

Cotton Fabrics Case Study (Part I)

Learning objective

To learn how to create a life cycle model based on given information regarding the input/output of processes

Overview

- Adapted from: Franziska Möller and Andreas Ciroth (2016) “Exercise on Life Cycle Assessment Life dataset creation”
- Goal: to estimate the environmental impacts of producing 1 kg cotton fabrics
- Database: ELCD, USDA crop database 1.1
- System boundary: “cradle-to-gate”

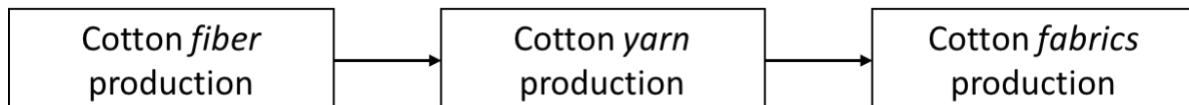


Figure 1. Life cycle stages included in this study (cotton growing is part of “Cotton fiber production”)

- Functional unit: 1 kg cotton fabrics
- Allocation method: none
- Geographic location: mixed
- Impact assessment method: ReCiPe 2016 Midpoint (H)
- Limitations:
 - Transportation of intermediate products are not modeled
 - Infrastructure (e.g., machinery) is not modeled
 - Geographic relevance of the data is not strictly preserved

Cotton fiber production

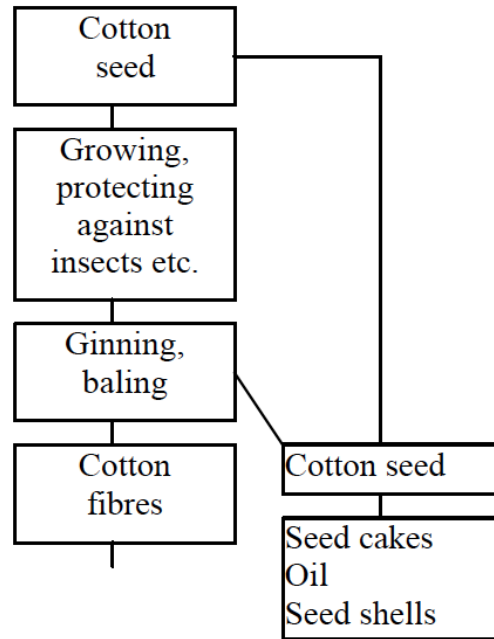


Figure 2. Steps involved in cotton fiber production stage

- Input/output for cotton fiber production

	Unit/output	Value	Flow in ELCD/USDA database
Input			
Cotton seed	kg	0.02	"cottonseed; at harvest in 2007; at farm; 90%-93% moisture" (first one, US-CA)
Electricity	MJ	12.1	"electricity mix" (2 nd to the last: 230 V processes; then in "Provider" choose the one with "CH")
Fossil fuel	MJ	47.7	"diesel" (choose the unit of "MJ-net calorific value")
Natural gas	kg	0.35	"Natural gas, at consumer EU-27"
Coal	kg	0.52	"Hard coal, at consumer EU-27"
Liquefied petroleum gas	MJ	1.383*	"LPG – liquefied petroleum gas"

Fertilizers	kg	0.457	"CUTOFF nitrogenous fertilizer, ammonium nitrate; at point-of-sale" (the first one: US-OR)
Pesticides	kg	0.016	"CUTOFF pesticide, 1-Naphthaleneacetamide; at point-of-sale; kg AI" (the first one: US-OR)
Water	kg	22,200	"CUTOFF irrigate; gravity, groundwater source, in 1996" (the first one: US-TX)
Output			
Cotton fiber	kg	1	Intermediate product flow created by the user
<i>Emissions to air</i>			
CO ₂	kg	4.265	"Carbon dioxide, from soil or biomass stock" (under "low population density" subfolder)
CH ₄	kg	0.0076	"Methane, from soil or biomass stock" (under "low population density" subfolder)
SO ₂	kg	0.004	"Sulfur dioxide" (under "low population density" subfolder)
NO _x	kg	0.0227	"Nitrogen oxides" (under "low population density" subfolder)
CH	kg	0.005	"Hydrocarbons, unspecified" (under "low population density" subfolder)
CO	kg	0.0161	"Carbon monoxide, from soil or biomass stock" (under "low population density" subfolder)

*Converted from "0.03 kg LPG" with the assumption of LHV as 46.1 MJ/kg LPG

Cotton yarn production

- Input/output for cotton yarn production

	Unit/output	Value	Flow in ELCD/USDA database
Input			
Cotton fiber	kg	1.1	Intermediate product flow created by the user
Machine operation and other activities	kWh	3.32	“electricity mix” (2 nd to the last: 230 V processes; then in “Provider” choose the one with “CH”)
Output			
Cotton yarn	kg	1	Intermediate product flow created by the user

Cotton fabrics production

- Input/output for cotton fabrics production

	Unit/output	Value	Flow in ELCD/USDA database
Input			
Cotton yarn	kg	1.08	Intermediate product flow created by the user
Machine operation and other activities	kWh	1.68	“electricity mix” (2 nd to the last: 230 V processes; then in “Provider” choose the one with “CH”)
Output			
Cotton fabrics	kg	1	Intermediate product flow created by the user

Product system

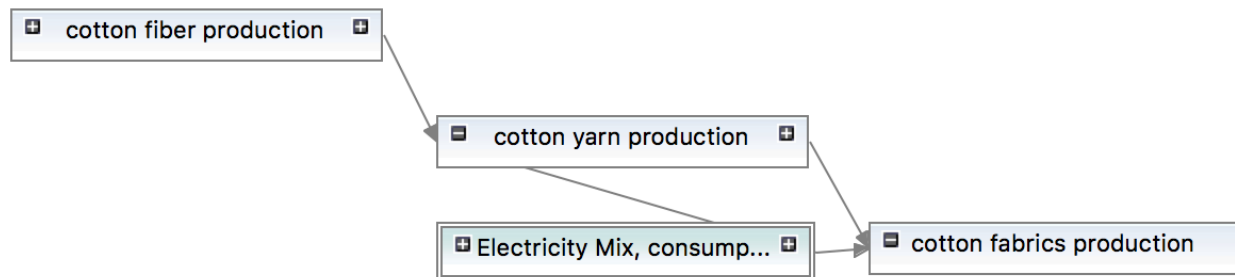


Figure 3. Product system diagram of the cotton fabrics production

Discussion

- [Results interpretation] What are the major contributors, e.g., to the impact of climate change? (hint: use “Contribution tree”)
- [Results interpretation] How does the choice of electricity grid affect climate change results? (hint: use “copy” function to duplicate the processes (*you also need to create new product flows for these duplicate processes in order to link them*), then change “Provider” for the electricity flow for ALL duplicated processes; create a new product system with duplicated processes and use “Project” to do side-by-side comparison)
 - Try “DE” as the provider
- [Results interpretation] Contribution from fertilizer and pesticides? (hint: use “Grouping”)
 - Try to explain your finding
- [Modeling choices] Take another look at input/output data table for “Cotton fiber production”, comment on:
 - The choice of flow for “CO₂ emission to air”
 - Any inventory is missing?