NŌ NASTIES

ORGANIC, FAIR TRADE, VEGAN CLOTHING

Comparative Life Cycle Impact Assessment of Organic Cotton vs. Conventional Cotton

GreenStory

Analysis Overview

- The objective of this study is to compare the impact of No Nasties'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 No Nasties, 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 No Nasties and comparative conventional fabric type
- The study examines No Nasties apparel manufacturing globally and compared it with conventional apparel manufacturing with global sourcing. Transportation between production processes and post apparel manufacturing processes including consumer's transportation, use and disposal are not part of this study.

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 No Nasties was performed by Green Story for this study. It is assumed that data provided by No Nasties and its suppliers is factual and accurate.

Critical Review

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

Key Assumptions

Overall assumptions

- No Nasties supply chains are compared to equivalent supply chains of the same material.
- No Nasties supply chains are compared to supply chains of the same material produced in the same country as No Nasties's production.

- 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.

Key Assumptions (cont.)

Fiber (Organic Cotton PE - India)

- Farming and ginning inputs inventory for organic cotton were adapted from PE International (2014) for Odisha province.
- 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 fibre 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).
- Cotton fabric is dyed with light reactive dyes for natural fabric.
- Transportation from farm to ginning is taken as 30km as per PE International (2014).

Key Assumptions (cont.)

Fiber (Organic Cotton- C&A Foundation)

- Environmental impacts for conventional seed cotton are taken from C&A Foundation, 2018.
- Ginning production processes were taken from PE International (2014) assuming same production process and inputs as organic cotton for India.

Fabric (Natural – country specific)

- The same yarn, fabric, and apparel production inputs are considered for both No Nasties 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).
- All dyeing processes are taken from GaBi 8.7 (2018) and adapted by energy source replacement.
- Cut & Sew electricity for apparel production was taken from Sustainable Energy Saving for the European Clothing Industry (n.a.) with product weight from No Nasties.
- Waste amount for Cut & Sew was retrieved from European Commission JRC (2014) based on No Nasties product categories.
- Cut & Sew eletriicty and waste for accessories (bags and scarves) were not considered for either No Nasties and conventional supply chain due to lack of data.

Key Assumptions (cont.)

Fabric (Knit & Weave)

- Both knitting and weaving were considered as per to No Nasties product types.
- The knitting process consists of knitting and compacting with input requirements taken from Van der Velden et al. (2014) and Cotton Inc. (2012).
- Circular knitting was assumed as stated in McCann et al. (2009).
- The weaving process includes sizing and warping, weaving, and sanforizing with inputs requirements from Van Eynde (2015) and Cotton Inc (2012).
- Sanforizing inputs are calculated with the assumption of material weight as 170 gsm (ARKET, 2018).

Key Assumptions (cont.)

No Nasties Supply chains

Material	Fiber	Yarn	Fabric	Dyeing	Cut & Sew	Warehouse
Organic Cotton	Odisha, India	Odisha, India	Kolkata, India	Kolkata, India	Kolkata, India	Goa, India

Conventional Supply chains

Material	Fiber	Yarn	Fabric	Dyeing	Cut & Sew	Warehouse
Cotton	India	India	India	India	India	Goa, India

Key Assumptions (cont.)

Overall waste

Waste scenario	Waste %
Yarn Production (Cotton)	12%
Knitting	2%
Weaving	3%
Dyeing	3%

Key Assumptions (cont.)

Transport (Country specific)

- All transportation between raw material production until warehouse storage is taken into consideration for both No Nasties and conventional production.
- 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).

Transport (PE International Cotton Fiber)

- An additional transport of 30 km is applied for organic cotton from farm to ginning facility as stated by PE International (2014).

Key Assumptions (cont.)

Transport

Stages	Organic (km)	Conventional (km)
Raw Material to Yarn (Truck)	30	1000
Yarn to Fabric (Truck)	487	1000
Fabric to Cut & Sew (Truck)	0	1000
Cut & Sew to Warehouse (Truck)	2185	1000

List of sources

Fiber (Organic Cotton PE India)

- 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/.

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Fiber (Organic Cotton – C&A Foundation)

- C&A Foundation. Life Cycle Assessment of Cotton Cultivation Systems: Better Cotton, Conventional Cotton and Organic Cotton. 0AD, Life Cycle Assessment of Cotton Cultivation Systems: Better Cotton, Conventional Cotton and Organic Cotton.

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Fabric (Natural – global cotton)

- 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.
- PARCL. Approximate Weight of Goods. Education Center, Approximate Weight of Goods.
- 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

- No Nasties proprietary data

List of sources

Fabric (Knit)

- 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.

List of sources

Fabric (Weave)

- “Cotton GSM.” ARKET, 2018, www.arket.com/en_eur/c/cs-cotton-gsm.html.
- 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.

List of sources

Transport (Global/ Quantis) & (Country specific) & (No 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/.

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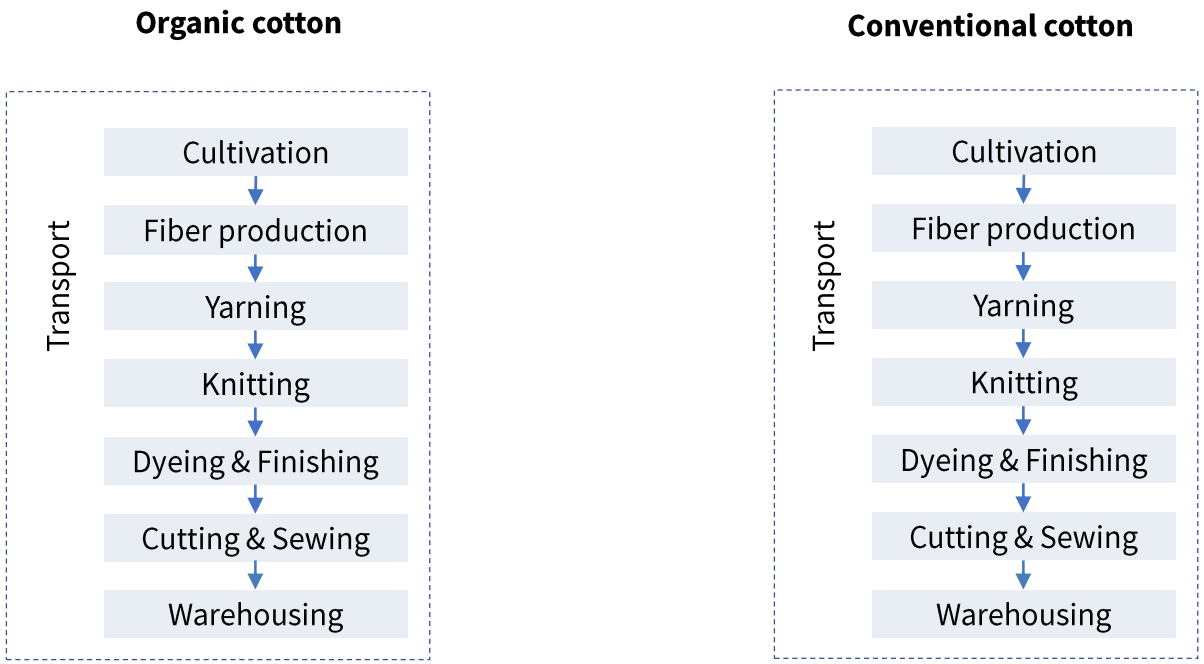
Transport (Cotton)

- 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.

Organic Cotton vs Conventional Cotton Comparative Impact Calculation Results

System boundary



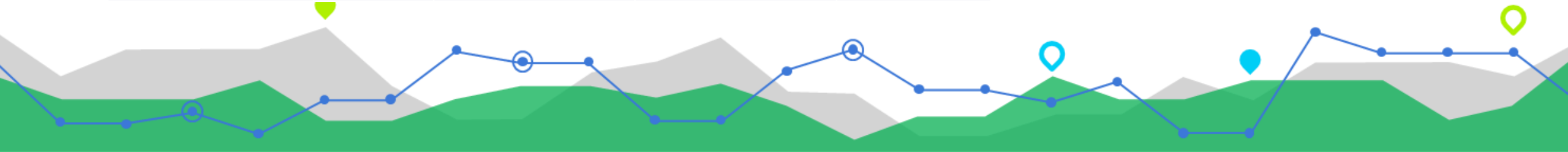
Organic Cotton vs. Conventional Cotton comparative LCI (per kg of clothing)

Net impact difference (knit)

Per kg of apparel	Unit	Organic Cotton	Conventional Cotton	Percentage lower
GHG emissions	kgCO2e	24.98	26.33	-5%
Energy	MJ	364.60	447.20	-18%
Water consumption	litres	447.10	1206.00	-63%

Net impact difference (weave)

Per kg of apparel	Unit	Organic Cotton	Conventional Cotton	Percentage lower
GHG emissions	kgCO2e	35.07	36.43	-4%
Energy	MJ	516.80	600.30	-14%
Water consumption	litres	482.30	1248.00	-61%



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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