THE LIFE CYCLE ASSESSMENT OF ORGANIC COTTON FIBER

- A GLOBAL AVERAGE

SUMMARY OF FINDINGS

TextileExchange

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CONTENTS

The Life Cycle Assessment (LCA) of Organic Cotton Fiber was commissioned by Textile Exchange. PE INTERNATIONAL conducted the research.

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> *“Every production system has impacts. But, encouragingly, there is evidence that the entire cotton industry is responding to the challenges it faces in terms of environmental, social and economic sustainability.*
>
> *Our goal at Textile Exchange is to promote the continued shift to greater stewardship of resources. We encourage the adoption of approaches, such as organic, that offer alternatives to resource-intensive agricultural systems and techniques that can be adopted by the industry.*
>
> *On behalf of over one million farmers who have invested in organic farming, and in support of the future growth of the organic cotton sector, we embarked upon a robust Life Cycle Assessment so that we are now able to quantify the benefits of organic cotton production systems.”*

La Rhea Pepper, Managing Director, Textile Exchange

INTRODUCTION

As the textile industry becomes increasingly active in sustainability initiatives, cotton – one of the primary raw materials – has gained a lot of attention. Recently, an in-depth and peer-reviewed study of conventional cotton, from farming to textile manufacturing, was published (Cotton Inc. 2012). The study published the life cycle inventory of conventional cotton fiber, representative of global production. Having a reliable inventory and impact assessment for conventional cotton on hand, the textile community has requested a similar study to provide data on organic cotton cultivation. Textile Exchange (TE) answered this industry need with an impartial, credible and vetted study, conducted by PE INTERNATIONAL. As TE is a non-profit organization, funding was comprised of commitments from a number of significant leaders in the sustainable textile industry.

The goal of this study was to build an up-to-date and well-documented Life Cycle Inventory (LCI) for organic cotton fiber (ginned and baled), representative of worldwide global production. In addition, the study provides a full Life Cycle Impact Assessment (LCIA) of organic cotton fiber (comprising cultivation and ginning operations) and identifies environmental hotspots. To the effect of achieving these goals the relevant ISO standards 14040 and 14044 were followed. The process was verified by an accompanying independent critical review process.

The data represent an aggregated average Life Cycle Inventory of global organic cotton fiber production. While data was collected from a number of countries, the study does not compare the impact of organic cotton production between countries or within regions in countries. This study does also not intend to conduct a comparative assertion as defined in the ISO standard (14040 series). Available published data on conventional cotton is used to set the results of the presented study into perspective, for discussion and interpretation.

METHODOLOGY

This study is based on primary data from producer groups located in the top five countries of organic cotton cultivation (India, China, Turkey, Tanzania, USA, respectively). These five countries account for 97 percent of global production (Textile Exchange, 2014).

The Life Cycle Assessment (LCA) model was set up using the GaBi 6.3 Software system, the functional unit being 1,000 kilograms (kg) of lint cotton at the gin gate.

Data Collection

Primary data for organic cotton cultivation was coordinated by Textile Exchange. PE INTERNATIONAL developed the questionnaires, specifically adapted to collect inventory data for agricultural systems, and directly managed the data collection process. The questionnaires were completed by local consultants or directly by representatives of producer groups. Upon return to PE INTERNATIONAL, the data was quality checked and benchmarked against literature and other primary cultivation data to ensure reliable results.

A full evaluation of the technological, geographical, and time reference, as well as an assessment of data quality can be found in the full report. In summary, the overall data quality using the Data Quality Rating (DQR) suggested by ILCD 2011, would result in an overall data quality indicator of “good” (2.4), giving a score of good to geographical representativeness, to methodological appropriateness and to consistency.

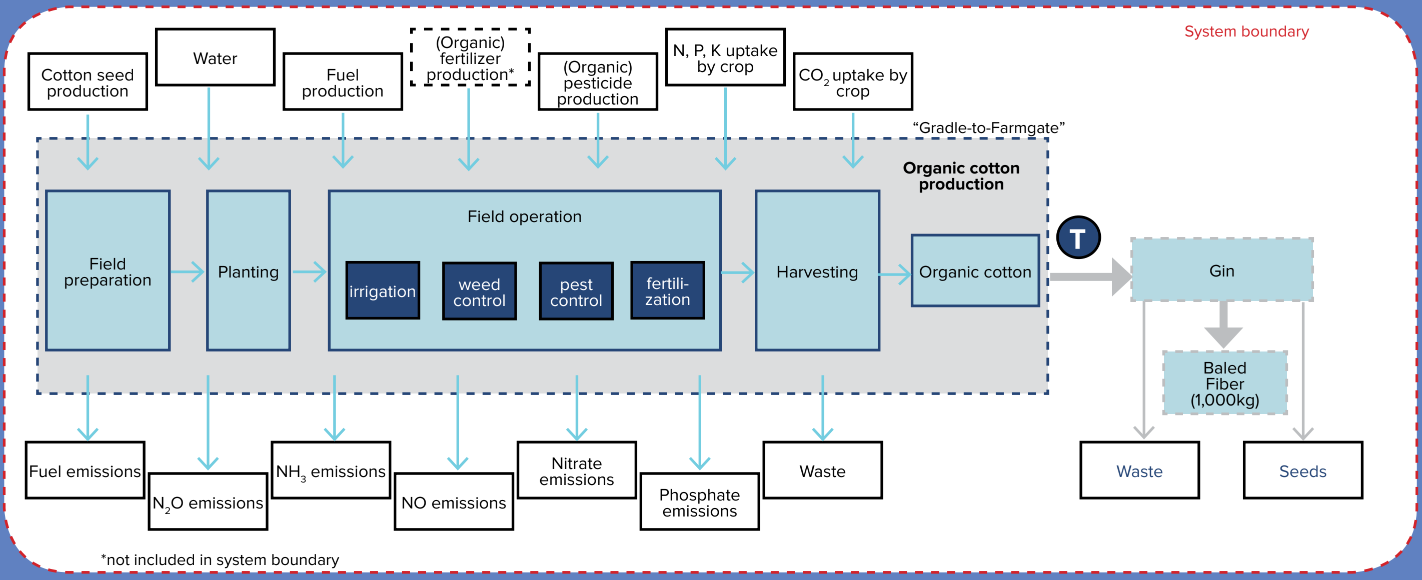
Table 1:
Geographical and time reference in data collection

Country	India	Turkey	China	Tanzania	USA
Sub-Region	Madhya Pradesh, Maharashtra, Odisha, Andhra Pradesh, Rajasthan	Aegean and South East Anatolia	Hutubi, Xingjang	Meatu and Mwasa District	Lubbuck (irrigated, non-irrigated)
Country share (produced mass) in global production (2013)	74%	6%	9%	6%	2%
Sub-Region share as percentage of country total production	98%	100%	95%	72%	89%
Percentage of area represented by production groups	14%	85%	26%	34%	89%
Percentage of production (lint) represented by production groups	18%	83%	35%	46%	89%
Number of farmers represented	14,000	210	767	2,202	30
Time frame	2008 – 2012	2012/13	2009-2012/13	2012/13	2012/13

System Boundaries

The system under consideration is a cradle-to-gate Life Cycle Inventory including the cultivation of the cotton plant until farm gate, the transport of the seed cotton to the gin and the ginning operations, until the fiber is packaged in bales and is ready for shipping.

Figure 1:
System boundaries considered in this study



Categories of contribution:

Field emissions: Emissions released from metabolic processes taking place in the soil being released into air, water and soil, and emissions to water from soil erosion.

Fertilizer: Includes resource use and emissions associated with the production of fertilizer. Organic fertilizers are assumed to enter the system burden free; impacts associated with this category are mineral fertilizer such as rock phosphate that are used in organic farming systems.

Machinery: Includes the resource use and emissions associated with the running of vehicles and machines used for cultivation. This includes the production and combustion of fuels (diesel).

Irrigation: Similarly to machinery, this category refers to energy (diesel or electricity) used to run the irrigation pumps.

Transport to the gin: Transport to the gin refers to the resource use and emissions associated with the production and combustion of fuels (diesel) during the transportation of the seed cotton to the gin.

Ginning: Includes resource use and emissions associated with the ginning process.

Impact Categories

In order to carry out an LCIA, the following impact categories were investigated (using the most recent update of the Institute of Environmental Sciences of the University of Leiden (CML) impact assessment methodology framework, CML2001, 2013):

- Global Warming Potential (GWP)
- Eutrophication Potential (EP)
- Acidification Potential (AP)
- Primary Energy Demand (non-renewable) (PED)
- Water Use and Water Consumption (WU and WC)

Additionally, Human- and Eco- Toxicity Potentials (HTP and ETP) were investigated (screening level). Please see further details about the challenges with this indicator on page 17.

Land Occupation was not included in the report. This indicator is indirectly proportional to the yield, i.e. a low yield will result in high land occupation. However, land occupation is only one dimension of land use, and land occupation alone does not allow drawing conclusions about the quality and environmental impact of the land use. It is also necessary to remark here that a low yield does not necessarily result in a high environmental profile.

Inclusion, Exclusion and Cut-Off Criteria

Included in the study are all material and energy flows required for the two phases of production (cultivation and ginning), as well as all associated wastes and emissions. This includes but is not limited to: fertilizer and pesticide production as well as field emissions (e.g. N_2O), electricity for ginning and all transportation (fertilizer to the field, seed cotton to gin).

At present, no product category rule exists for cotton fiber LCAs. This is why there is no generally accepted document to refer to for justification of inclusions and exclusions. Therefore, this study aimed to align system boundaries (as well as modelling approaches) to the publicly available and critically reviewed Cotton Inc. 2012 study of conventional cotton.

Items were included or excluded from the study based on their expected environmental relevance (contribution of >2 percent to one of the selected impact categories). However, the environmental relevance of some of the excluded cases (e.g. livestock labor) can be hard to determine, because large regional variations exist, data availability is limited and consensus is lacking on methodology regarding assumptions made. The full LCA report contains a number of scenarios to estimate the possible environmental impact of some of the excluded cases, though with large uncertainty.

Table 2:
Table showing system elements included within and excluded from the system boundaries

Included items	Excluded items
Seed production	Human labor (out of system boundary)
Cultivation of cotton	Animal labor (scenario provided)
Production of operating materials	Transport of agricultural equipment (scenario provided)
Energy production and utilization	Certification; extension, farm visits (scenario provided)
Fuel production and utilization	Production and transport of packaging materials (expected to be below 2 percent cut-off criteria)
Water supply, use and consumption	Construction of capital equipment (expected to be below 2 percent cut-off criteria)
Transportation of operating materials and product	

Scenarios

Scenario analysis was carried out to evaluate the influence of assumptions with regards to system boundaries and modelling approaches on the final results. The full report contains details of the different scenarios that were explored. These include provision of organic fertilizer, draught animals, composting of field residues, economic allocation between the lint and the seed, soil protection, nitrous oxide emissions from agricultural soils, machinery transportation and certification trips.

Function and Functional Unit

The function of the product is organic cotton fiber for further processing in the textile industry. The functional unit is 1,000 kilograms (kg) of organic cotton fiber at the gin gate. System boundaries are shown in Figure 1. Please note that differences in fiber quality were not considered in this study.

Critical review

A critical review of the study was performed to ensure that:

- the methods used to carry out the LCA are consistent with ISO 14040 and ISO 14044;
- the methods used to carry out the LCA are scientifically and technically valid;
- the data used are appropriate and reasonable in relation to the goal of the study;
- the interpretations reflect the limitations identified and the goal of the study; and
- the study report is transparent and consistent.

The panel was composed of:

- Ing. Paolo Masoni (chair of review panel), Research Director and head of the LCA and Ecodesign Laboratory. President of the Italian LCA network, member of the Technical Advisory Board of PEF/OEF c/o European Commission. Past President of SETAC Europe and member of the editorial board of Clean Technologies and Environmental Policy and the Journal of Environmental Accounting and Management.
- Dr Niels Jungbluth, Chief Executive Officer of ESU-Service. Member of the editorial board of the International Journal of LCA and expert advisor to e.g. Deutsche Bundesstiftung Umwelt, United Nations Framework Convention on Climate Change UNFCCC, CEN TC 383 standard (GHG accounting on biofuels), UNEP-SETAC life cycle initiative.
- Dr. Christian Schader, sustainability assessment lead coordinator at the Research Institute for Organic Agriculture (FiBL) and Managing Director of the Sustainable Food Systems Society (SFSS) and Co-author of the SAFA Guidelines.

The critical review statement is available in the full report.

Limitations

While the study provides LCA inventory data of a good overall quality for organic cotton lint, there are some limitations that need to be taken into consideration in the interpretation of the results. In relation to the inventory, the time representativeness of the data could be improved by systematic collection of data over several cultivation periods covering the same time span.

The agricultural model used in this study is constantly updated and improved, thus claiming to cover all relevant emissions and to allow a comprehensive LCI setup and LCIA of agricultural systems. However, for many relevant aspects (such as soil types, nutrient content of soils, soil erosion) primary data is very hard to obtain and so default values need to be applied. These default values do not necessarily represent local conditions. To aggregate data into regional averages is additionally challenging and can potentially lead to distortions in a model trying to represent a realistic cultivation system. Agricultural systems are complex, and methodological decisions as well as the choice of modelling approaches and assumptions can influence the results significantly, illustrated by different scenarios shown in the full report. Absolute numbers should therefore be interpreted with care.

This study does not intend to compare different countries producing organic cotton or different regions within countries. However, the aggregation into a global average hides the regional variability of the results.

RESULTS AND INTERPRETATION

LCIA results are difficult to interpret without a context. On the one hand, LCIA results are highly dependent on methodological decisions. On the other hand, one needs to be aware of LCIA results of other similar systems to tell whether a value can be considered high, average or low.

The following section presents a summary of the results of the LCIA as well as placing these results into context of selected literature in order to better understand the environmental hotspots of cotton cultivation and ginning and inviting dialogue on measures to improve cotton sustainability. In particular, the Cotton Inc. study has provided a solid baseline with up-to-date Life Cycle Inventory (LCI) data for evaluating conventional cotton products and is used in this summary document to provide a baseline for conventional cotton production. The current TE study on organic cotton attempted to define similar system boundaries up to the gin gate and to use the same modelling approaches as the Cotton Inc. study. It should be noted though that the comparability of the two studies has not been verified in the critical review. It should also be noted that environmental impacts are calculated as potentials, therefore savings that may be visible are also savings potentials.

Table 3:
Table summarizing project impact categories and indicators

Indicators		Unit	Reference
Environmental Impact Categories	Global Warming Potential (GWP)	[kg CO_2 eq]	GUINÉE ET AL. 2001
	Categories	[kg SO_2 eq]	GUINÉE ET AL. 2001
	Eutrophication Potential (EP)	[kg Phosphate eq]	GUINÉE ET AL. 2001
Additional Environmental Indicators	Water use and consumption	[m^{3}]	BAYART ET AL. 2010
	Environmental Indicators	[MJ net calorific]	N/A - Inventory level indicator
Screening Assessment of toxicity potential (USEtox)	Human Toxicity Potential (HTP)	[CTUh]	ROSENBAUM ET AL. 2008
	Eco-toxicity Potential (ETP)	[CTUe]	ROSENBAUM ET AL. 2008

Global Warming Potential – Climate change

Definition

Climate change, measured as global warming potential, is deemed to be one of the most pressing environmental issues of our times. It is also one of the most discussed and best understood impact categories with global implications and will therefore receive primary attention.

The mechanism of the greenhouse effect can be observed on a small scale, as the name suggests, in a greenhouse. These effects are also occurring on a global scale. In addition to the natural mechanism, the greenhouse effect is enhanced by human activities. The greenhouse gases caused or increased, anthropogenically, are for example carbon dioxide, methane and nitrous oxide.

The category indicator results are provided in kg of CO_2 equivalent per functional unit. The carbon uptake in the cotton fiber is not considered as it is only temporarily stored in the product and is released at the End of Life of the product.

Results

The Global Warming Potential (GWP) resulting from the greenhouse gases emitted from the production of 1,000 kg organic cotton (global average), adds up to 978 kg CO_2 equivalents.

Field emissions dominate this impact category with an over 50 percent share. Field emissions refer to gases emitted from soils as a result of agricultural activity. The contributions in the other aspects of cotton fiber production largely depend on the fossil fuel combustion in each of the processes. Ginning accounts for a large proportion (18 percent) because electricity provision in many countries has a high share of coal and other fossil fuels. Machinery use is also a significant contributor (16 percent) as the combustion of fossil fuels releases carbon dioxide and other greenhouse gases. Irrigation and transport to the gin contribute smaller amounts in relation to the amount of fossil fuels they combust. The impact of fertilizer is almost negligible due to the fact that very little mineral fertilizer is applied and organic fertilizer is not included.

Interpretation

The global average GWP of conventionally grown cotton is calculated to be 1,808 kg of CO_2 equivalent per 1,000 kg of cotton fiber produced. This study has arrived at 978 kg of CO_2 equivalent. per 1,000 kg of cotton fiber grown under the extensive cultivation system of organic agriculture, resulting in a global warming potential saving of 46 percent.

Under current system boundaries, the difference in results can be attributed to the lower agricultural inputs that are required by the principles of organic agriculture, namely of mineral fertilizer, pesticides, as well as the practices related to tractor operations and irrigation. The field emissions per kg fiber (not per ha) do not differ significantly between the two systems, as every system has an optimum where additional application of fertilizer increases yield with a less than proportional increase in emissions.

Figure 2:
Global warming potential of the global average organic cotton fiber shown for 1,000 kg of product at gin gate

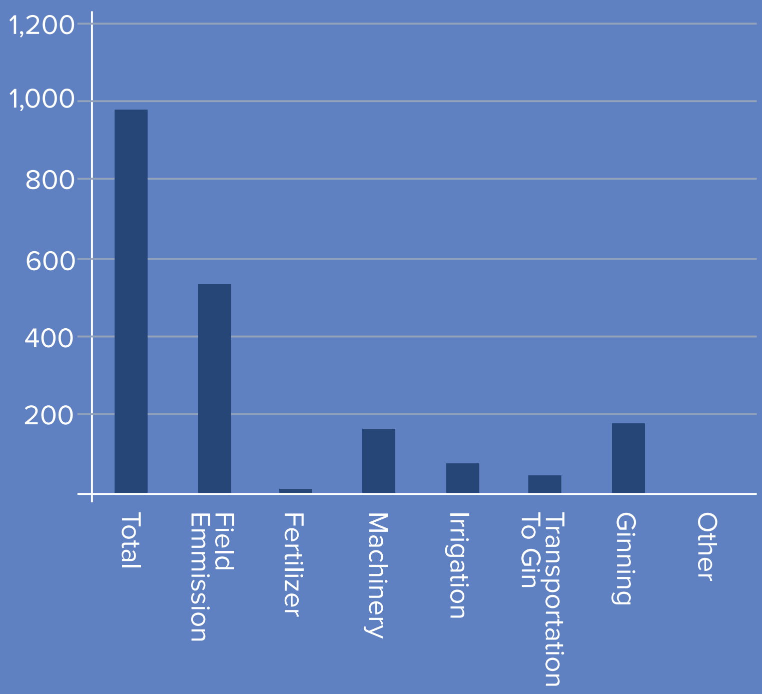
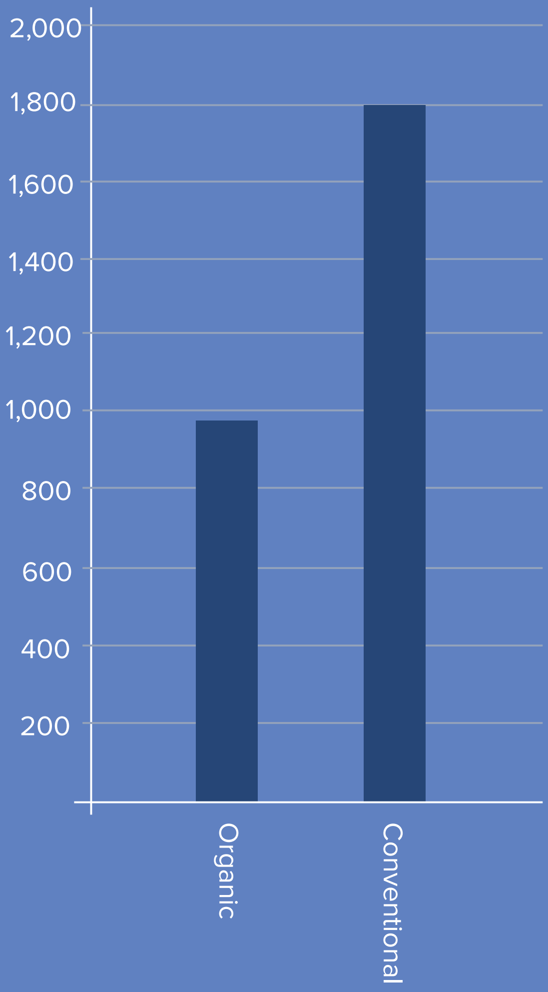


Figure 3:
Comparison of global warming potential result against conventional benchmark



Acidification Potential

Definition

Acidification, causing for example acid rain, was chosen because it is closely connected to air, soil, and water quality and relevant to environmental aspects of agricultural systems. The category indicator results are shown in kg SO_2 equivalent.

Results

Evaluating the global average organic cotton fiber production has resulted in an acidification potential (AP) of 5.7 kg SO_2 equivalent for 1 metric ton of fiber. At a first glance, the contribution analysis paints a similar picture to that of Global Warming: field emissions contribute the most followed by ginning and machinery. However, all three of the mentioned contributors have very similar shares between ca. 20 and 30 percent. The similarity is due to the fact that both AP and GWP are influenced by fossil fuel combustion processes. While CO_2 emissions contribute to GWP, the parallel releases of SO_2 and nitrogen oxides increase AP. In addition to mentioned gases, ammonia is an important contributor to acidification with an AP 1.6 times higher than SO_2.

The impact of field emissions is dominated by ammonia (dependent upon the amount of nitrogen applied) whereas nitrogen oxides and sulfur dioxide emissions influence other processes within the production chain of organic cotton fiber. Sulfur dioxide production is dependent upon the type of fossil fuel used and nitrogen oxides depend upon conditions of the combustion process, therefore the amount and type of fuels used determine the order of importance in the other categories (ginning, machinery, irrigation and transport to the gin).

Interpretation

The acidification potential reported for conventional cotton is 18.7 kg SO_2 equivalent for 1,000 kg lint cotton whereas the value assessed for organic cotton was 5.7 SO_2 equivalent. This is equal to a potential saving of 70 percent. Again, the difference is driven by reduced or avoided agricultural inputs in the organic cotton systems, i.e. fertilizer and pesticide production, irrigation pumps and tractor operations. The difference is also caused by differences in field emissions due to the different amounts of nutrients applied.

Figure 4:
Acidification potential of the global average organic cotton fiber shown for 1,000 kg of product at gin gate

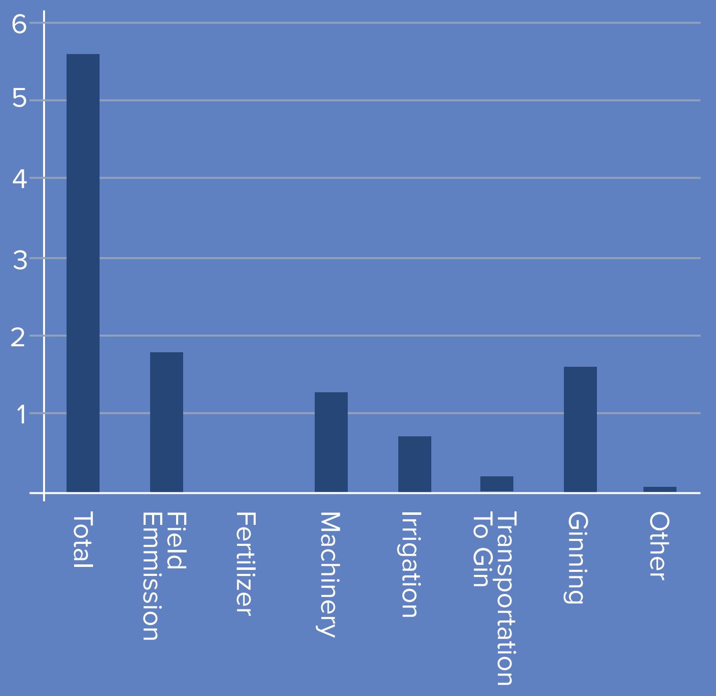
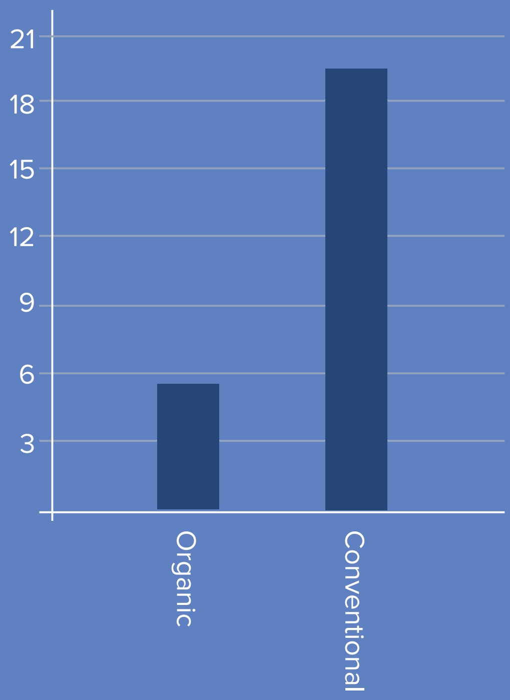


Figure 5:
Comparison of acidification potential result against conventional benchmark



Eutrophication Potential

Definition

Eutrophication, also known as over-fertilization, was also chosen for its connection to air, soil and water quality and relevance to agricultural systems. The category indicator results are shown in or PO_4^3 equivalent per functional unit. Eutrophication is mainly caused by nutrient leaching and soil erosion, both successfully reduced in organic farming via soil protection measures.

Results

Global average organic cotton fiber production has an eutrophication potential (EP) of close to 3 kg PO_4^3 equivalent. EP is dominated by field emissions (80 percent) and is also influenced by machinery use (11 percent), while all other processes of the production chain combined contribute less than 10 percent. Eutrophication in agriculture can be significantly influenced by soil erosion. Through soil erosion, nutrients are removed from the cultivated system via water and soil and lead to the fertilization of neighboring water bodies and soil systems. EP is measured in phosphate equivalent and is influenced mainly by P- and N-containing compounds. Soil erosion rates can be drastically reduced by soil protection measures that are widely used among many organic cotton farmers.

Interpretation

While soil erosion rates are often difficult to specify, the present study is built on evidence of strong soil protection measures applied in the organically cultivated systems capable of preventing 90 percent of the soil erosion that would otherwise enable the washing off of nutrients into the neighboring water and soil bodies. Cultivation of rotation crops and intercropping contribute to the reduction of losses of nutrients due to leaching. Considering these effects, eutrophication of the organic cotton fiber is calculated to be 2.8 kg $PO_4$3 equivalent per 1,000 kg fiber. Cotton Inc. 2012 calculated 3.8 kg PO_4^3 equivalent for the same amount of conventional fiber. Equivalent to a eutrophication potential 26 percent less.

Figure 6:
Eutrophication potential of the global average organic cotton fiber shown for 1,000kg of product at gin gate

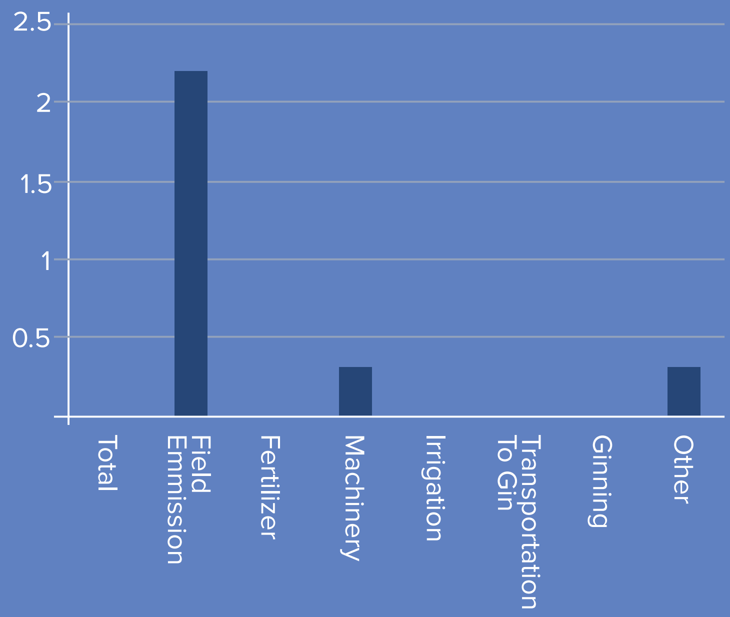
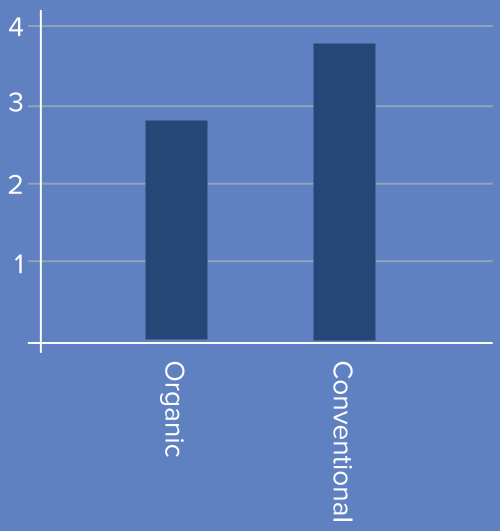


Figure 7:
Comparison of eutrophication potential result against conventional benchmark



Water Use and Consumption

Definition

The importance of water use in agricultural systems is evident. This is why an environmental assessment of water use is specifically important in the assessment of agricultural products. In this study, methods and terminology as defined by the UNEP/SETAC working group on water and in the new ISO standard are used (Bayart et al. 2010, Pfister et al. 2009, ISO 14046).

According to these publications, the following terms are used:

- Water use: use of water by human activity. Use includes, but is not limited to, any water withdrawal, water release or other human activities within the drainage basin impacting water flows and quality.
- Water consumption: water removed from, but not returned to the same drainage basin. Water consumption can be because of evaporation, transpiration, product integration or release into a different drainage basin or the sea. Evaporation from reservoirs is considered water consumption.
- Green water refers to the precipitation on land that does not run off or recharges the groundwater but is stored in the soil or temporarily stays on top of the soil or vegetation. Eventually, this part of precipitation evaporates or transpires through plants. Green water can be made productive for crop growth.
- Blue water refers to water withdrawn from groundwater or surface water bodies (e.g. via irrigation). The blue water inventory of a process includes all freshwater inputs but excludes rainwater.

Water use values are only of limited informative value with regard to the environmental relevance of the water withdrawal. Of much more interest is the water lost to the watershed, i.e. water consumption, and hereby only the values for consumption of blue water (surface and ground water), as it is assumed that precipitation would follow the natural hydrologic cycle regardless of the land use type and therefore has no environmental burden from an LCA perspective.

With regards to water use, consumption of blue water should be the focus of water use assessments. Water consumption benefits from the climatic settings of areas where organic cotton is grown, but soil fertility and protection measures are also likely to contribute to preserving soil moisture content available for plant uptake.

Results

The global average total of water consumed while producing 1 metric ton of organic cotton fiber is 15,000 m^3. While total water use and consumption are almost the same implying that almost all water used is consumed; 95 percent of water used is green water (rainwater and moisture stored in soil and used for plant growth). About 97 percent of water use takes place in agricultural processes (irrigation), and 3 percent derives from upstream processes (production of ancillary materials, fuels and electricity). In summary, water is almost exclusively used in agriculture and almost all of the water used is green water.

Interpretation

In the regions under study, organically cultivated cotton receives relatively little irrigation in addition to naturally occurring rainfall. The irrigation water requirement of a crop is mainly determined by climatic conditions and the actual usage is also influenced by irrigation techniques. This is why low irrigation rates cannot be attributed exclusively to the organic cultivation scheme. Soil and water conservation measures (composting, rainwater harvesting etc.) are also known to help to conserve water and thus potentially contribute to lower the irrigation water requirement in arid areas (Blanco-Canqui 2008).

All regions under investigation in Cotton Inc. 2012 are at least partially irrigated. As a consequence, blue water consumption – the impact category with a high environmental relevance – of conventional cotton is reported to be 2,120 m^3/1,000 kg cotton fiber (results of this study 182 m^3/1,000 kg lint cotton fiber).

Figure 8:
Blue water consumption of the global average organic cotton fiber production shown for 1,000kg of product at gin gate

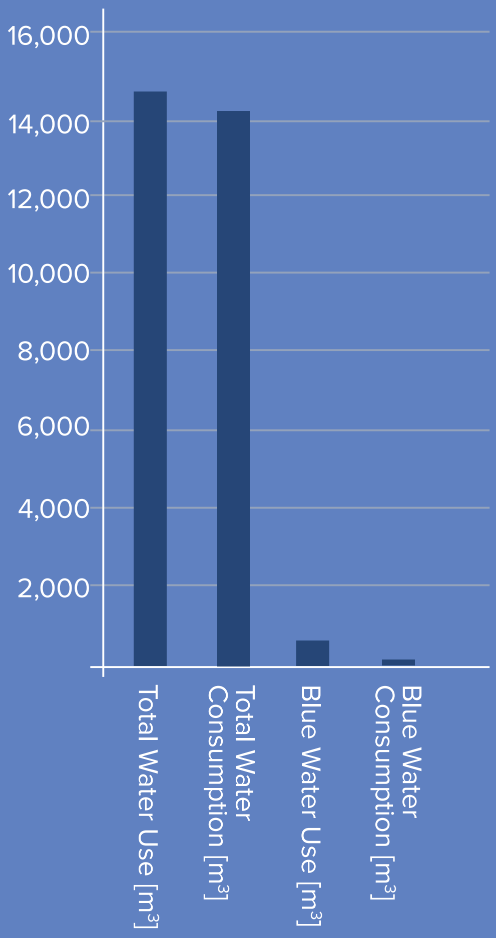
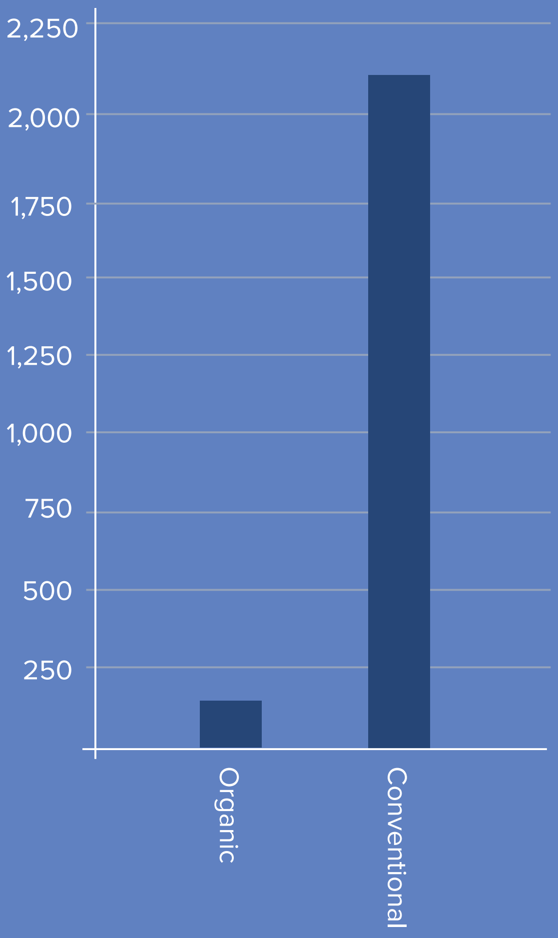


Figure 9:
Comparison of blue water consumption result against conventional benchmark



Primary Energy Demand

Indicator definition

Primary energy demand from non-renewable sources (e.g. petroleum, natural gas etc.) was chosen as an environmental impact category chosen because of its relevance to energy and resource efficiency and its interconnection with climate change.

Results

The global average organic cotton fiber has a primary energy demand (PED) from non-renewable resources of ca. 5,800 MJ, per 1 ton of product at gin gate. Non-renewable PED is an indicator of the dependence on fossil resources. Machinery (39 percent) and ginning (33 percent) were both equally significant contributors. Unlike in other fossil fuel combustion-determined categories such as GWP or AP, ginning plays a slightly less important role than machinery, because of use of a variety of fossils. Electricity relies on coal to a large degree in many of the studied regions. Diesel, on the other hand is used in running vehicles (machinery) and pumps (irrigation) and has a higher energy-to-emission ratio than coal, for example. Diesel used in running vehicles (machinery) and pumps (irrigation) have a higher energy-to-emission ratio than coal, for example. As an indicator for fossil resources, it is only the resource consuming process steps that influence this indicator.

Interpretation

The PED for conventional cotton (Cotton Inc. 2012) is ca. 15,000 MJ/1,000 kg lint cotton (value assessed in this study for organic cotton: ca. 5800 MJ). This results in a reduced primary energy demand (non renewable) of 62 percent. As in the case for GWP, avoiding the use of mineral fertilizer reduces the use of non-renewable fossil energy, since mineral fertilizers are petroleum-derived and carry a high PED.

Figure 10:
Primary energy demand (net calorific value) from non-renewable resources of the global average organic cotton fiber shown for 1,000 kg of product at gin gate

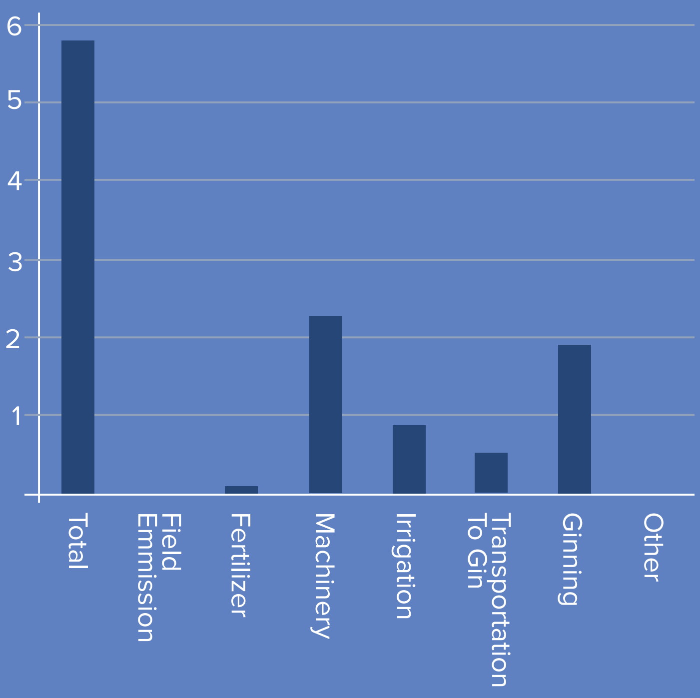
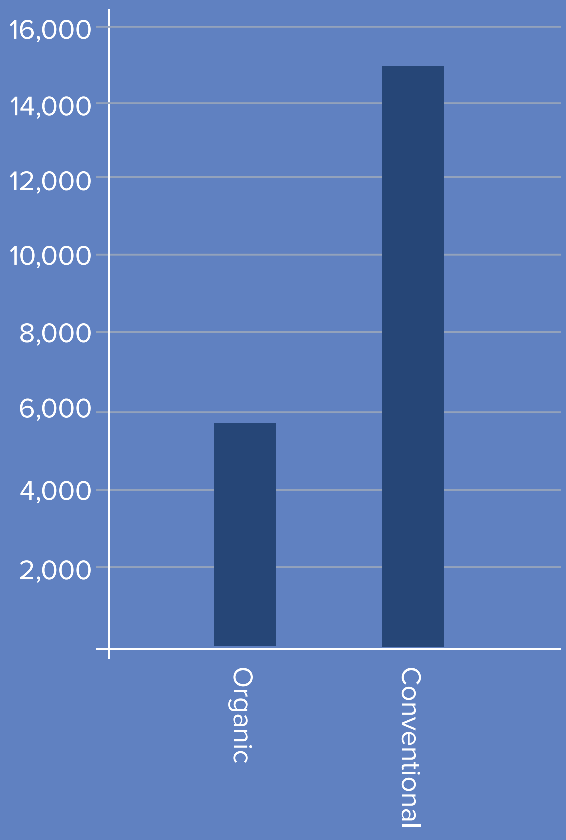


Figure 11:
Comparison of primary energy demand result against conventional benchmark



Toxicity Screening

Toxicity is not expected to be of high importance in organic cotton cultivation since toxic and persistent pesticides are banned. The impact category “toxicity” was included to provide information for possible further studies or comparisons, in order to capture the possible advantage of organic cotton.

Indicator definition

Assessment of the toxicological effects of a chemical emitted into the environment implies a cause–effect chain that links emissions to impacts through three steps: environmental fate, exposure, and effects.

In this LCA, environmental fate and exposure were taken into account by the application of the emission factors to soil, plant, water, and air, while the environmental effects were considered in the United Nations Environmental Program (UNEP) – Society of Environmental Toxicology and Chemistry (SETAC) toxicity model, USEtox™. The main objective of the USEtox™ model is to develop a scientific consensus model for use in Life Cycle Impact Assessments but USEtox™ has known limitations, specifically in representing agricultural systems (Rosenbaum et al. 2008).

Despite these weaknesses (when applied to agricultural systems) the USEtox™ model is a result of significant scientific cooperation and consensus and does build on a combination of established LCA models. The focus in using the USEtox methodology in LCAs of agricultural systems laid on pesticide use, as pesticides are known to be the major contributor to toxicity in agricultural products (Cotton Inc. 2012, Berthoud et al, 2011).

Result and Interpretation

Given the findings that pesticide use typically dominates USEtox profiles of agricultural products (Berthoud et al 2011, Cotton Inc. 2012), it is expected that the USEtox profile of organic cotton would well withstand comparison with other cultivation systems in this impact category.

CONCLUDING REMARKS

The results of this study can be applied as a reference value for organic cotton production worldwide and can be used with confidence in any further LCA studies e.g. along the value chain of the apparel industry.

Results indicate that organically grown cotton has the following potential impact savings (per 1,000kg Cotton Fiber) over conventional:

- 46 percent reduced global warming potential
- 70 percent reduced acidification potential
- 26 percent reduced eutrophication potential (soil erosion)
- 91 percent reduced blue water consumption
- 62 percent reduced primary energy demand (non-renewable)

The values shown here derive from two independent peer-reviewed studies with aligned modeling approaches and system boundaries definition, allowing indicative comparison, but the comparability has not been verified as part of the critical review process. Some of the potential environmental benefits of organic cotton such as the impact on biodiversity or soil carbon sequestration are not assessed in this study due to limitations in the LCA methodology in this regard. Whilst the initial objective of creating a global average data set for organic cotton has been achieved, future updates will build on systematic data collection and a broadening of scope as the methodologies for LCA develop further.

REFERENCES

Please note references specific to statements made in this summary report are listed below. For an extensive list of study references please refer to the full report.

PE INTERNATIONAL, 2014	PE INTERNATIONAL (2014) Life Cycle Assessment (LCA) of Organic Cotton - A global average
BAYART ET AL. 2010	Bayart, J.B.; Bulle, C.; Koehler, A.; Margni, M.; Pfister, S.; Vince, F.; Deschenes, L. (2010) A framework for assessing off-stream freshwater use in LCA, Int J Life Cycle Assess 15, 439–453
BERTHOUD ET AL 2011	Berthoud A, Maupu P, Huet C, Poupart A. (2011): Assessing freshwater ecotoxicity of agricultural products in life cycle assessment (LCA): a case study of wheat using French agricultural practices databases and USEtox model. International Journal of Life Cycle Assessment;16(8):841–847
BLANCO-CANQUI 2008	Blanco-Canqui, H. (2008). Principles of soil conservation and management. Springer.
COTTON INC. 2012	Cotton Inc. (2012) Life Cycle Assessment of Cotton Fiber and Fabric. Prepared 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 INTERNATIONAL; available online (after registration): http://cottontoday.cottoninc.com/Life-Cycle-Assessment/ .
GUINÉE ET AL. 2001	Guinée, J.B.; Gorrée, M.; Heijungs, R.; Huppes, G.; Kleijn, R.; Koning, A. de; Oers, L. van; Wegener Sleeswijk, A.; Suh, S.; Udo de Haes, H.A.; Bruijn, H. de; Duin, R. van; Huijbregts, M.A.J. Handbook on life cycle assessment. Operational guide to the ISO standards. I: LCA in perspective. IIa: Guide. IIb: Operational annex. III: Scientific background. Kluwer Academic Publishers, ISBN 1-4020-0228-9, Dordrecht, 2002, 692 pp..
ILCD 2011	European Commission-Joint Research Centre – Institute for Environment and Sustainability (2011): International Reference Life Cycle Data System (ILCD) Handbook- Recommendations for Life Cycle Impact Assessment in the European context. First edition November 2011. EUR 24571 EN. Luxemburg. Publications Office of the European Union
ISO 14040	EN ISO 14040:2009-11 Environmental management – Life cycle assessment – Principles and framework.
ISO 14044	EN ISO 14044:2006-10 Environmental management – Life cycle assessment – Requirements and guidelines.
ISO 14046	EN ISO 14046:2014 Environmental management – Water footprint – Principles, requirements and guidelines.
PFISTER ET AL. 2009	Pfister, S.; Koehler, A.; Hellweg, S. (2009) Assessing the environmental impact of freshwater consumption in LCA. Environ Sci Technol 43(11), 4098–4104.
ROSENBAUM ET AL. 2008	Rosenbaum et al. (2008) USEtox—the UNEP-SETAC toxicity model: recommended characterisation factors for human toxicity and freshwater ecotoxicity in life cycle impact assessment, International Journal of Life Cycle Assessment 13:532–546, 2008.
TE 2014	Textile Exchange (2014) Organic Cotton Market Report

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