Minimalism

Comparative Life Cycle Impact Assessment of Minimalism

GreenStory

Analysis Overview

- The objective of this study is to compare the impact of Minimalism's sustainable apparel against comparative conventional fabrics. The findings of the study are intended to be used as a basis for communication and future process improvements. The primary audience for this study is Minimalism, its investors and customers.
- This cradle-to-gate comparative life cycle inventory (LCI) encompasses all upstream processes of apparel manufacture from, raw material acquisition to fiber and fabric manufacture. All the relevant life-stages of sustainable and conventional fabric apparels are analyzed to estimate the net impact savings across three key metrics: GHG emissions, primary energy use, and blue water consumption.
- This analysis does not include impact assessment except for Global warming potential impact. It does not attempt to determine the fate of emissions, or the relative risk to humans or to the environment due to emissions from the systems.

Scope of Study

- This is a cradle-to-gate comparative life cycle inventory study.
- Functional unit is 1 kg of finished apparel for each Minimalism and comparative conventional fabric type.
- The study examines Minimalism apparel manufacturing and compared it with conventional apparel manufacturing.

Analysis Overview (cont.)

Other data

- Transportation is included between all production stages and until warehouse storage.

Data Audit

- No internal or external audit of resource utilization data provided by Minimalism was performed by Green Story for this study. It is assumed that data provided by Minimalism and its suppliers is factual and accurate.

Critical Review

- No third-party critical review has been performed for this study.

Key Assumptions

Overall assumptions

- Minimalism supply chains are compared to equivalent global supply chains of the same material.
- Impacts for CO_2 emissions are given as non-biogenic carbon dioxide equivalence (CO_2e) as it is assumed that all biogenic CO_2e stored in the apparel will be released back to the environment at their end-of-life.

Key Assumptions (cont.)

Fiber (Organic Cotton- India)

- Farming and ginning inputs inventory for organic cotton were adapted from PE International (2014).
- Cow dung manure is taken as a waste-product of the livestock industry and thus the burden is borne by that industry.
- Calculations for nitrate leaching was taken from Brentrup et al. (2000).
- Soil carbon sequestration is not considered as to align to the PE International (2014).
- Infrastructure creation like shed, trailer and tractor are not considered.
- Heavy metals amount in soil are taken from the United States, Lubbock region and calculated with soil erosion rates in India.
- Economic allocation was used to assign burden between organic cotton linters and fiber for the ginning process, with prices taken from based on PE International (2014).
- Waste for ginning production is taken as 30%, as done in PE International (2014).
- Transportation from farm to ginning is taken as 90 km as per PE International (2014).
- Renewable primary energy requirement for the production of ginned fiber was taken from “Cotton fiber (organic) (at gin gate)” dataset from Textile Exchange in GaBi 9.2.1 (2018) as renewable energy is not disclosed by PE International (2014).
- Proportions of fiber from India regions were considered based on Textile Exchange (2018) and scaled up according to regions where data is available from PE International (2014).
- Contributions of Indian regions for organic cotton cultivation were taken as follows:

Key Assumptions (cont.)

Fiber

- Contributions of Indian regions for organic cotton cultivation were taken as follows:

Region	Contribution %
Madhya Pradesh	55%
Andhra Pradesh	0.3%
Odisha	30%
Rajasthan	1%
Maharashtra	13%

Key Assumptions (cont.)

Fiber (Organic Cotton- Turkey)

- Farming and ginning inputs inventory for organic cotton were adapted from PE International (2014).
- Cow dung manure is taken as a waste-product of the livestock industry and thus the burden is borne by that industry.
- Calculations for nitrate leaching was taken from Brentrup et al. (2000).
- Soil carbon sequestration is not considered as to align to the PE International (2014).
- Infrastructure creation like shed, trailer and tractor are not considered.
- Heavy metals amount in soil are taken from the United States, Lubbock region and calculated with soil erosion rates in Turkey.
- Economic allocation was used to assign burden between organic cotton linters and fiber for the ginning process, with prices taken from based on PE International (2014).
- Renewable primary energy requirement for the production of ginned fiber was taken from "Cotton fiber (organic) (at gin gate)" dataset from Textile Exchange in GaBi 9.2.1 (2018) as renewable energy is not disclosed by PE International (2014).
- Waste for ginning production is taken as 30%, as done in PE International (2014).
- Transportation from farm to ginning is taken as 30 km as per PE International (2014).
- The locations of Turkish cotton cultivation is assumed to be done 50% in Aegean and 50% in South east Anatolia.

Key Assumptions (cont.)

Fiber (rPET)

- Recycled PET granulate and PET granulate production processes are taken as Switzerland processes from Ecoinvent (2019) and adapted to Minimalism and comparative supplier chain through fuel, electricity grid and other raw material inputs' geographical source changes.
- The bottle collection process and sorting for recycled PET are also based on Swiss data and modified through key process and fuel source substitutions.

Key Assumptions (cont.)

Yarn (Natural)

- The same yarn, fabric, and apparel production inputs are considered for both Minimalism and conventional apparel production.
- Yarn production includes the spinning of fibers into yarn and includes all subprocesses; blowing, cleaning, combing, carding, groving, and winding. Input requirements are taken from Hasanbeigi (2014) and Koç & Kaplan (2007).

Yarn (Synthetic)

- Yarn production covers the spinning of granulate material to partially-orientated yarn and the drawing and texturing for draw textured yarn. Inputs needed for these processes are taken from Van der Velden et al. (2014).

Dyeing (Natural)

- Dyeing and finishing processes are taken from Ecoinvent (2019) and adapted by energy source replacement.
- Compacting is assumed to be done after finishing with input requirements taken from Cotton Inc. (2012).

Dyeing (Synthetic)

- All dyeing processes are taken from GaBi 9.2.1 (2018) and adapted by energy source replacement.

Key Assumptions (cont.)

Fabric

- The knitting process is taken as circular knitting from Ecoinvent (2019) and adapted by energy replacement.
- The weaving process is taken from Ecoinvent (2019) and adapted by energy replacement.
- Cut & Sew energy for apparel production was taken from Sustainable Energy Saving for the European Clothing Industry (n.a.) with product weight from Minimalism.
- Waste amount for Cut & Sew was retrieved from European Commission JRC (2014) based on Minimalism product categories.

Fabric (Socks)

- Knitting energy for socks production and waste was taken from Ross (2013).
- Cut & Sew energy is excluded for socks production as socks are knitting directly into product.

Key Assumptions (cont.)

Global Distribution (for Polyester)

- Conventional global distributions for fiber, yarn, fabric and cut and sew production is taken from Quantis (2018) and energy sources (electricity, steam, light fuel oil, thermal energy and diesel) considered as a weighted average of these distributions.

Global Distribution (for conventional Cotton)

- Conventional cotton fiber and yarn distribution is assumed based on USDA (2019) by largest cotton producing countries.
- Conventional global distributions for fabric and cut and sew production is taken from Quantis (2018) and energy sources (electricity, steam, light fuel oil, thermal energy and diesel) considered as a weighted average of these distributions.

Key Assumptions (cont.)

Minimalism Supply chains (SC)

Material	Fiber (Recycling for SC3)	Yarn	Fabric	Dyeing	Cut & Sew	Warehouse
Organic Cotton-SC1	India	Portugal	Portugal	Portugal	Portugal	Spain
Organic Cotton-SC2	Turkey	Portugal	Portugal	Portugal	Portugal	Spain
rPET- SC3	China	China	Vietnam	Vietnam	Vietnam	Spain
Organic Cotton-SC4	Turkey	Portugal	Portugal	Portugal	Portugal	Spain

Conventional Supply chains (SC)

Material	Fiber	Yarn	Fabric	Dyeing	Cut & Sew	Warehouse
Conventional Cotton-SC1, SC2, SC4	Global	Global	Global	Global	Global	Spain
Polyester-SC3	Global	Global	Global	Global	Global	Spain

Key Assumptions (cont.)

Overall waste

Waste scenario	Waste %
Yarn Production (Cotton)	12%
Yarn Production (rPET/Polyester)	9%
Knitting	2%
Weaving	3%
Dyeing (Cotton)	1%
Dying (rPET/Polyester)	3.5%
Cut & Sew –SC1	12%
Cut & Sew –SC2	16%
Cut & Sew-SC3	15%
Cut & Sew-SC4	1%

Key Assumptions (cont.)

Transport

- All transportation between raw material production until warehouse storage is taken into consideration for both Minimalism and conventional production.
- For the conventional material, transport was taken as weighted averages between production facilities based on the global distributions for each production stage. Global distributions for each stage are based on Quantis (2018).
- Global distributions for cotton fiber and yarn are taken based on USDA (2019) by largest cotton producing countries, and fabric and assembly global distributions from Quantis (2018).
- For Europe production in the global supply chain, Italy was assumed as the country of departure/arrival.
- Transport for conventional materials from Cut & Sew facility to warehouse was calculated as a weighted average from global distribution of Quantis (2018) to Minimalism warehouse.
- Conventional transport from Cut & Sew facility to warehouse was taken as 92% via ship and 8% via air as standard practice specified by Quantis (2018).
- A distance of 1000 km is applied when production processes are done in the same country but cities are unknown, as indicated by Quantis (2018).
- A distance of 2000 km is applied in large countries such as Brazil, China, USA, and India.
- Transportation by ship and air for the conventional supply chain was taken as the distance from harbor/airport to harbor/airport plus 500 km in each country as done by Quantis (2018).
- An inner-city standard transportation distance of 30 km is assumed for production processes in the same city with different facilities when exact locations are unknown.
- Conventional dyeing is assumed to be in the same city as fabric production, hence 30 km transportation is included at this stage.
- All distances were calculated with SeaRates LP (2018) and www.distance.to (only for air distances).

List of sources

Fiber (Organic Cotton)

- Amon, T, and J Boxberger. “Biogas Production from Farmyard Manure.” Institute for Agricultural, Environmental and Energy Engineering, University for Agricultural Sciences.
- Brentrup, Frank, et al. "Methods to estimate on-field nitrogen emissions from crop production as an input to LCA studies in the agricultural sector." The International Journal of Life Cycle Assessment 5.6 (2000): 349.
- l’IFTH. Institut Francais du textile et de l'habillement. Aide à la prise en compte de l’environnement dans la conception d’articles textiles.
- Le Mer, Jean, and Pierre Roger. "Production, oxidation, emission and consumption of methane by soils: a review." European journal of soil biology 37.1 (2001): 25-50.
- PE International . Life Cycle Assessment (LCA) of Organic Cotton: A Global Average. Textile Exchange, 2014, Life Cycle Assessment (LCA) of Organic Cotton: A Global Average.
- Pennsylvania State University . Compose Analysis Report. 2016, Compose Analysis Report.
- Textile Exchange. Organic Cotton Market Report 2018. 2018, pp. 1–82, Organic Cotton Market Report 2018.
- NRCCA. “Northeast Region Certified Crop Adviser (NRCCA) Study Resources.” Certified Crop Advisor Study Resources (Northeast Region), 2010, nrcca.cals.cornell.edu/.

Fiber (rPET)

- Ecoinvent (2019) Database Ecoinvent version v3.6. The Swiss Centre for Life Cycle Inventories.

List of sources

Fabric (Natural)

- Ecoinvent (2019) Database Ecoinvent version v3.6. The Swiss Centre for Life Cycle Inventories.
- European Commission JRC. “Environmental Improvement Potential of Textiles (IMPRO Textiles). JRC Scientific and Policy Reports. (January 2014).
- GaBi 9.2.1: Leinfelden-Echterdingen GaBi Software-system and Databases for Life Cycle Engineering, Thinkstep AG, 2018.
- Hasanbeigi, Ali, and Lynn Price. "A review of energy use and energy efficiency technologies for the textile industry." Renewable and Sustainable Energy Reviews 16.6 (2012): 3648-3665.
- Koç, Erdem, and Emel Kaplan. "An investigation on energy consumption in yarn production with special reference to ring spinning." fibers & Textiles in Eastern Europe 4 (63) (2007): 18-24.
- Quantis. “Measuring Fashion. Environmental Impact of the Global Apparel and Footwear Industries Study. Full report and methodological considerations.” 2018
- Sustainable Energy Saving for the European Clothing Industry. “Benchmarking energy efficiency in apparel production”. (n.a).
- USDA. Cotton: World Markets and Trade. 2019, pp. 1–28, Cotton: World Markets and Trade

Primary Sources

- Minimalism proprietary data

List of sources

Fabric (rPET/Polyester)

- Ecoinvent (2019) Database Ecoinvent version v3.6. The Swiss Centre for Life Cycle Inventories.
- European Commission JRC. “Environmental Improvement Potential of Textiles (IMPRO Textiles). JRC Scientific and Policy Reports. (January 2014).
- GaBi 9.2.1: Leinfelden-Echterdingen GaBi Software-system and Databases for Life Cycle Engineering, Thinkstep AG, 2018.
- Quantis. “Measuring Fashion. Environmental Impact of the Global Apparel and Footwear Industries Study. Full report and methodological considerations.” 2018
- Sustainable Energy Saving for the European Clothing Industry. “Benchmarking energy efficiency in apparel production”. (n.a).
- Van der Velden, Natascha M., Martin K. Patel, and Joost G. Vogtländer. "LCA benchmarking study on textiles made of cotton, polyester, nylon, acryl, or elastane." The International Journal of Life Cycle Assessment 19.2 (2014): 331-356.

List of sources

Fabric (Socks)

- Ecoinvent (2019) Database Ecoinvent version v3.6. The Swiss Centre for Life Cycle Inventories.
- Hasanbeigi, Ali, and Lynn Price. "A review of energy use and energy efficiency technologies for the textile industry." Renewable and Sustainable Energy Reviews 16.6 (2012): 3648-3665.
- Koç, Erdem, and Emel Kaplan. "An investigation on energy consumption in yarn production with special reference to ring spinning." fibers & Textiles in Eastern Europe 4 (63) (2007): 18-24.
- Quantis. “Measuring Fashion. Environmental Impact of the Global Apparel and Footwear Industries Study. Full report and methodological considerations.” 2018
- USDA. Cotton: World Markets and Trade. 2019, pp. 1–28, Cotton: World Markets and Trade.
- Roos, Sandra. “Life cycle assessment (LCA) of Life Wear bamboo garments” Swerea IVF AB, 2013.

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Fabric (Weave)

- “Cotton GSM.” ARKET, 2018, www.arket.com/en_eur/c/cs-cotton-gsm.html.
- Cotton Inc, 2012. Life Cycle Assessment of Cotton fiber and Fabric. Pre-pared for VISION 21, a project of The Cotton Foundation and managed by Cotton Incorporated, Cotton Council International and The National Cotton Council. The research was conducted by Cotton Incorporated and PE Inter-national.
- Van der Velden, Natascha M., Martin K. Patel, and Joost G. Vogtländer. "LCA benchmarking study on textiles made of cotton, polyester, nylon, acryl, or elastane." The International Journal of Life Cycle Assessment 19.2 (2014): 331-356.

Fabric (Knit)

- Cotton Inc, 2012. Life Cycle Assessment of Cotton fiber and Fabric. Pre-pared for VISION 21, a project of The Cotton Foundation and managed by Cotton Incorporated, Cotton Council International and The National Cotton Council. The research was conducted by Cotton Incorporated and PE Inter-national.
- Van der Velden, Natascha M., Martin K. Patel, and Joost G. Vogtländer. "LCA benchmarking study on textiles made of cotton, polyester, nylon, acryl, or elastane." The International Journal of Life Cycle Assessment 19.2 (2014): 331-356.

List of sources (cont.)

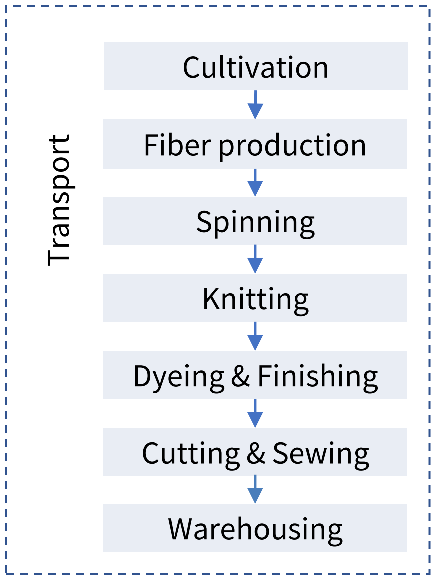
Transport

- PE International . Life Cycle Assessment (LCA) of Organic Cotton: A Global Average. Textile Exchange, 2014, Life Cycle Assessment (LCA) of Organic Cotton: A Global Average.
- Quantis. “Measuring Fashion. Environmental Impact of the Global Apparel and Footwear Industries Study. Full report and methodological considerations.” 2018
- SeaRates LP. “Current Market Rate.” SeaRates, 2018, www.searates.com/reference/portdistance/.
- distance.to. “Distance Calculator - Calculate the Distance Online!” Distance Calculator, n.a. , www.distance.to/.

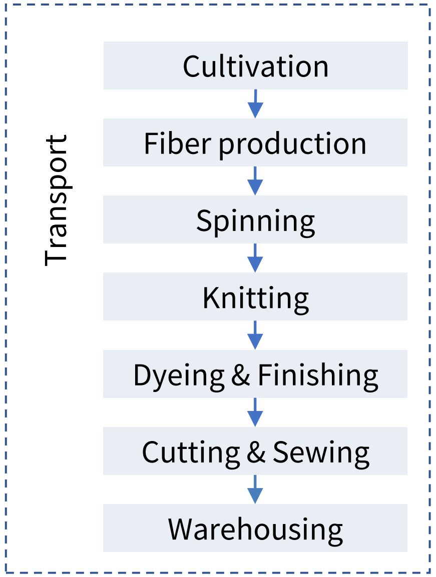
Comparative Impact Calculation Results:
(1) Organic Cotton vs Conventional Cotton
(2) rPET vs Polyester

System boundary

Organic cotton

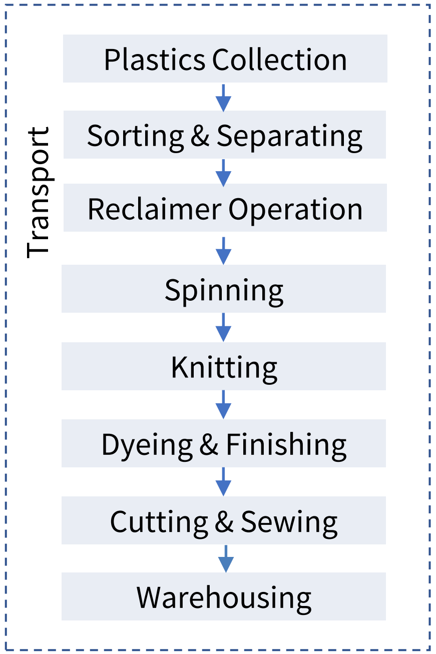


Conventional cotton

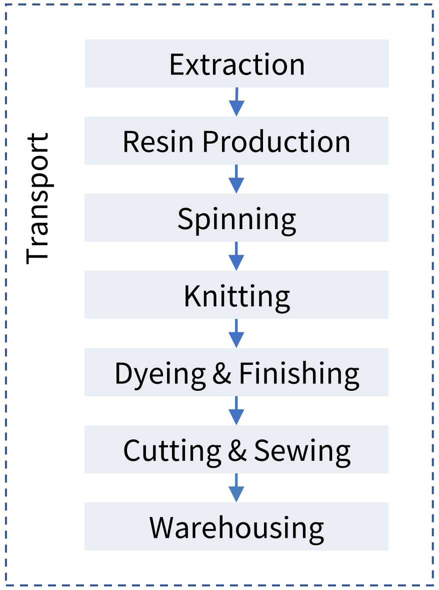


System boundary

rPET



Virgin polyester



Organic Cotton (SC1) vs Conventional Cotton comparative LCI (per kg of clothing)

Net impact difference

Per kg of apparel	Unit	Organic Cotton	Conventional Cotton	Percentage lower
GHG emissions	kg CO_2e	9.92	19.50	49%
Energy	MJ	296	351	15%
Blue water consumption	litres	648	3107	79%

Organic Cotton (SC2-Knit) vs Conventional Cotton comparative LCI (per kg of clothing)

Net impact difference

Per kg of apparel	Unit	Organic Cotton	Conventional Cotton	Percentage lower
GHG emissions	kg CO_2e	8.33	15.30	46%
Energy	MJ	215	287	25%
Blue water consumption	litres	243	3130	92%

Organic Cotton (SC2-Weave) vs Conventional Cotton comparative LCI (per kg of clothing)

Net impact difference

Per kg of apparel	Unit	Organic Cotton	Conventional Cotton	Percentage lower
GHG emissions	kg CO_2e	8.86	19.60	55%
Energy	MJ	227	355	36%
Blue water consumption	litres	253	3238	92%

rPET(SC3) vs Polyester comparative LCI (per kg of clothing)

Net impact difference

Per kg of apparel	Unit	rPET	Polyester	Percentage lower
GHG emissions	kg CO_2e	14.30	21.10	32%
Energy	MJ	210	376	44%
Blue water consumption	litres	56	121	54%

Organic Cotton (SC4) vs Conventional Cotton comparative LCI (per kg of clothing)

Net impact difference

Per kg of apparel	Unit	Organic Cotton	Conventional Cotton	Percentage lower
GHG emissions	kg CO_2e	5.69	13.40	58%
Energy	MJ	170	256	34%
Blue water consumption	litres	254	2922	91%

About Green Story

The Green Story team is led by Akhil Sivanandan and Navodit Babel. Both members received their sustainability reporting training from the Global Reporting Initiative.

- Navodit has 10+ years of experience in consulting and product management with global corporations. He has successfully overseen the launch of national card strategies in Canada. During his MBA at the University of Toronto, he developed a sustainability ranking algorithm for mining projects for Sustainalytics which used in the company's global operations.

- Akhil has worked on sustainability projects for companies such as Philips Lighting and given presentations and interviews on the topic for multiple publications including the New York Times. He was also intimately involved in the Ontario Cap and Trade and Offsets programs as part of the Government. Akhil received his MBA from the University of Toronto.

Green Story's mission is help companies communicate environmental and social impact to stakeholders in a clear, credible and relatable manner.

We work with a range of companies from waste management firms to one of North America's largest ecofashion manufacturers to engage stakeholders and measure and communicate impact.

Green Story is a Ministry of Environment Agent of Change, Social Capital Markets scholarship recipient, a member of the MaRS Centre for Impact Investing and of Ryerson University's Social Venture Zone.

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