PRESENTATION

Session:
A Wider View

Title:
Sustainable Cotton Production Systems

Speaker:
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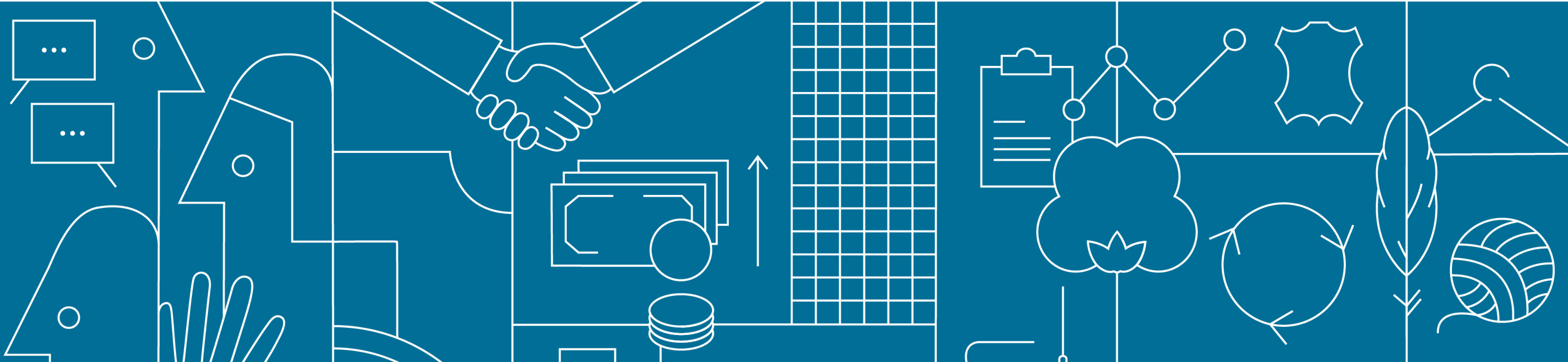
Partnership for Sustainable Textiles

Bremen Cotton Conference

20th March 2024, A wider view



Sustainable Cotton Production Systems

and their nuances – the case of environmental sustainability

Guiding information for retailers, brands and other buyers

Jens Soth, HELVETAS Swiss Intercooperation

Partnership for Sustainable Textiles
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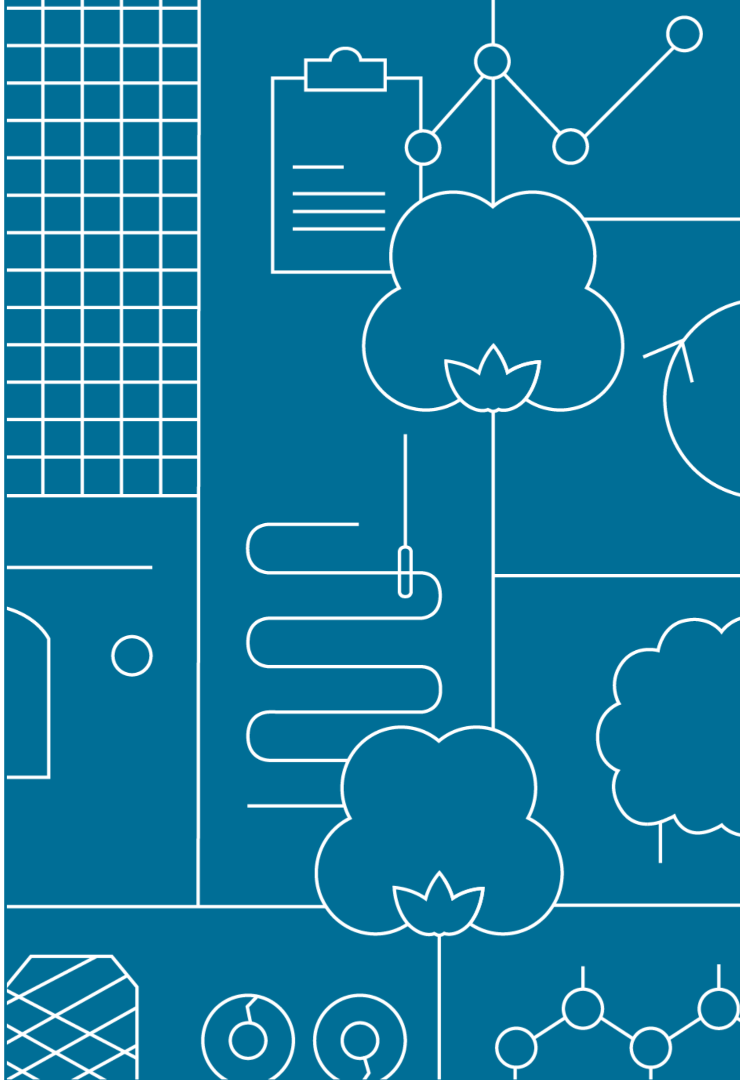
INA Initiative für nachhaltige Agrarlieferketten
HELVETAS Swiss Intercooperation

Components of today's presentation

1. **Idea of the study project presented and key questions**
2. **LCAs as methodical approach and its limitations**
3. **Overview of results**
4. **Conclusions and recommendations**

TOP 1
Idea of the study project presented and key questions



Entry point for the study and fact sheet work

Partnership for Sustainable Textiles

«Cacophonia» of irritating and contradictory statements about the sustainability of textiles and fibres

- Demand to have updated overview material as quick reference → **Fact-Sheets generated from this study**
- Search for comprehensible and neutral information about differences of standards and labels → **Ad hoc: Add-on to fact-sheets; long-term: updated Siegelklarheit.de platform**
- Interest in understanding the nuances of sustainable cotton production systems → **Compile actually applied agricultural practices**
- Guidance to find the best purchase options (from environmental perspective) → **Filter our comparable LCAs and extract environmental data**

Important methodical difference

Most of the literature, websites, brochures look at the theory of standards.

Our study looks at the real implementation and thus ex-post collected data and identified environmental impacts!

Key questions for the LCA component

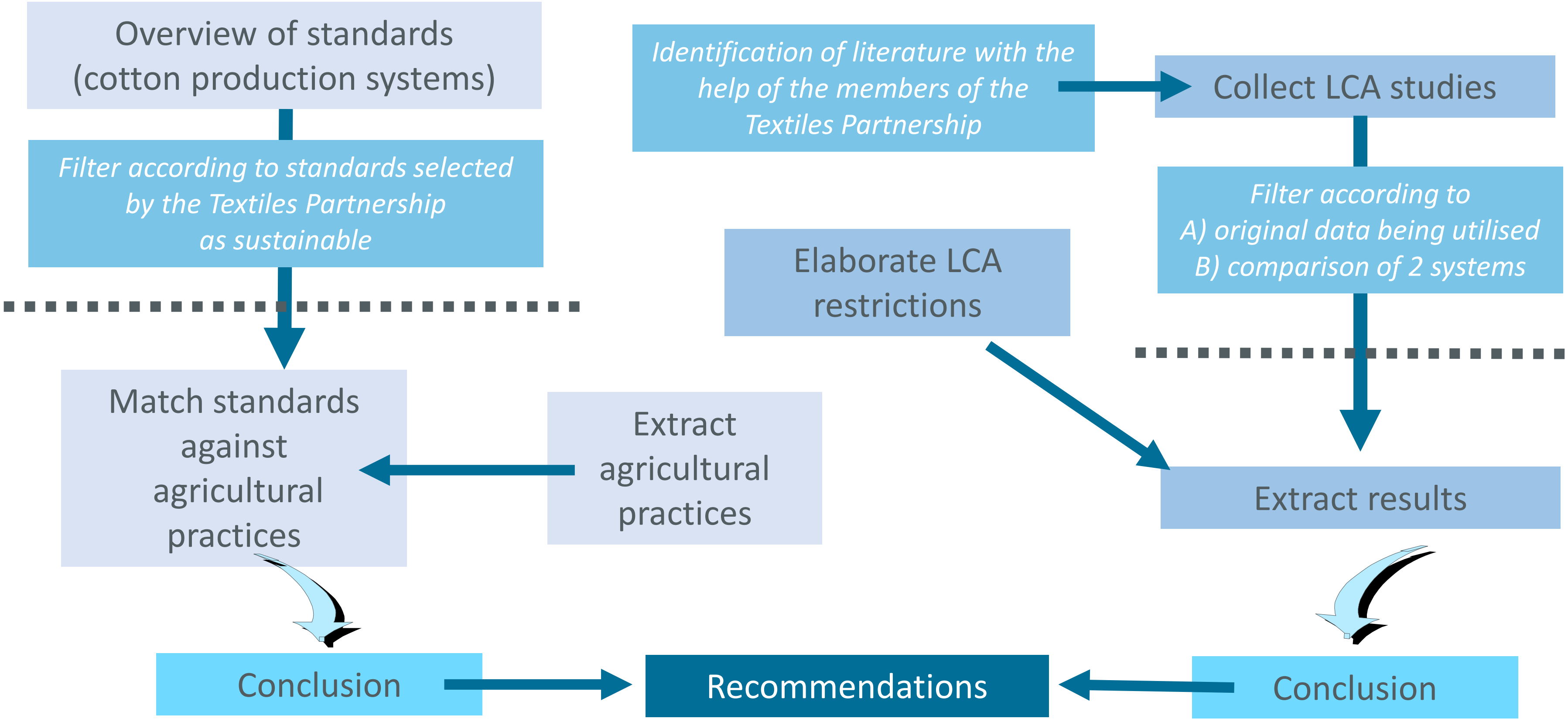
Does the theory of the standards translate into field level practice?

Or more specific for the environmental aspects:

Is there a proof for environmental improvements by following the sustainable cotton production guidance?

Are there differences between the standards?

Structure and working steps



Key elements of agricultural practices occurring in most sustainable cotton standards


Organic fertilizers and judicious fertilizer management


Locally adapted crop rotations

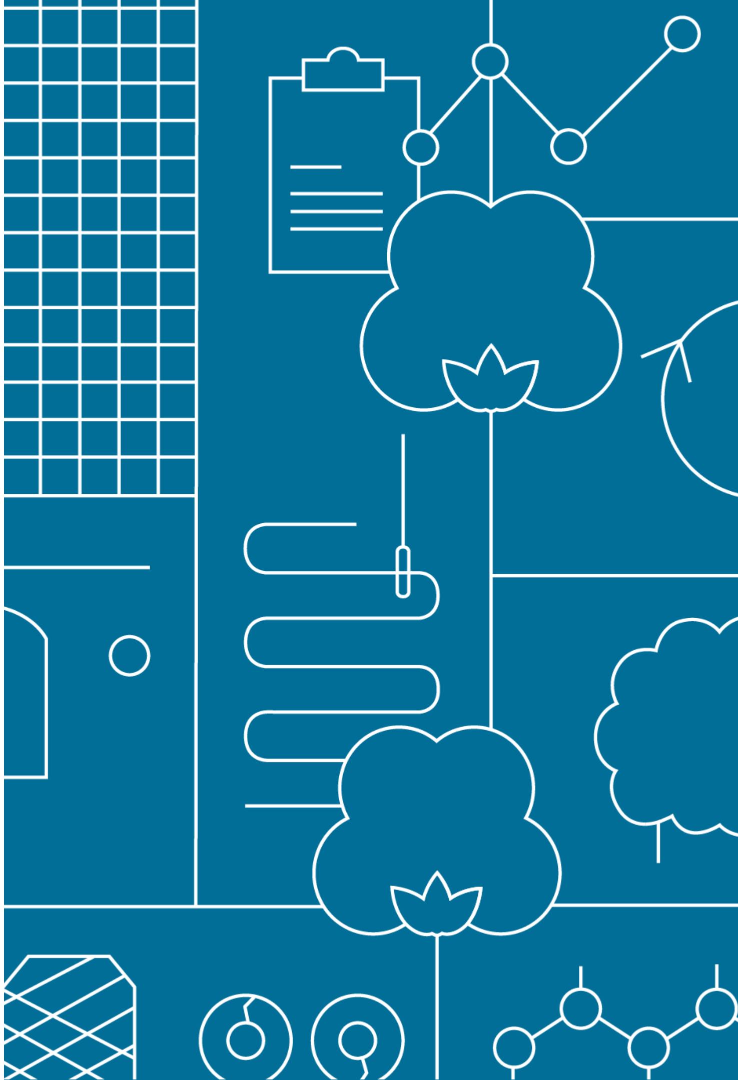
Photo: Dr. Shafiq Ahmad, BCI Pakistan

Underseeded wheat in cotton

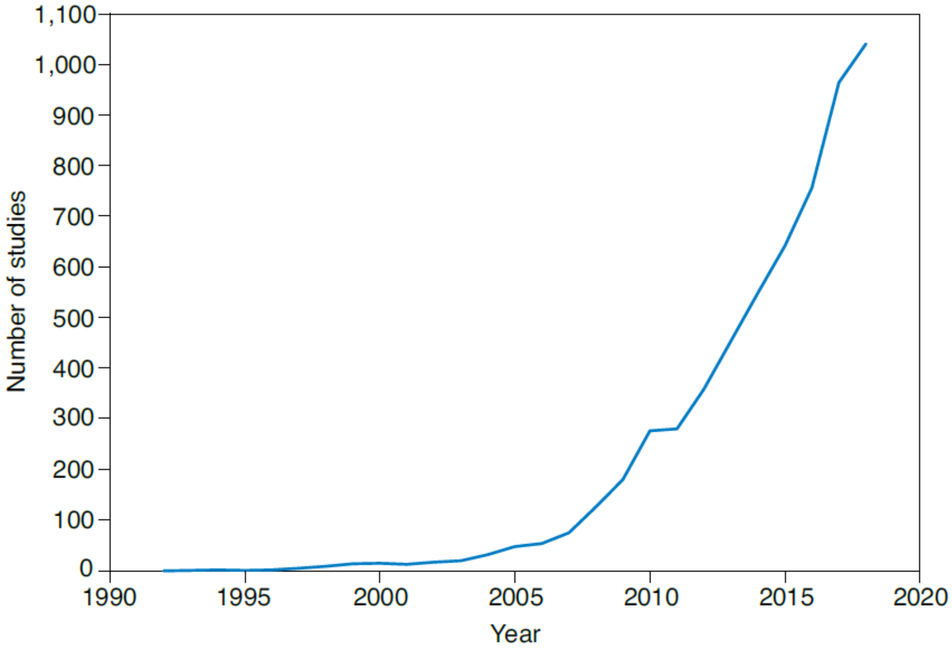

Biocontrol for environmental sound crop management


Soil health management

TOP 2
Ökobilanzen (=LCA) as methodical approach and its limitations



LCA as tool – “proliferation graph”



Attention:
This entails all industry sectors, NOT only textiles

Source: van der Werf 2019

Environmental risks and impacts of cotton

Key sector risks as identified by OECD

- Hazardous chemicals (pesticides)
- Water consumption
- Fertilizers
- Energy & fuel for machinery
- Chemicals (plant growth regulators, defoliants)
- Land use

- Greenhouse Gases (GHG)
- Water pollution
- Soil erosion (Eutrophication)
- Acidification
- Toxicity
- Biodiversity loss
- Soil fertility loss

LCA as tool - restrictions

Pitfall 1: Agriculture is an open system

Pitfall 2: Cotton has particularly broad variation of data

Pitfall 3: Mixing of data should be avoided , but is common

Pitfall 4: Impacts not accounted for

Pitfall 5: Benefits not accounted for

Social aspects are not assessed or taken into account at all in LCAs

Example Pitfall 1: Agriculture as open system

Closed systems:

LCAs for chemical engineering

Replicable and controlled conditions (temperature, moisture, pressure, etc.)

Open system with broad variations with regard to influencing factors:

LCAs for agricultural systems

Temperature

Rainfall

Pest pressure

Conclusion: Much higher variations from farm to farm and season to season than LCAs usually have to deal with

Example Pitfall 2: Cotton has particular broad variation of data

Example Pitfall 3: Mixing of data from different sources is common

Example Pitfall 4: Impacts not accounted for

ELSEVIER
Marine Pollution Bulletin
Volume 112, Issues 1–2, 15 November 2016, Pages 39-45

Release of synthetic microplastic plastic fibres from domestic washing machines: Effects of fabric type and washing conditions

Imogen E. Napper, Richard C. Thompson

Show more

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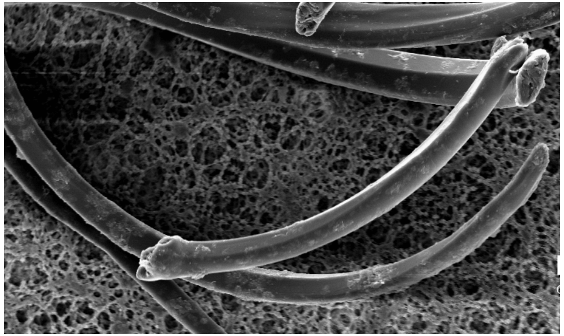
https://doi.org/10.1016/j.marpolbul.2016.09.025 Get rights and content

Highlights

- Washing clothes made from synthetic materials is a potentially important source of microplastic into the environment.
- This study examined the release of fibres from common fabrics; polyester, polyester-cotton blend and acrylic.
- Fibre release varied according to wash treatment with various complex interactions.
- For an average wash load of 6 kg, over 700,000 fibres could be released per wash.



OCEANS

Microplastics in the seas

Concern is rising about widespread contamination of the marine environment by microplastics

By **Kara Lavender Law**[1] *and* **Richard C. Thompson**[2]

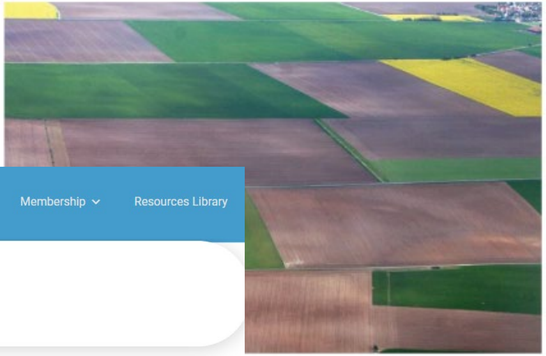
10.1126/science.1254065

11 JULY 2014 • VOL 345 ISSUE 6193 145

Example Pitfall 5: Beneficial aspects not accounted for

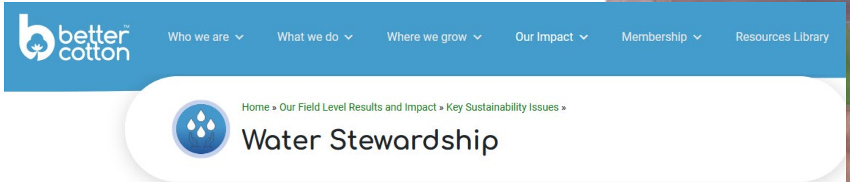
Image source: van der Werf 2019

a



b

Diversified, resilient landscape with high recreational value



Advantages of collective action for water stewardship

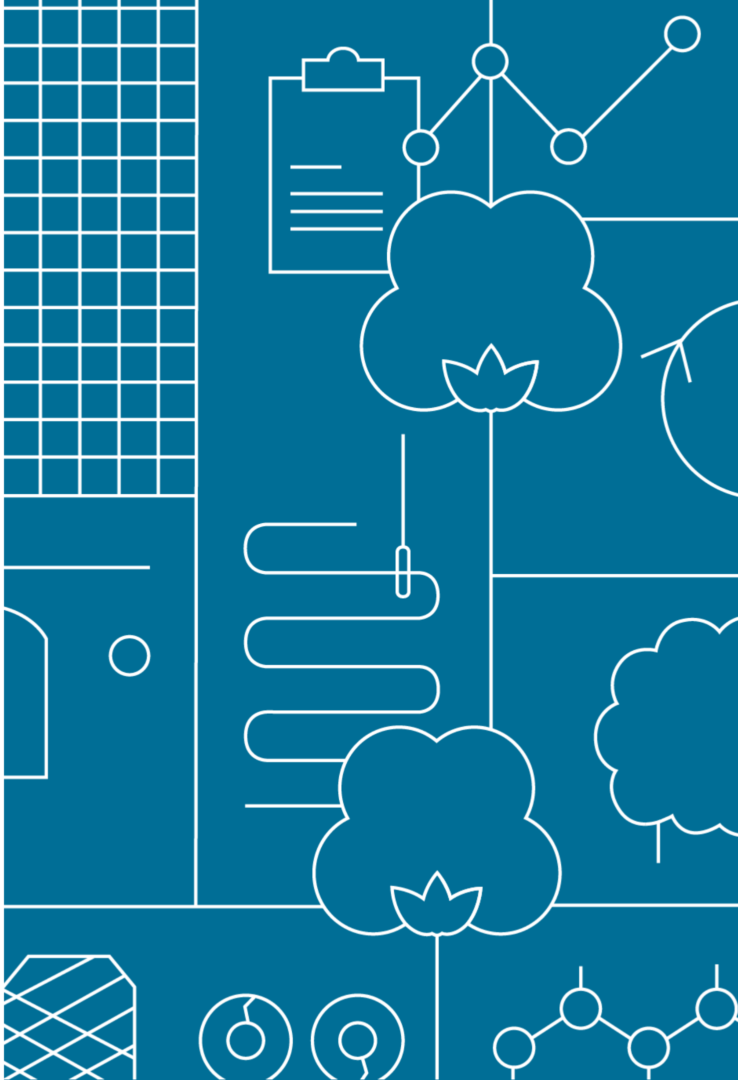
LCA as tool - restrictions

Pitfall 1: Agriculture is an open system
Pitfall 2: Cotton has particularly broad variation of data
Pitfall 3: Mixing of data should be avoided , but is common
Pitfall 4: Impacts not accounted for
Pitfall 5: Benefits not accounted for

Conclusions:

- LCAs require a lot of caution with regard to the generalization and transfer of their results
- LCAs do not give the full picture of environmental issues and particularly do not reflect benefits of production systems

TOP 3
Overview of results

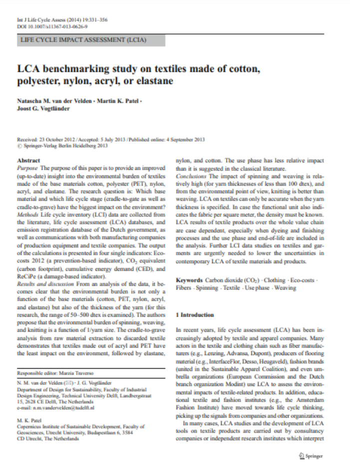


Collection of textile and cotton LCAs

More than More than 80 scientific articles or studies since 1999

39 studies have utilised original field data

11 studies allowed comparisons between standards


Int J Life Cycle Assess (2014) 19:331–356
DOI 10.1007/s11367-013-0626-9

LIFE CYCLE IMPACT ASSESSMENT (LCIA)

LCA benchmarking study on textiles made of cotton, polyester, nylon, acryl, or elastane

Natascha M. van der Velden · Martin K. Patel · Joost G. Vogtländer

Received: 23 October 2012 / Accepted: 5 July 2013 / Published online: 4 September 2013

Abstract
Purpose The purpose of this paper is to provide an improved (up-to-date) insight into the environmental burden of textiles made of the base materials cotton, polyester (PET), nylon, acryl, and elastane. The research question is: Which base material and which life cycle stage (cradle-to-gate as well as cradle-to-grave) have the biggest impact on the environment?
Methods Life cycle inventory (LCI) data are collected from the literature, life cycle assessment (LCA) databases, and emission registration database of the Dutch government, as well as communications with both manufacturing companies of production equipment and textile companies. The output of the calculations is presented in four single indicators: Eco-costs 2012 (a prevention-based indicator), CO_2 equivalent (carbon footprint), cumulative energy demand (CED), and ReCiPe (a damage-based indicator).
Results and discussion From an analysis of the data, it becomes clear that the environmental burden is not only a function of the base materials (cotton, PET, nylon, acryl, and elastane) but also of the thickness of the yarn (for this research, the range of 50–500 dtex is examined). The authors propose that the environmental burden of spinning, weaving, and knitting is a function of 1/yarn size. The cradle-to-grave analysis from raw material extraction to discarded textile demonstrates that textiles made out of acryl and PET have the least impact on the environment, followed by elastane, nylon, and cotton. The use phase has less relative impact than it is suggested in the classical literature.
Conclusions The impact of spinning and weaving is relatively high (for yarn thicknesses of less than 100 dtex), and from the environmental point of view, knitting is better than weaving. LCA on textiles can only be accurate when the yarn thickness is specified. In case the functional unit also indicates the fabric per square meter, the density must be known. LCA results of textile products over the whole value chain are case dependent, especially when dyeing and finishing processes and the use phase and end-of-life are included in the analysis. Further LCI data studies on textiles and garments are urgently needed to lower the uncertainties in contemporary LCA of textile materials and products.

Keywords Carbon dioxide (CO_2) · Clothing · Eco-costs · Fibers · Spinning · Textile · Use phase · Weaving

1 Introduction

In recent years, life cycle assessment (LCA) has been increasingly adopted by textile and apparel companies. Many actors in the textile and clothing chain such as fiber manufacturers (e.g., Lenzing, Advansa, Dupont), producers of flooring material (e.g., InterfaceFlor, Desso, Heugaveld), fashion brands (united in the Sustainable Apparel Coalition), and even umbrella organizations (European Commission and the Dutch branch organization Modint) use LCA to assess the environmental impacts of textile-related products. In addition, educational textile and fashion institutes (e.g., the Amsterdam Fashion Institute) have moved towards life cycle thinking, picking up the signals from companies and other organizations.

In many cases, LCA studies and the development of LCA tools on textile products are carried out by consultancy companies or independent research institutes which interpret

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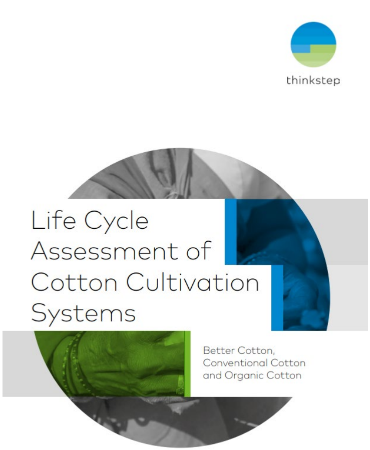
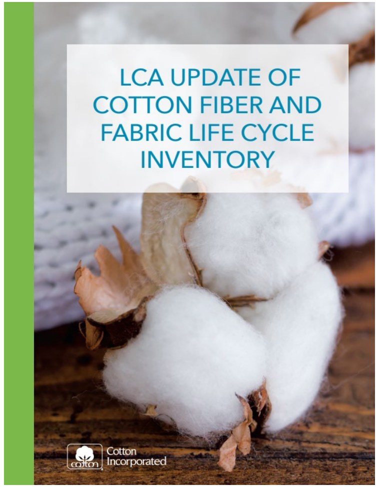
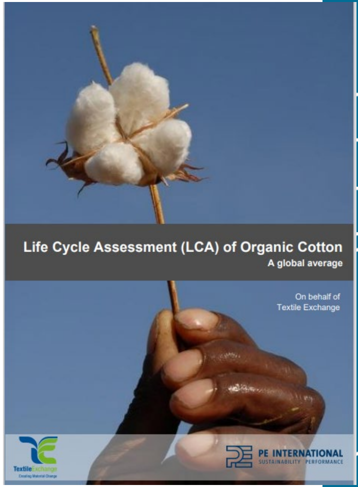






“Filtering” of textile and cotton LCAs – example of the method

Filter criterion 1 → Operating with original Data

Filter criterion 2 → Conventional cotton; Organic

Year	Author	impact category or LCA (if more than 3 impact categories)	Products resp. functional unit	Operating with original Data	Year of collection	Country of cotton production	Conventional cotton (= no specified farming system or standard)	Organic	BCI	CmiA
2013	Cardoso	LCA	wool and cotton yarn	yes	2011		x	x		
2013	Nalley et al.	GHG	cotton, pound - GMO, non GMO	yes	1997, 2005, 2008	US (Arkansas)	x			
2013	Aid by Trade Foundation	Carbon and water footprint	cotton, 1 kg lint	yes	??	CmiA countries, var. Cotton	x			x
2013	WWF India and WWF UK	GHG	kg CO2e / ha ; kg CO2e / kg seed cotton	yes	2010	India (Warangal district)	x		(x)	
2014	van der Velden, Patel and Vogtländer	LCA	textiles, PE cotton , nylon, elastane	yes	2011-2012		x			

Comparing cotton LCAs – example of method

Colour code for the cells:

Sustainable cotton better	No comparison possible	Sustainable cotton and conventional equal	Sustainable cotton worse

Publication year	2015	2016	2018, 2019	2021	2021
Author	Baydar, Ciliz and Mammadov	Cotton Incorporated	C&A Foundation, Shah, Bansal and Sing (same data, different publications)	Aid by Trade Foundation (utilising Cotton Inc 2016 as benchmark	Fidan, F. , Aydogan, E. and Uzal, N.
Products resp. functional unit	T-Shirt, conventional and eco	cotton, MT fiber and 1000kg of finished garment	1 MT seed cotton at farm gate	1 t of fibre at gin gate	1 sqm denim fabric
Country of cotton production	Turkey	US, China, India , Australia	India	RCI, Zambia, Cameroon	Turkey
Standards	Organic, conventional	Conventional benchmarking basis	Organic, BCI, conventional	CmiA, conventional (Cotton Inc 2016 as benchmark)	Organic, conventional
Relevant results	Organic T-shirt lower emissions in all impact categories	Highest impact throughout all impact categories from use phase followed by industrial processes	The only study that compares the systems organic, BCI conventional cotton in a defined region and thereby allowing direct comparisons	Rather than benchmarking, the study focused on the identification of hotspots for improvements	The study compared organic and conventional textile for a broad range of impact categories. Significantly lower impacts throughout all categories for the organic textile were proven

Results of LCA comparison: Visual impression

Colour code for the cells: Sustainable cotton better | No comparison possible | Sustainable cotton and conventional equal | Sustainable cotton worse

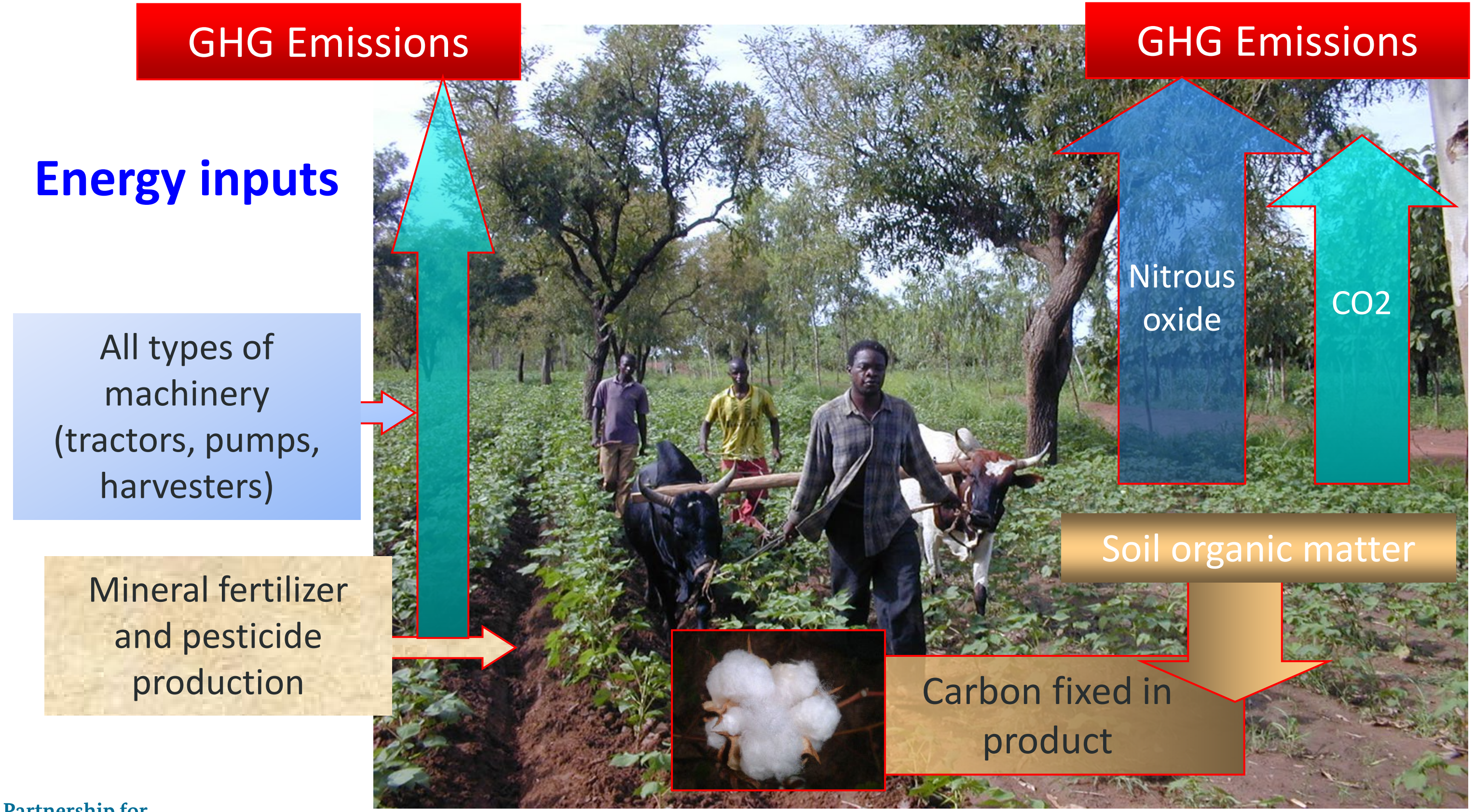
A	B	C	D	E	F	G	H	I	J	K	L
Publication year		2013	2013	2013	2014	2014	2015	2016	2018, 2019	2021	2021
Author	Data (unit)	[illegible]	Aid by Trade Foundation	WWF India and WWF UK	Cotton made in Africa	Textile Exchange	Baydar, Ciliz and Mammadov	Cotton Incorporated	C&A Foundation, Shah, Bansal and Singh (same data, different publications)	Aid by Trade Foundation (utilizing Cotton Inc 2016 as benchmark)	Fidan, F., Aydoğan, E. and Uzal, N.
Products resp. functional unit		[illegible] yarn, but for cotton also 1 [illegible]	cotton, 1 kg lint	kg CO2e / kg; kg CO2e / kg seed cotton	cotton, 1 MT lint	cotton, 1 MT lint	T-Shirt, conventional and eco	[illegible] 1000kg of finished [illegible]	1 MT seed cotton at farm gate	1 t of fiber at gin gate	1 sqm denim fabric
Country of cotton production		Tajikistan	Benin, Burkina Faso, Cote d'Ivoire, Malawi, Mozambique, Zambia, Cameroon	India (Warangal district)	Zambia, Ivory Coast	India, Turkey, China, US, TZ	Turkey	US, China, India, Australia	India	RCI, Zambia, Cameroon	Turkey
Standards		Organic, conventional	CmiA, conventional	BCI (a BmP predecessor), conventional	CmiA, conventional (Cotton Inc 2012 as benchmark)	Organic, conventional (Cotton Inc 2012 as benchmark)	Organic, conventional	Conventional benchmarking basis	Organic, BCI, conventional	CmiA, conventional (Cotton Inc 2016 as benchmark)	Organic, conventional
Relevant results		Organic has lower impact throughout all impact categories, except human toxicity, where a high amount of heavy metals was calculated due to the use of chicken manure	Study focused on the impact categories water and GHG	Fertiliser management highly relevant for GHG reduction. Thus BCI system very appropriate to lower Carbon footprint of cotton	Erosion control scenario applied revealed high potential to further reduce eutrophication potential	Driving factors for eutrophication impact are erosion and nutrient leaching - thus organic system regarded as advantageous	Organic T-shirt lower emissions in all impact categories	Highest impact throughout all impact categories from use phase followed by industrial processes	The only study that compares the systems organic, BCI conventional cotton in a defined region and thereby allowing direct comparisons	Rather than benchmarking, the study focused on the identification of hotspots for improvements	The study compared organic and conventional textile for a broad range of impact categories. Significantly lower impacts throughout all categories for the organic [illegible]
GHG	Key results	Lower impact due to avoidance of fertilisers and pesticides	CmiA GHG emissions significantly lower due to differences in farming system	Emissions resulting from fertilisers are main driver of GHG emissions	Lower carbon footprint due to lower inputs and lower mechanisation	Lower carbon footprint (benchmarked against Cotton Inc 2012) of the organic system due to lower inputs (no synthetic fertilisers or pesticides)	Global warming potential highest relevance for conventional and organic T-Shirt in use phase as major factor followed by cotton production	Highest GHG emissions due to use phase followed by industrial processes	Strong reduction of GHG emissions in organic due to lower inputs; lower emission of BCI due to controlled inputs	Lower GHG emissions due to lower and controlled inputs	Lower GHG emissions for organic fabric
GHG (actual data)	kg CO2 equivalent	conventional: 2.33 kg Ce / kg lint organic: 0,537 kg Ce / kg lint	1.92 to 4.64 Ce / kg lint	conventional: 1.5 kg Ce / kg seed cotton better management: 0.45 Ce / kg seed cotton	1,037 kg Ce / kg for CmiA cotton lint compared to 1,800 Ce / kg conventional cotton	0,970 kg Ce / kg for organic cotton lint compared to 1,800 Ce / kg conventional cotton	75% reduction of GHG for Eco T-Shirt		In CO2e per 1000 kg seed cotton: Organic 295 BCI 455 conv 731	Farm to gin gate: CmiA: 1,24 kg / 1000 kg lint Conventional: 1,45 kg / 1000 kg lint	In kg CO2e per sqm fabric: organic: 3,34 conventional: 4,28
Water Consumption	Key results	Blue water calculation (irrigation water)	Rainfed stated as advantageous as compared to the irrigated systems of the benchmark of Cotton Inc 2012 compared to irrigated cotton			Rainfed stated as advantageous as compared to the irrigated systems of the benchmark of Cotton Inc 2012 compared to irrigated cotton			Blue water consumption calculated (irrigation water)	Blue water (irrigation water) calculated, thus rainfed in CmiA has "0"	
Water consumption (actual data)	litres of water equivalent	Conventional: 1,29 m3 / kg lint Organic: 0,34 m3 / kg lint	11 m3 (CmiA) to 13.3 m3 (green water)						In m3 per 1000 kg seed cotton: Organic 331 BCI 333 conventional 511	CmiA: 0 Conventional: 1563 m3 per 1000 kg lint	
Toxicity (Ecotoxicity and / or Human toxicity)	Comparative Toxic Units (CTU)	Higher amount of toxicity (cancer effect) organic due to heavy metal in chicken manure (not verified locally) lower amount of toxicity for non-cancer effects				Toxicity models explained and avoidance of pesticides emphasized, but no data given					Human toxicity, fresh aquatic ecotoxicity, marine aquatic ecotoxicity and terrestrial ecotoxicity
Eutrophication	Kg of PO4 equivalent	conventional: 0,00243 kg PO4e / kg lint organic: 0,00201 kg PO4e / kg lint			2,04 kg PO4 / kg CmiA lint cotton, but corresponding data re. soil erosion highly uncertain	2,0 in organic as compared to 3.0 PO4e per 1000 kg lint conventional	37% reduction as compared to conventional due to avoidance of synthetic fertilisers		In kg PO4e per 1000 kg seed cotton organic: 0,46 BCI: 2.43 conventional: 731	CmiA: 0,017 kg PO4e conventional: 0,000 kg PO4e	In kg PO4e / sqm fabric: 0,0020 conventional 0.0015 organic
Acidification	kg of SO2 equivalent	Organic has lower impact albeit not international common soil limits comparability			For field to gin life cycle: Field emissions most relevant factor for acidification as compared to gin and transport	5,07 kg SO eq / 1000 kg lint as compared to 18.7 SO eq / 1000 kg lint conventional			In kg SO2e per 1000 kg seed cotton organic: 5,34 BCI: 12,14 conventional: 14,06	CmiA: 0,020 kg SO2e conventional: -,026 kg So2e	In kg SO2e / sqm fabric: 0,0120 conventional 0.0057 organic
Further impact categories assessed		Ozone depletion, marine eutrophication				Primary energy demand		• Photochemical Ozone Creation Potential • Ozone Depletion Potential • Human Health Particulate Air		Biodiversity Scenarios for soil carbon stocks	abiotic depletion, abiotic depletion fossil fuels, ozone layer depletion, photochemical oxidation

Results of LCA comparison: Detailed look on GHG

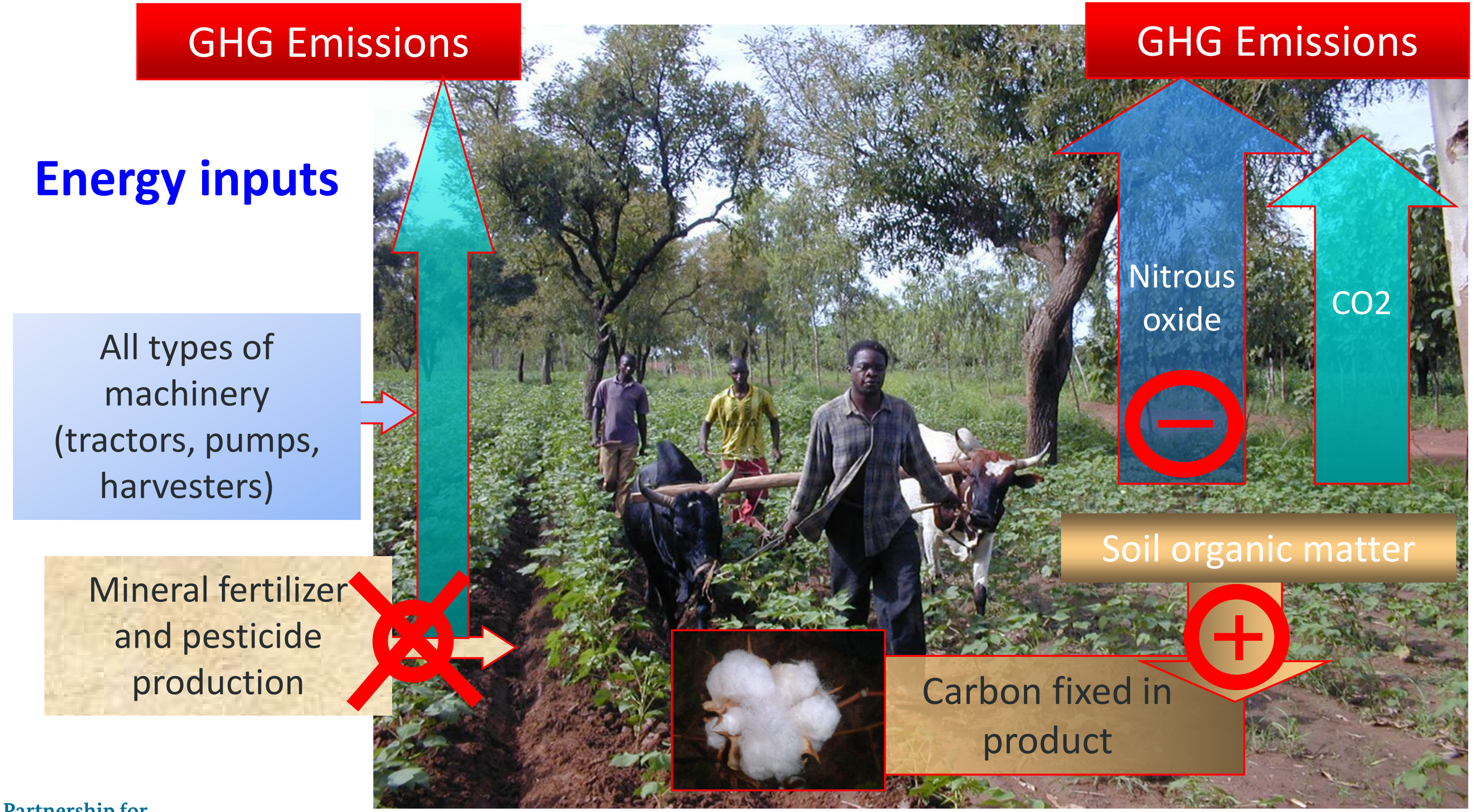
Colour code for the cells: Sustainable cotton better | No comparison possible | Sustainable cotton and conventional equal | Sustainable cotton worse

GHG	Key results	Lower impact due to avoidance of fertilizers and pesticides	CmiA GHG emissions significantly lower due to difference in farming system	Emission resulting from fertilizers are main driver of GHG emissions	Lower carbon footprint due to lesser inputs and lesser mechanization	Lower carbon footprint (benchmarked against Cotton Inc 2012) of the organic system due to lesser inputs (no synthetic fertilizers or pesticides)
GHG (actual data)	kg CO2 equivalent	conventional: 2.93 kg Ce / kg lint organic: 0,597 kg Ce / kg lint	1.92 to 4.64 Ce /kg lint	conventional:1.5 kg Ce / kg seed cotton better management :045 Ce / kg seed cotton	1,037 kg Ce / kg for CmiA cotton lint compared to 1,808 Ce / kg conventional cotton	0,978 kg Ce / kg for organic cotton lint compared to 1,808 Ce / kg conventional cotton

Major GHG components in cotton production



Major GHG components in cotton production

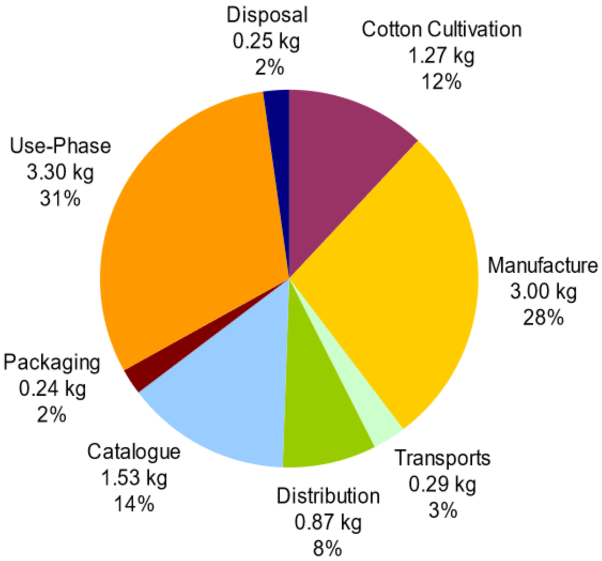


GHG conclusions from LCA assessment

What is the functional unit – cotton or Textile?

- If you look at GHG and energy use of a textile, bear in mind that the hotspots of GHG footprint of a textile are
  a) in the use phase
  b) in the wet processing stages

- All sustainability standards that take care of a judicious management of inputs will fare much better



Source: Jungmichel 2010

- For small-farmer the adaptation is much more relevant than the mitigation

- Organic advantages could be lost by farmers handling manure or water unwisely

Results of LCA comparison: Detailed look on Water

Colour code for the cells: | Sustainable cotton better | No comparison possible | Sustainable cotton and conventional equal | Sustainable cotton worse

Water Consumption	Key results	Blue water calculation (irrigation water)	Rainfed stated as advantageous as compared to the irrigated systems of the benchmark of Cotton Inc 2012 compared to irrigated cotton			Rainfed stated as advantageous as compared to the irrigates systems of the benchmark of Cotton Inc 2012 compared to irrigated cotton
Water consumption (actual data)	litres of water equivalent	Conventional: 1,29 m3 / kg lint Organic: 0,94 m3 / kg lint	14 m3 (CmiA) to 13.3 m3 (green water)			

Water consumption: Conclusion from LCA assessment

<u>Individual behaviour of farmer more relevant than differences between the standards</u>

- Water stewardship in place is the key aspect for the local water challenges
- Water stewardship is relevant for irrigated areas, but fully underestimated for rainfed areas
- Standards have a key role to implement water stewardship and train farmers on water saving practices
- Usually water savings of 20 to 40 % can be realized, with simple means, if the farmer can be incentivized
- Water quality is frequently overlooked in the water debate. Standards and organic have a very relevant role for that

Summary of results in a nutshell Slide 1 of 2

1. Methodically properly conducted LCAs show: sustainable cotton initiatives (organic, BCI and CmiA) lower the environmental impact of cotton production when benchmarked to conventional peers.

2. The driving factor for better environmental performance: thoughtful and well managed utilization of agro-chemicals

3. Fairtrade was not included in the identified LCAs.
   As also the Fairtrade system has a focus on judicious use of fertilizers and pesticides,
   it can be assumed, that the environmental performance is likewise better as conventional peers.

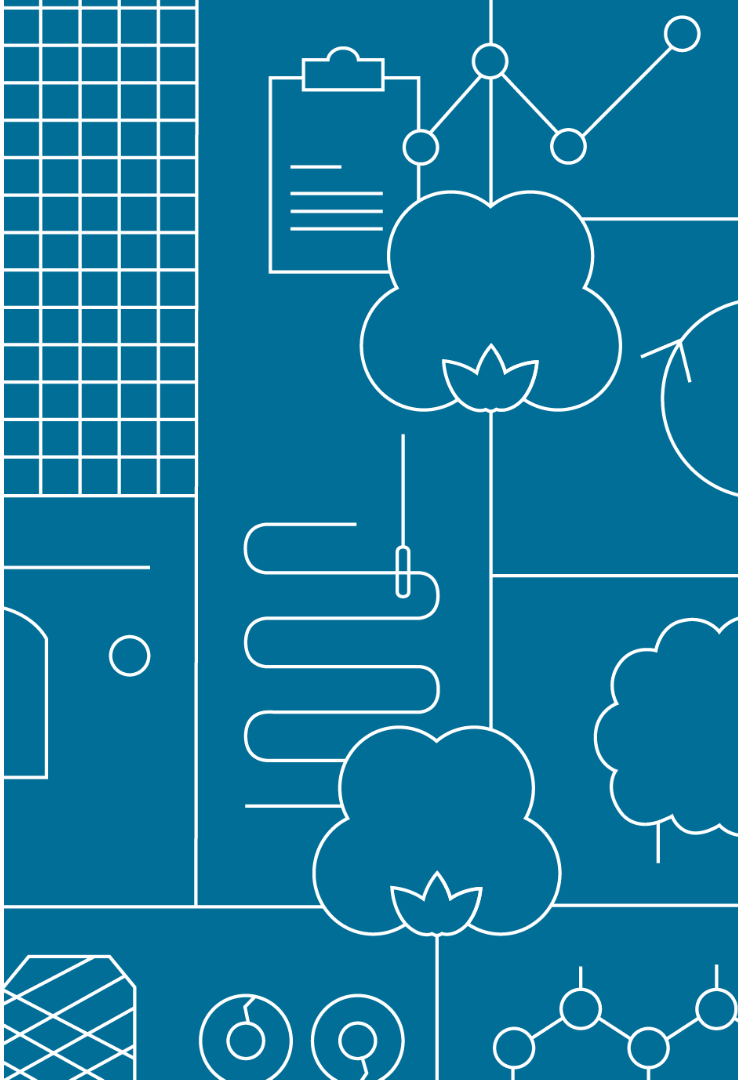
Summary of results in a nutshell Slide 2 of 2

4. The only existing comparative LCA that evaluates organic, BCI and conventional cotton production can additionally prove that organic has the lowest environmental impact at least for the regional context the study was referring to.

5. The LCA data regarding toxicity are very incomplete. Doubtless organic would fare better, when proper toxicity comparisons would be conducted.

6. Water consumption as impact category is handled in very different ways and thus hardly to compare legitimately.
   Water stewardships in place (as done in BCI and CmiA) might be more relevant than the blue water footprint.

TOP 4
Conclusions and recommendations



Recommendations

- **Engage in the sustainable cotton sector**
  Rather than getting lost in differences between the standards a targeted engagement for sustainable cotton is key.

  The Textiles Partnership standard recognition process gives space for the selection of relevant standards. Each standard contains different levels of social aspects, toxicity, water, climate, etc.

- **Embrace, support and demand data collections and compilations**
  Demanding, understanding and working with supply-chain data, particularly field and farmer data could bring benefits to the sector.
  - For the fibre production sector:
    - Continuous improvement
  - For the textile sector:
    - Due Diligence and risk management for supply-chain regulations becomes easier and more tangible
    - Long-term averages to be included into processing data or blockchains
    - Good basis to inform consumers and risk management for supply-chain regulations

Partnership for Sustainable Textiles

Partnership for Sustainable Textiles

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