Comparative Life Cycle Impact Assessment for Boody

GreenStory

Analysis Overview

- The objective of this study is to compare the impact of Boody'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 Boody, 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 fibre 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 Boody and comparative conventional fabric type
- The study examines Boody apparel manufacturing globally 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 Boody was performed by Green Story for this study. It is assumed that data provided by Boody and its suppliers is factual and accurate.

Critical Review

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

Key Assumptions

Overall assumptions

- Boody supply chains are compared to equivalent global supply chains of the same material.
- Impacts for CO2 emissions are given as non-biogenic carbon dioxide equivalence (CO2e) as it is assumed that all biogenic CO2e stored in the apparel will be released back to the environment at their end-of-life.
- Primary energy for all supply chains is taken as “primary energy from non renewable resources (net cal. value)” as SCS Global Services (2017) only provides non renewable impact numbers.

Key Assumptions (cont.)

Fiber and Fabric

- Environmental impacts for bamboo fiber production are taken from SCS Global Services (2017) for production in China.
- Bamboo fiber impacts are taken as the scenario 'Chinese Production from Chinese Bamboo'.
- The same yarn, fabric, and apparel production inputs are considered for both Boody 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).
- 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.
- All dyeing processes are taken from GaBi 8.7 (2018) and adapted by energy source replacement.
- Cut & Sew energy for apparel production was taken from Sustainable Energy Saving for the European Clothing Industry (n.a.) with product weight from Boody for applicable supply chains.
- Waste amount for Cut & Sew was retrieved from European Commission JRC (2014) based on Boody product categories.
- Solely knitting was considered due to Boody product types.
- The knitting process consists of circular knitting and compacting with input requirements taken from Van der Velden et al. (2014) and Cotton Inc. (2012).

Key Assumptions (cont.)

Boody Supply chains

Material	Fiber	Yarn	Fabric	Dyeing	Cut & Sew	Warehouse
Bamboo - Supply Chain 1	Gaocheng City, Hebei Provice, China	Weihai, Shandong Province, China	Fotang Town Yiwu City, China	N/a	N/a	Sydney, Australia
Bamboo - Supply Chain 2	Gaocheng City, Hebei Provice, China	Weihai, Shandong Province, China	Yiwu City Zhejiang Province China	N/a	N/a	Sydney, Australia
Bamboo- Supply Chain 3	Gaocheng City, Hebei Provice, China	Weihai, Shandong Province, China	Binghu District , Wuxi, China	N/a	N/a	Sydney, Australia
Bamboo - Supply Chain 4	Gaocheng City, Hebei Provice, China	Weihai, Shandong Province, China	Yaqian Town Xiaoshan District, Hangzhou	Binhai Industrial Zone Shanxing, Zhejiang	Binh Tan District Ho Chi Minh City, Vietnam	Sydney, Australia
Bamboo - Supply Chain 5	Gaocheng City, Hebei Provice, China	Weihai, Shandong Province, China	Yaqian Town Xiaoshan District, Hangzhou	Binhai Industrial Zone Shanxing, Zhejiang	Falandi, Dadra and Nagar Haveli, India	Sydney, Australia

Conventional Supply chains

Material	Fiber	Yarn	Fabric	Dyeing	Cut & Sew	Warehouse
Cotton	Global	Global	Global	Global	Global	Sydney, Australia

Key Assumptions (cont.)

Overall waste (General)

Waste scenario	Waste %
Yarn Production (Cotton)	12%
Yarn Production (Bamboo)	9%
Knitting	2%
Dyeing	3.5%
Cut & Sew	13%

Key Assumptions (cont.)

Transport

- All transportation between raw material production until warehouse storage is taken into consideration for both Boody 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).
- 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 Boody warehouse.
- Conventional transport from Cut & Sew facility to warehouse was taken as 92% via ship and 8% via air as standard practice for overall textiles 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).
- 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 30km is assumed for production processes in the same city with different facilities when exact locations are unknown.
- Conventional dyeing is assumed to be done at the same facility as fabric production, hence no transportation is included at this stage.
- All distances were calculated with SeaRates LP (2018).

Key Assumptions (cont.)

Transport

Stages	Supply Chain 1 (km)	Supply Chain 2 (km)	Supply Chain 3 (km)	Supply Chain 4 (km)	Supply Chain 5 (km)
Fiber to Yarn (Truck)	790	790	790	790	790
Yarn to Fabric (Truck)	1208	1198	904	1094	1094
Fabric to Dyeing (if applicable) (Ship + Truck)	-	-	-	32	32
Fabric to Cut & Sew (Ship + Truck)	-	-	-	-	-
Fabric to Warehouse (Ship + Truck)	8872	8881	8805	-	-
Fabric to Warehouse (Air + Truck)	7796	7784	7990	-	-
Dyeing to Cut & Sew (Ship + Truck)	-	-	-	3099	8782
Cut & Sew to Warehouse (Air + Truck)	-	-	-	6869	10297
Cut & Sew to Warehouse (Ship + Truck)	-	-	-	8055	11431

Key Assumptions (cont.)

Conventional Transport

Stages	Cotton (km)
Raw Material to Yarn (Ship + Truck)	Not disclosed by Gabi, 2018
Yarn to Fabric (Ship + Truck)	10806
Dyeing to Cut & Sew (Ship + Truck)	7942
Cut & Sew to Warehouse (Air + Truck)	10320
Cut & Sew to Warehouse (Ship + Truck)	12338

List of sources

Fiber (Bamboo)

- Schultz, Tobias, et al. Life Cycle Assessment Comparing Ten Sources of Manmade Cellulose Fiber. SCS Global Services, 2017, pp. 1–158, Life Cycle Assessment Comparing Ten Sources of Manmade Cellulose Fiber.

List of sources

Fabric

- Ecoinvent (2017) Database Ecoinvent version v3.7. 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 8.7: 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." Fibres & 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).
- Cotton Inc, 2012. Life Cycle Assessment of Cotton Fibre 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.

Primary Sources

- Boody proprietary data

List of sources

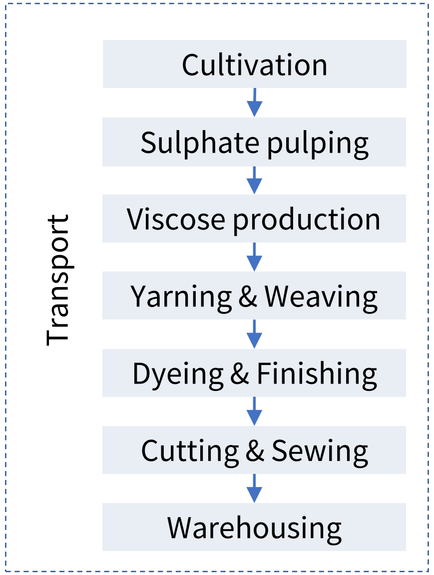
Transport

- 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/.

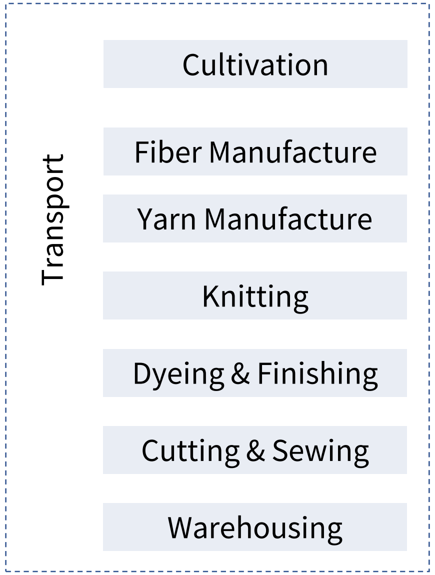
Bamboo vs Conventional Cotton
Comparative Impact Calculation Results

System boundary

Bamboo



Conventional cotton



Bamboo Supply Chain 1 vs. Conventional Cotton comparative LCI (per kg of clothing)

Net impact difference

Per kg of apparel	Unit	Bamboo	Conventional Cotton	Percentage lower
GHG emissions	kgCO2e	13.02	17.89	27%
Blue water consumption	litres	877.1	2600	66%
Energy	MJ	114.9	223.2	49%

Net impact difference in equivalences

Per kg of apparel	Unit	Equivalence	Value
GHG emissions	kgCO2e	km of driving emissions	0.26
Blue water consumption	litres	days of drinking water	1.9
Energy	kWh	light bulbs powered for an hour	0.013

Bamboo Supply Chain 2 vs. Conventional Cotton comparative LCI (per kg of clothing)

Net impact difference

Per kg of apparel	Unit	Bamboo	Conventional Cotton	Percentage lower
GHG emissions	kgCO2e	13.02	17.89	27%
Blue water consumption	litres	877.1	2600	66%
Energy	MJ	114.9	223.2	49%

Net impact difference in equivalences

Per kg of apparel	Unit	Equivalence	Value
GHG emissions	kgCO2e	km of driving emissions	0.26
Blue water consumption	litres	days of drinking water	1.9
Energy	kWh	light bulbs powered for an hour	0.013

Bamboo Supply Chain 3 vs. Conventional Cotton comparative LCI (per kg of clothing)

Net impact difference

Per kg of apparel	Unit	Bamboo	Conventional Cotton	Percentage lower
GHG emissions	kgCO2e	12.97	17.89	28%
Blue water consumption	litres	876.9	2600	66%
Energy	MJ	114	223.2	49%

Net impact difference in equivalences

Per kg of apparel	Unit	Equivalence	Value
GHG emissions	kgCO2e	km of driving emissions	0.26
Blue water consumption	litres	days of drinking water	1.9
Energy	kWh	light bulbs powered for an hour	0.013

Bamboo Supply Chain 4 vs. Conventional Cotton comparative LCI (per kg of clothing)

Net impact difference

Per kg of apparel	Unit	Bamboo	Conventional Cotton	Percentage lower
GHG emissions	kgCO2e	15.43	21.53	28%
Blue water consumption	litres	1009	2994	66%
Energy	MJ	139	271.2	49%

Net impact difference in equivalences

Per kg of apparel	Unit	Equivalence	Value
GHG emissions	kgCO2e	km of driving emissions	0.26
Blue water consumption	litres	days of drinking water	1.9
Energy	kWh	light bulbs powered for an hour	0.013

Bamboo Supply Chain 5 vs. Conventional Cotton comparative LCI (per kg of clothing)

Net impact difference

Per kg of apparel	Unit	Bamboo	Conventional Cotton	Percentage lower
GHG emissions	kgCO2e	13.72	18.84	27%
Blue water consumption	litres	914.1	2709	66%
Energy	MJ	122	235.7	48%

Net impact difference in equivalences

Per kg of apparel	Unit	Equivalence	Value
GHG emissions	kgCO2e	km of driving emissions	0.26
Blue water consumption	litres	days of drinking water	1.9
Energy	kWh	light bulbs powered for an hour	0.013

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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