-to consumer covers: phase 1 – raw materials, phase 2 – raw material transport, phase 3 – production and phase 4 – distribution. **Cradle-to-grave covers: phase 1 – raw materials, phase 2 – raw material transport, phase 3 – production, phase 4 – distribution, phase 5 – use of product and phase 6 – end-of-life of product (all life cycle phases).

It was found that 'Phase 1 – raw materials' is the most contributing life cycle phase to climate change, contributing with 52-70%. This is mainly due to the cultivation of grass rope.

'Phase 4 – distribution' is the second most contributing life cycle phase to the climate change impacts, especially the retail and distribution by ship.

'Phase 3 – production' is the third most contributing life cycle phase to climate change, mainly due to the packaging material and waste and wastewater.

In a sensitivity analysis, it was assessed how sensitive the results were to changes in certain input parameters. Firstly, it was found that the choice of proxy dataset for Sabai grass has moderate-high influence on the results. The dataset applied in this LCA gave the highest climate change impact of the 5 tested alternatives, thus representing a conservative scenario.

Secondly, it was found that the amount of grass consumed to produce 1 kg of grass rope has moderate-high influence on the results.

Furthermore, it was found that using 100% grid mix in the production phase instead of a mix consisting mainly of solar electricity (baseline) showed a small increase in the overall climate change impact (3-4%), although it was concluded to have low sensitivity.

It was also found that using truck transport from factory to port in the distribution phase instead of electric train (baseline) showed a small increase in the overall climate change impact (3-5%), although it was concluded to have low sensitivity.

It was also found that the assumptions regarding how the products are stored in the retail store had medium-high influence on the results. For non-flat products, stacking five products together to minimize the space they take up in the store led to significant decreases in the calculated climate change impact (12-20%) compared to the baseline (not stacking products).

Finally, it was found to have a very high influence on the products OPM, RPM and RDB (the lightest products in the LCA) when the consumer drives to the store only to buy one item instead of buying 10 kg of goods. This is because the whole roundtrip of the consumer will be allocated to that single product instead of being divided across 10 kg of products.

9 References

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- DS/EN ISO 14044:2008, *Environmental management – Life cycle assessment – Requirements and guidelines*
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- PEFCR, 2018, Product Environmental Footprint Category Rules Guidance
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- Tripathy, S. K., Mohapatra, S., 2017, *Research and development of sabai grass (Eulaliopsis binata) in India*, In: Range Mgmt. & Agroforestry 38 (1) : 1-9, 2017
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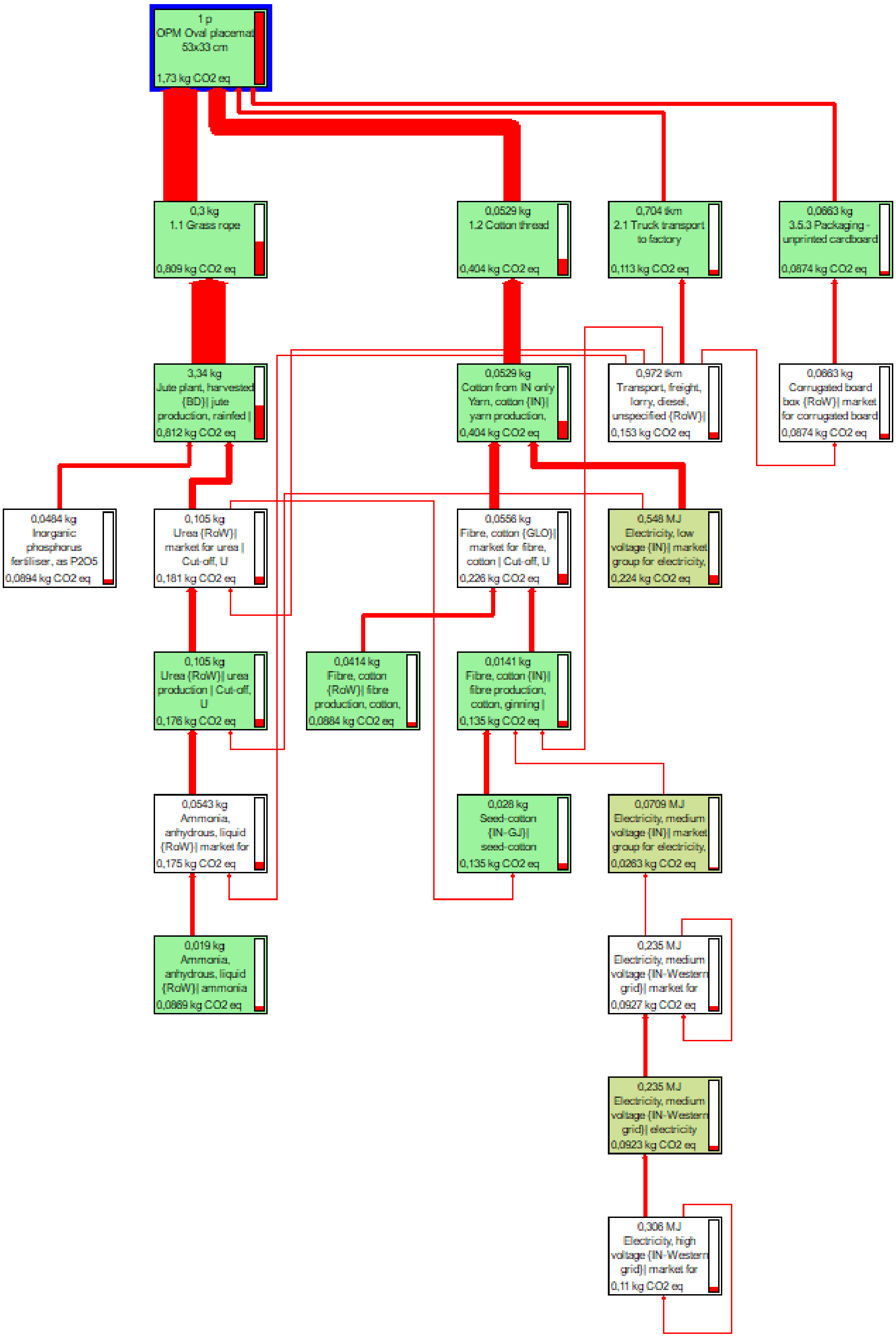
10 Appendix

10.1 SimaPro model

Below the SimaPro model network is shown at 5% cut-off for the climate change impact for the product OPM (this means that the processes contributing 95% are shown).



10.2 Contribution analysis for all environmental impacts

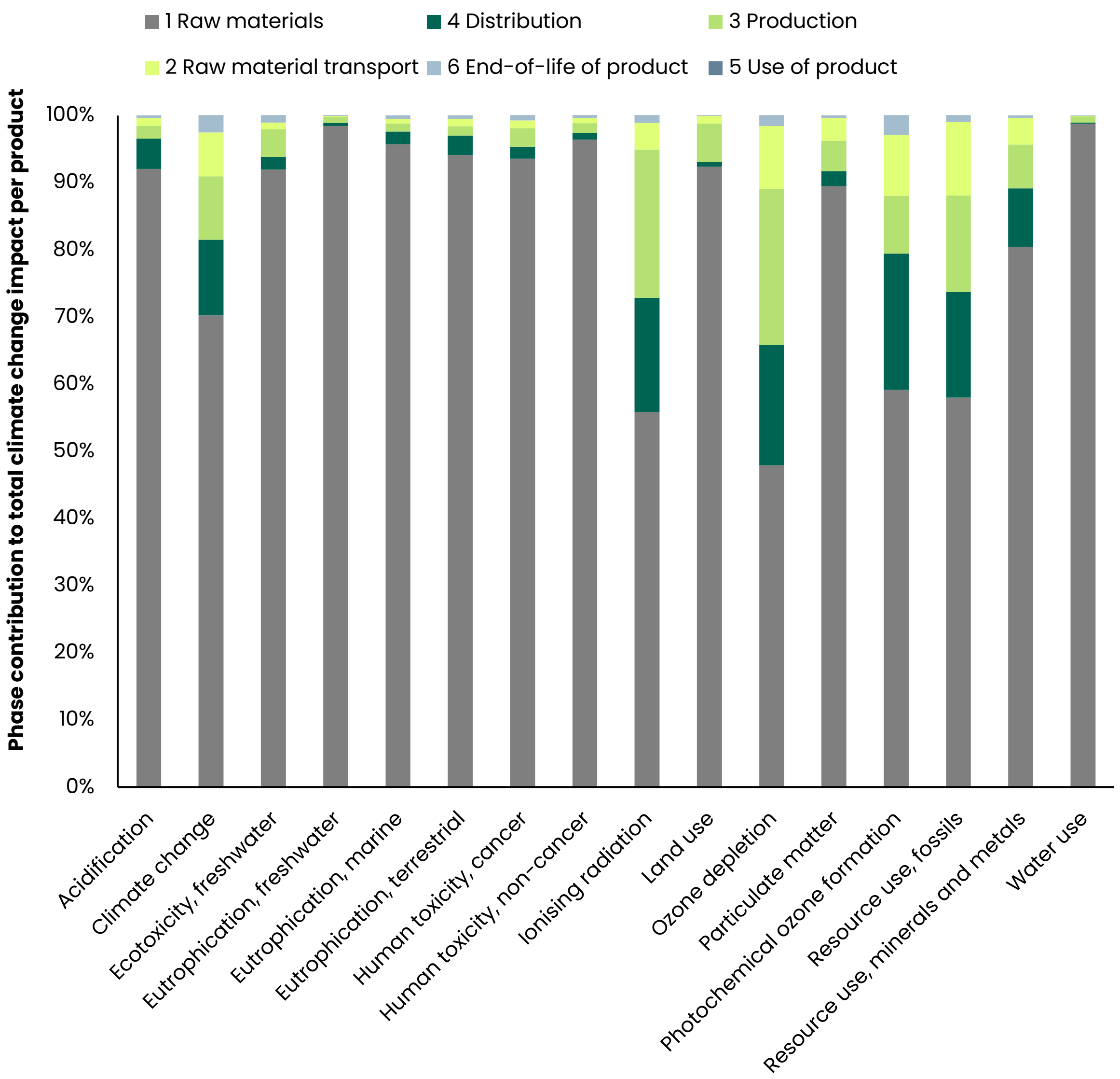


Figure 16 – Environmental impact per indicator for OPM per life cycle phase.

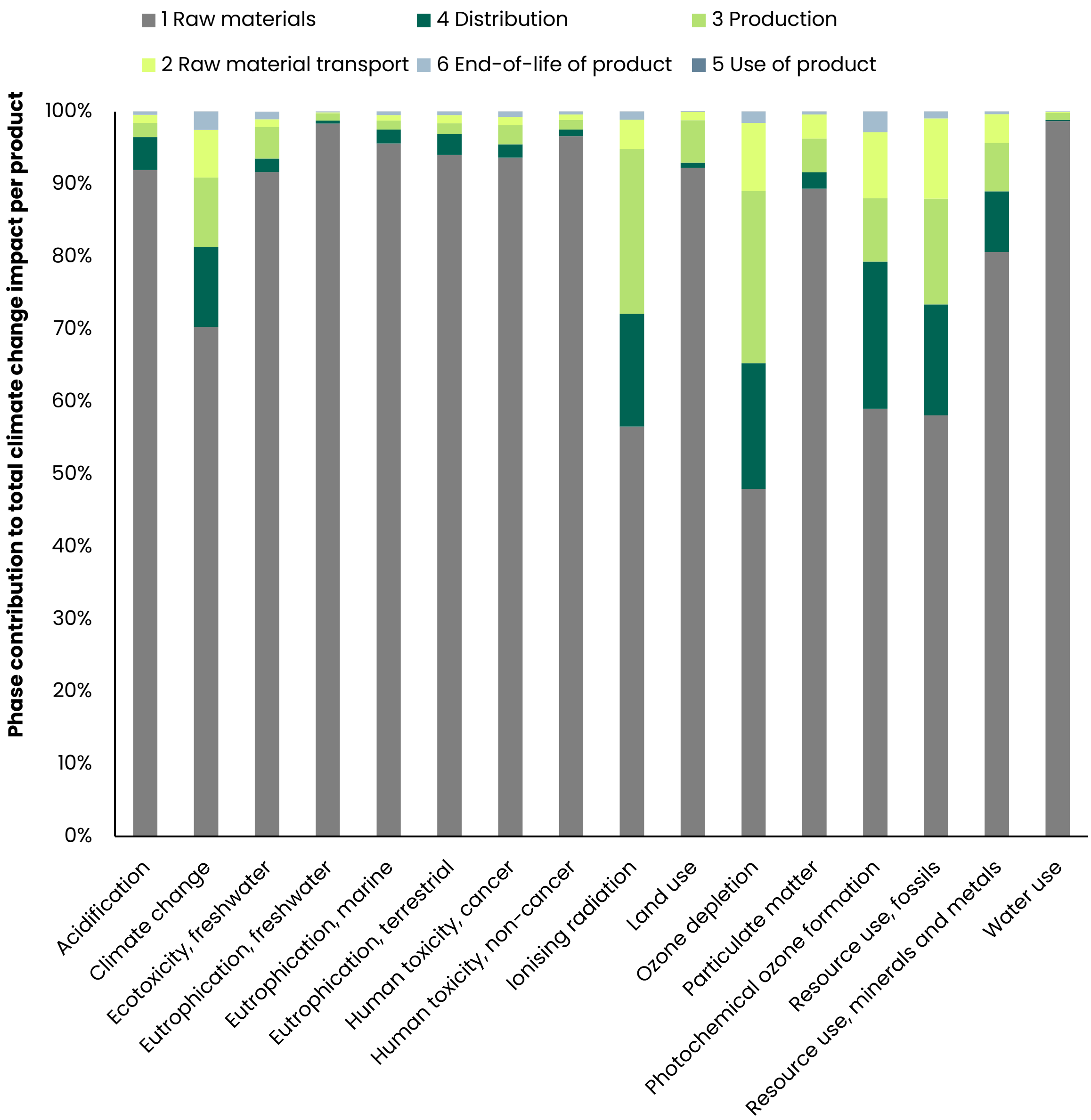


Figure 17 - Environmental impact per indicator for RPM per life cycle phase.

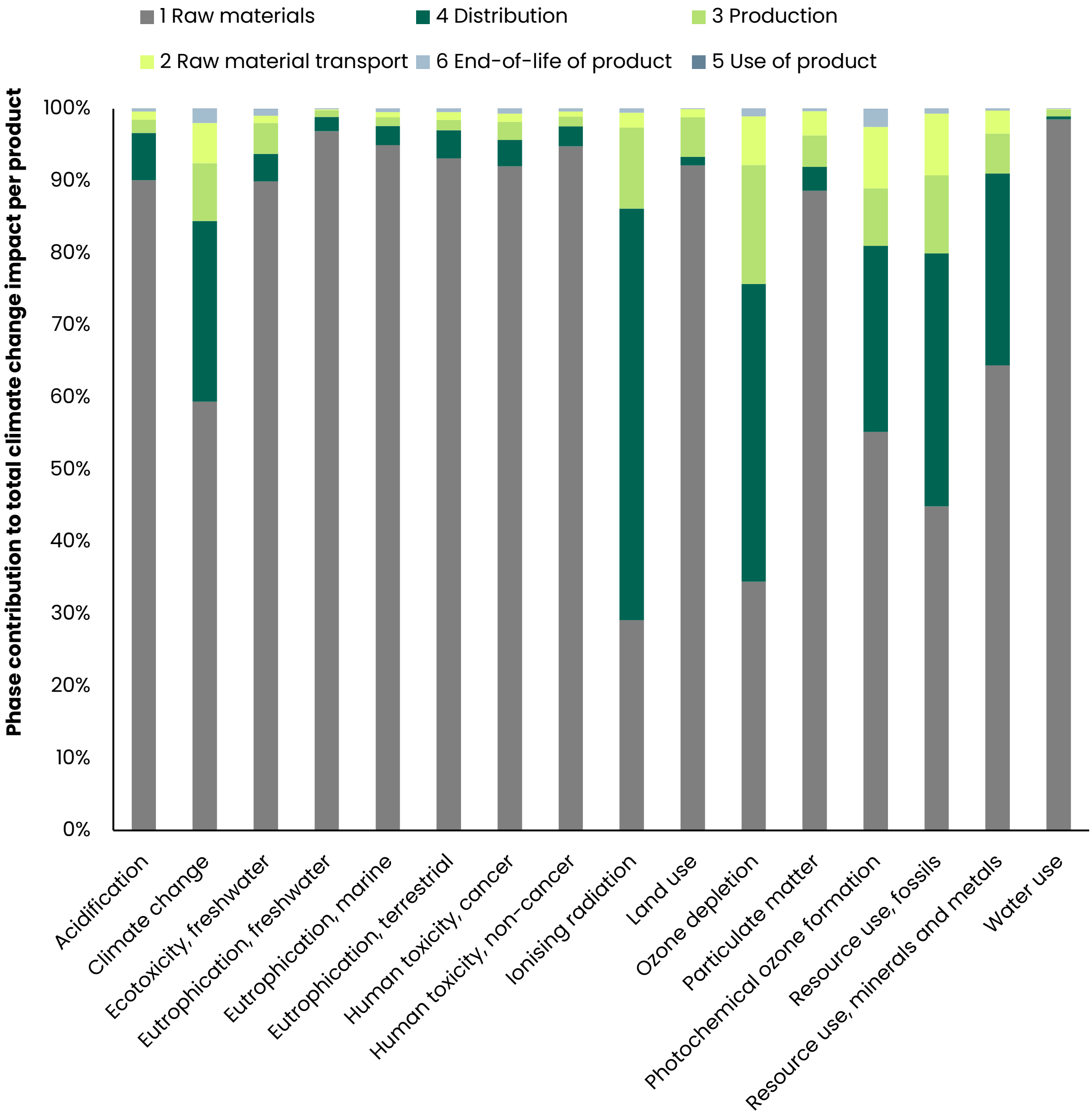


Figure 18 - Environmental impact per indicator for RDB per life cycle phase.

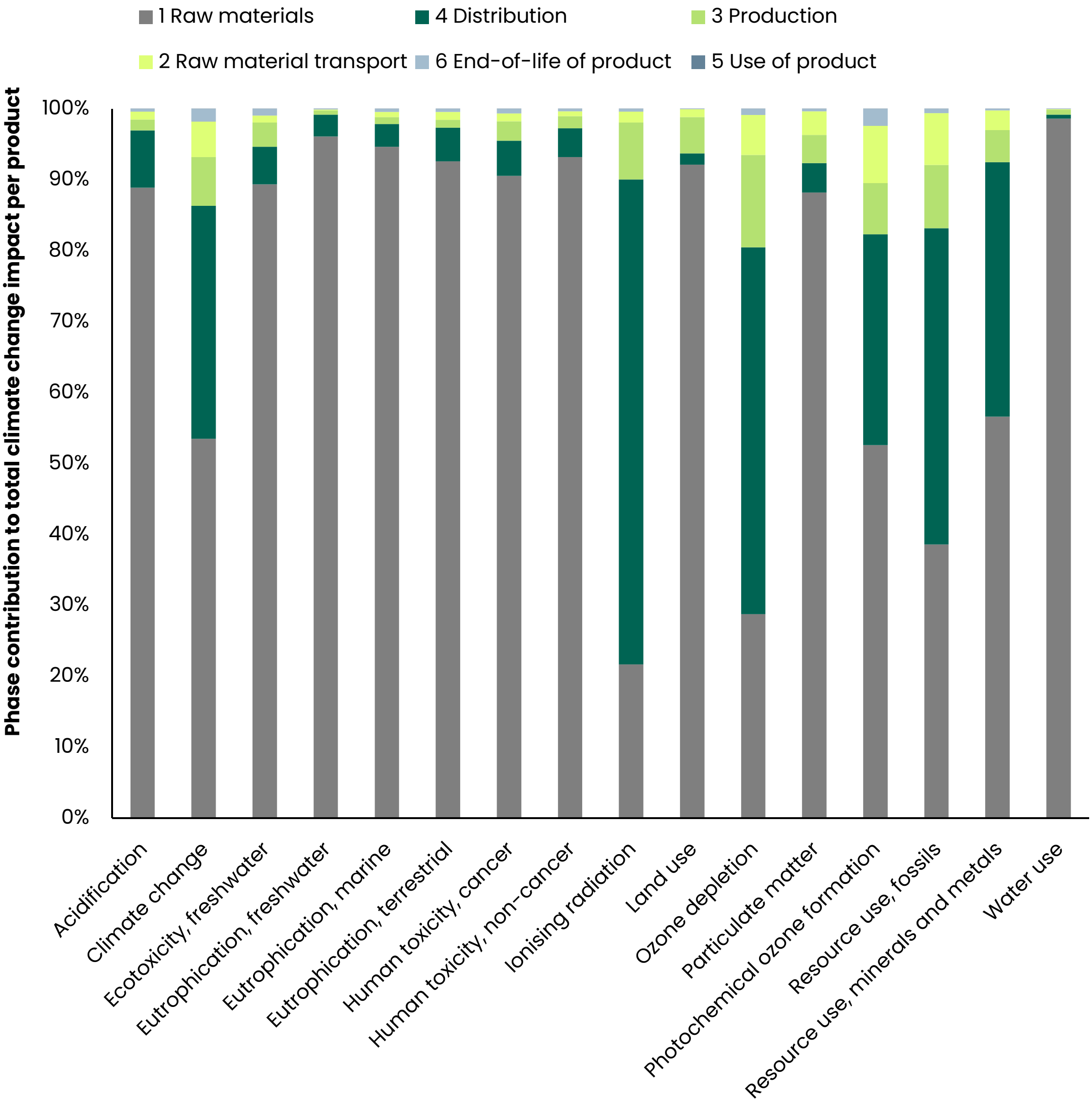


Figure 19 - Environmental impact per indicator for LBS per life cycle phase.

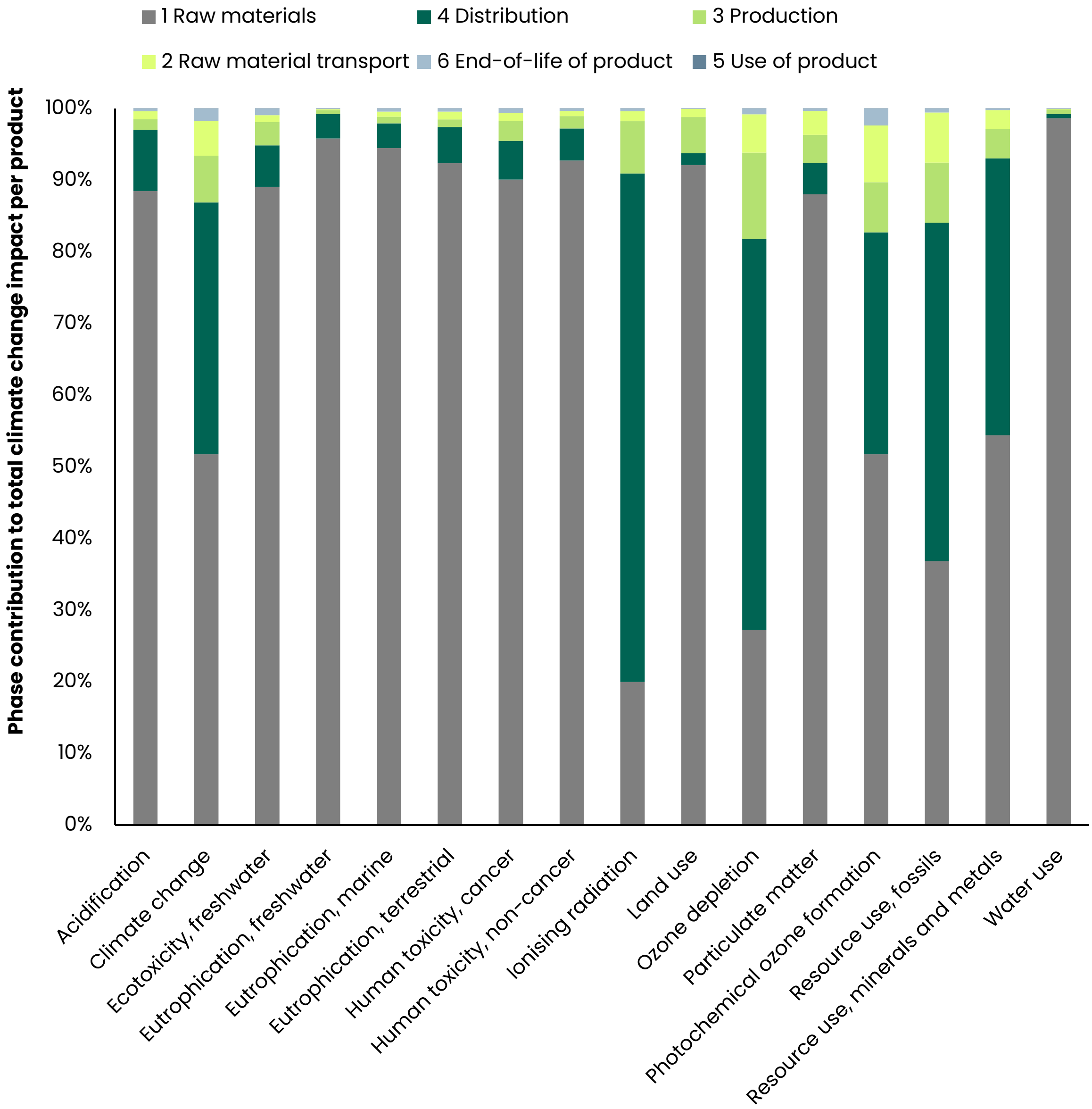


Figure 20 - Environmental impact per indicator for LBL per life cycle phase.

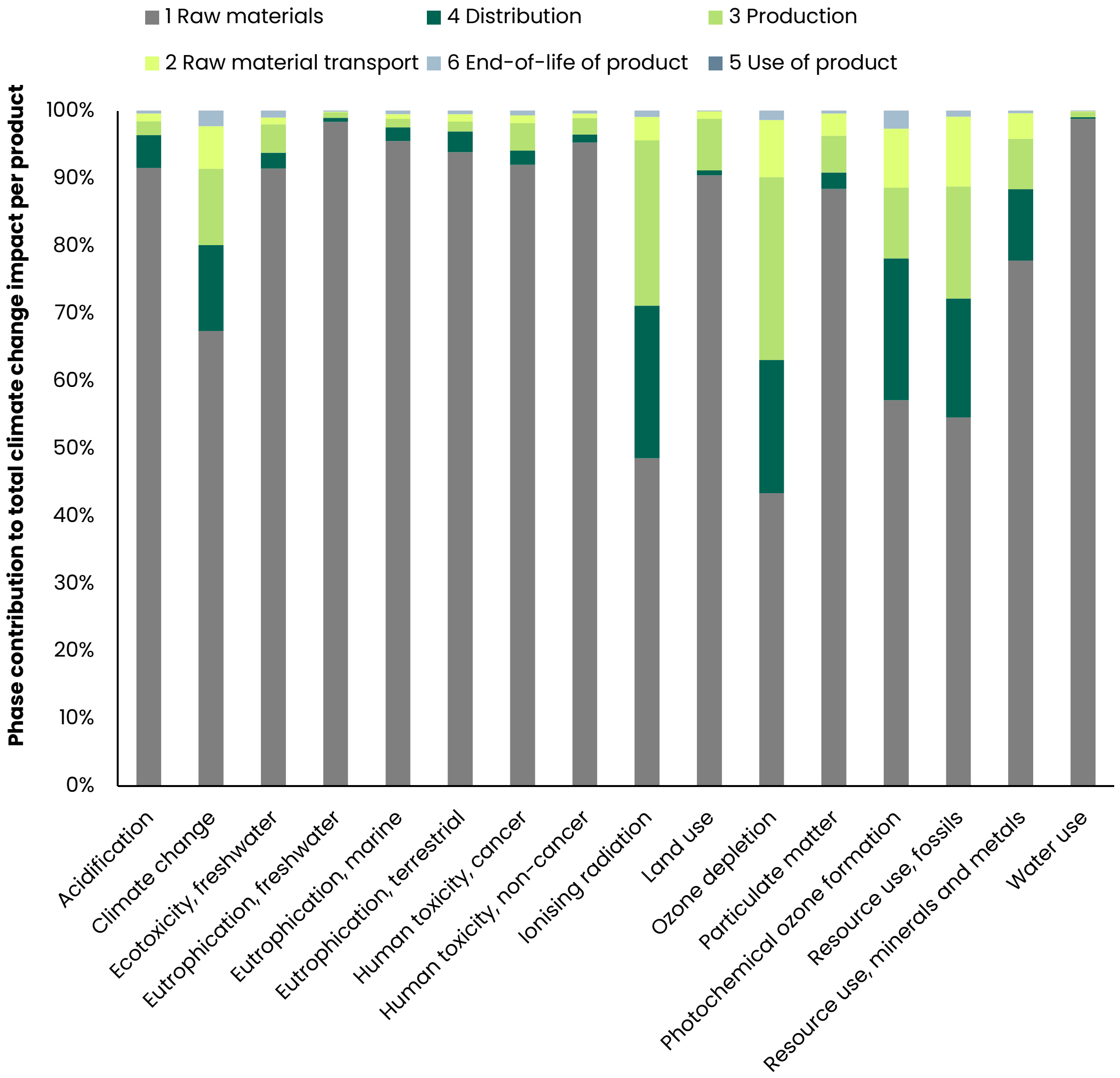


Figure 21 - Environmental impact per indicator for OFR per life cycle phase.

10.3 Data quality numerical rating

Table 44 Numerical data quality rating per process in the LCA. The numerical values are added based on the following: 'Very poor' = 5, 'Poor' = 4, 'Fair' = 3, 'Good' = 2 and 'Very good' = 1. The average DQR per processes is the average rating for accuracy, geography, time and technology. Weighing is based on the average contribution of each process to the overall climate change impact across all products. The weighted score is calculated as the product of the average DQR per process and the weighting. The final DQR score is the sum of the weighted score for all processes.

Activity	Accuracy	Geography	Time	Technology	Average DQR	Weighting	Weighted score
1.1 Grass rope	3	2	1	3	2,25	41,38%	0,93
1.1 Grass rope - processing	3	1	1	2	1,75	0,00%	0,00
1.2 Cotton thread	2	1	1	1	1,25	20,53%	0,26
2.1 Truck transport to factory	2	3	1	2	2	5,80%	0,12
3.1.1 Electricity from grid	2	1	1	1	1,25	0,34%	0,00
3.1.2 Electricity from solar	2	3	1	1	1,75	0,19%	0,00
3.1.3 Electricity from diesel generator	2	4	1	1	2	0,06%	0,00
3.2.1 Inputs - plastic	3	4	1	2	2,5	0,80%	0,02
3.2.2 Inputs - paper	2	3	1	2	2	0,17%	0,00
3.3.1 Waste - plastic	3	3	1	2	2,25	0,18%	0,00
3.3.2 Waste - paper	2	3	1	2	2	0,44%	0,01
3.4.1 Loss - cotton waste	2	3	1	2	2	0,37%	0,01
3.4.2 Loss - Grass rope waste	2	3	1	3	2,25	0,47%	0,01
3.5.1 Packaging - jute rope	1	1	1	1	1	0,23%	0,00
3.5.2 Packaging - printed cardboard	1	4	1	2	2	0,08%	0,00
3.5.3 Packaging - unprinted cardboard	1	3	1	2	1,75	4,77%	0,08
3.5.4 Packaging - LDPE	1	4	1	2	2	0,79%	0,02
4.1 Distribution by truck IN	1	3	1	2	1,75	0,03%	0,00
4.2 Distribution by train IN	1	1	1	1	1	1,53%	0,02
4.3 Distribution by ship	1	3	1	2	1,75	2,73%	0,05
4.4 Distribution by truck EU	1	2	1	2	1,5	0,79%	0,01
4.5 Warehouse	3	1	1	1	1,5	1,32%	0,02
4.6 Retail	3	1	1	1	1,5	11,80%	0,18

Activity	Accuracy	Geography	Time	Technology	Average DQR	Weighting	Weighted score
4.7 Freight packaging disposal LDPE	1	1	1	2	1,25	0,67%	0,01
4.8 Freight packaging disposal cardboard	1	1	1	2	1,25	0,23%	0,00
4.9 Transport to consumer home	5	2	1	3	2,75	2,18%	0,06
5.2 Consumer packaging cardboard disposal	1	1	1	2	1,25	0,01%	0,00
5.1 Consumer packaging jute disposal	1	3	1	2	1,75	0,00%	0,00
6.1 End-of-life cotton	1	3	1	1	1,5	1,61%	0,02
6.2 End-of-life grass rope	1	3	1	2	1,75	0,49%	0,01
Sum	**-**	**-**	**-**	**-**	**-**	**100,00%**	**1,85 = Good**

10.4 Critical review dialogue

No.	PAGE NUMBER	REFERENCE TO CHECKLIST OR PROGRAMME INSTRUCTIONS	REVIEWER COMMENT AND RECOMMENDATION	LCA PRACTITIONER ANSWER	FINAL REVIEWER STATEMENT
1	2	ISO 14044:2008	Julie M. V. Larsen, LCA & EPD Consultant.	Added.	OK, approved
2	4	ISO 14044:2008	2. See above for name and title.	Added.	OK, approved
3	11	ISO 14044:2008	Does this include packaging or only the product? Does the product have packaging?	The product has packaging - a hangtag consisting of cardboard and jute rope. It has been specified here.	OK, approved
4	12	ISO 14044:2008	Some outputs and inputs are missing in the diagram, such has energy inputs to warehouse and packaging waste for disposal. Please add these.	Flow diagram updated.	OK, approved
5	13	ISO 14044:2008	I would delete this, to avoid confusion to the reader.	We have deleted the text about consequential LCA methods.	OK, approved
6	14	ISO 14044:2008	Spelling error.	Not a spelling error - as explained in the review meeting.	OK, approved
7	14	ISO 14044:2008	Please also included the maximum for eack production step/LCA stage.	Has been added.	OK, approved
8	14	ISO 14044:2008	Please explain the temporal scope during review meeting. Is seems that the data is maybe assumed, since the temporal scope is set in the future.	As explained during review meeting: The specific batch is not produced yet, but the products have been produced many times before. By 'the specific batch' we mean the physical products which will have the CO2 CO2 footprint printed on their hang-tags. This batch is being produced right now (in 2026). The data from the factory is collected for 2025, and in 2025 the same products were also produced (earlier batches). This has been cleared up in the text.	OK, approved
9	15	ISO 14044:2008	See name of reviewer above.	Added.	OK, approved
10	16	ISO 14044:2008	It is unclear what the purpose of the cotton is in the product. Please show a diagram or similar on how the cotton is integrated into the product.	It has been described further in the text. It has not been possible to get a photo or diagram of sufficient quality/relevance to put it in the LCA report. But we will show you a photo here of the sewing process from the actual factory - the product in the photo is partly colored, which is not the	OK, approved

No.	PAGE NUMBER	REFERENCE TO CHECKLIST OR PROGRAMME INSTRUCTIONS	REVIEWER COMMENT AND RECOMMENDATION	LCA PRACTITIONER ANSWER	FINAL REVIEWER STATEMENT
				case for Mørkegaards products (natural color). Right click to maximize photo (see photo in report comment).	
11	18	ISO 14044:2008	Is this use of water included in the modelling, if not it shall be included to remian representative.	As explained during review meeting, only the dataset for cultivation of jute has been applied in this LCA - not the processing of jute into rope, which varies significantly from Sabai grass. The jute process is divided into multiple processes in ecoinvent (cultivation, retting, spinning) and we have only used the cultivation process. The text has been adapted to avoid confusion.	OK, approved
12	18	ISO 14044:2008	This should be rated as poor, due to "The processing of harvested jute is fundamentally different from the processing of Sabai grass"	As discussed during the review meeting, we have now divided the process into "grass cultivation" and "grass rope production" to be able to rate the data quality more accurately. In this LCA the grass cultivation is based on jute cultivation, which we rate as "fair". The text you are quoting is related to the processes taking place after the harvest - the processing into rope - which is fundamentally different for jute and seagrass. Therefore, in this LCA, the processing of grass into rope is not based on jute processing (the sabai grass processing is entirety manual/using handdriven tools).	OK, approved
13	20	ISO 14044:2008	Please also include a note about the manual treatment of the plant to turn it into rope.	This has been added.	OK, approved
14	21	ISO 14044:2008	Section 5.3 should be moved up in the report due to the needed context for properly understanding the report.	It has been elaborated in section 5.1 now.	OK, approved
15	22	ISO 14044:2008	Why is time rated so low? Please explain.	Time has been reassessed to "Very good" since v3.11 of ecoinvent has been used.	OK, approved
16	24	ISO 14044:2008	What is the loss presentage based on?	It is added that is based on data from the factory.	OK, approved
17	25	ISO 14044:2008	The 25%/75% split seem like an overestimation on the lighting/ventilation part, what is it based on? Please explain.	As explained during review meeting this is a very conservative estimate. This has been reassessed to 50%/50%, in order to not be too conservative. The results have been updated due to this change in the LCA model. It does not have a visible effect on the results.	OK, approved
18	25	ISO 14044:2008	Please provide documentation for the	We are attaching documentation from the factory.	Documentation reviewed,

No.	PAGE NUMBER	REFERENCE TO CHECKLIST OR PROGRAMME INSTRUCTIONS	REVIEWER COMMENT AND RECOMMENDATION	LCA PRACTITIONER ANSWER	FINAL REVIEWER STATEMENT
			solar plant. It has to be confimed that it is real and ind use. If no documentation is avaliable the data cannot be used for modelling.		including declaration from the factory, picture of the solar cells and batteries. OK, approved
19	26	ISO 14044:2008	What kind of plastic is it? Please explain.	It has been added to the text that the plastic stems from packaging materials and that it is assumed to be LDPE.	OK, approved
20	28	ISO 14044:2008	Why is this rated so low, please justify.	See previous answers regarding DQR for time.	OK, approved
21	29	ISO 14044:2008	GLO and RoW are rated the same here, please adjust or explain why.	GLO has been reassesed to "Poor" and "RoW" has been reassessed to "Fair".	OK, approved
22	32	ISO 14044:2008	Technically the geografic centre of Denmark is in Odsherred. Please use this instead or state a different, still plausible reason.	We have elaborated so it is clear that we don't claim that it is the most geographically central location.	OK, approved
23	32	ISO 14044:2008	See comment above regarding centre of Denmark.	See answer above.	OK, approved
24	34	ISO 14044:2008	Which on of the pilot studies are you using here? Please specify. Why is the pilot PEFCR used and not the currently valid PEFCR?	The scenario comes from PEF (2021). Since these products are not apparel and footwear, it is considered relevant to use the general PEF rules. PEFCR pilot reference is deleted from the text.	OK, approved
25	35	ISO 14044:2008	4 hours, 4 times, 4 what? What is the unit of this value?	4 weeks. Specified in table now.	OK, approved
26	36	ISO 14044:2008	If the consumer purchases 10 kg of product, then they will buy nearly 5 of the heaviest product. If it is assumed that they buy other items, then it should be allocated to reflect this.	As explained during review meeting, it is assumed that they buy other items and it is already allocated accordingly.	OK, approved
27	42	ISO 14044:2008	The consumer would not take the item apart before discarding. They would be burned together. Please adjust.	As explained during the review meeting, we believe this is the most accurate way to model the incineration. It is not assumed that the product is taken apart before incineration. The whole product is burned in a municipal incineration plant, which incinerates many different material fractions, and the emissions related to incinerating the product are independent of whether the product is still assembled or disassembled. I.e. if we have a pair of glasses consisting of glass and plastic, we will also model the incineration with two different datasets, although it is unlikely that the materials will be taken apart before incineration, if you throw	OK, approved

No.	PAGE NUMBER	REFERENCE TO CHECKLIST OR PROGRAMME INSTRUCTIONS	REVIEWER COMMENT AND RECOMMENDATION	LCA PRACTITIONER ANSWER	FINAL REVIEWER STATEMENT
				them in the general waste. We have elaborated a bit in the text to make it clear.	
28	51	ISO 14044:2008	Retail does not clearly contribute the most to the OFR product. Why is the retail contribution so much larger for RDB, LBS and LBL? Please explain.	Retail is the most contributing single life cycle stage for OFR, while it does not contribute with most of the impact. It has been rephrased now to make it more clear. The explanation for higher contribution from retail for RDB, LBS and LBL (higher volume compared to weight) has been added to the text.	OK, approved
29	53	ISO 14044:2008	Spelling error.	Corrected.	OK, approved
30	56	ISO 14044:2008	Sensitivity of electricity should be done in reverse if no documentation for the solar plant can be presented.	Documentation for solar energy is attached.	Documentation reviewed. OK, approved
31	58	ISO 14044:2008	How likely is it that air travel would be used in this case? What is the rational behind this test?	Not likely. The scenario has been removed.	OK, approved
32	59	ISO 14044:2008	Would it not be high for LBL? What is the likelyhood that the products are not stacked in a retail setting? Should this not be done in reverse?	Text adjusted to high-medium. As explained during the review meeting, it is not guaranteed that t he products are stacked in the store, since some store may receive very few pieces of each item. Therefore no stacking has been assumed, and can be considered a conservative estimate. This explanation has been added to the text.	OK, approved
33	61	ISO 14044:2008	A table of all processes and their data quality should be listed here, so the reader can see all of them. Please add this table here or in an annex	It has been added in Annex.	OK, approved
34	62	ISO 14044:2008	Why is the majority of these assumptions not tested for sensitivity? Please explain.	We have tested assumptions relating to the most contributing processes in the LCA as well as some other relevant scenarios. We have added the following scenarios now: 1) Amount of harvested grass used for production of 1 kg rope. 2) How much the consumer buys in one trip	OK, approved

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				The following assumptions are not tested because the processes they relate to have very low contribution to the overall climate change impact of the products or because they are conservative estimates: 1) Electricity consumption of sewing machine - conservative estimate + contributes less than 1% 2) Overhead electricity - same as 1). 3) Efficiency of the diesel generator, since diesel only contributes less than 0,1% to the overall climate change impact of the products. 4) Incineration at EOL - we do not see a realistic alternative scenario.	
35	63	ISO 14044:2008	Please add pr product.	Added.	OK, approved
36	67	ISO 14044:2008	Negative values shall be presented as positive when showing the contribution. Please adjust.	Adjusted according to comment.	OK, approved