

Uncertainty Analysis of Physical-Based Carbon Accounting in Cotton T-shirt Manufacturing

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Contents

1	Calculation tables	2
2	Pedigree scores by process	3

1 Calculation tables

In Table S1, the column *Adjusted Yield* represents the emissions associated with producing 1 kg of finished T-shirt. This accounts for process losses across the value chain. For example, in the case of blowing, the direct emission factor is 0.068 kgCO₂/kg of yarn. However, because more than 1 kg of yarn is required to obtain 1 kg of finished garment, the adjusted value increases to 0.078 kgCO₂/kg.

The column *Adjusted FU* normalises emissions to the functional unit of the study, which is a 0.15 kg T-shirt. Therefore, the adjusted emission per functional unit is obtained by dividing the adjusted yield by 0.15 kg.

Table S1 Process-level activity data, emission factors, adjusted emissions, and contributions to the total cradle-to-gate footprint for one 150 g cotton T-shirt.

Stage	Process		AD [1] (kWh/kg)	EF [2] (kgCO ₂ /kWh)	Emissions (kgCO ₂ /kg)	Adj. Yield ¹ (kgCO ₂ /kg)	Adj. FU ² (kgCO ₂ /kg)	Share (%)
Yarn Production	Blowing		0.0832	0.8225	0.068	0.078	0.0120	0.88
	Carding		0.1068	0.8225	0.088	0.100	0.0155	1.13
	Drawing		0.1417	0.8225	0.116	0.132	0.0205	1.50
	Roving		0.1770	0.8225	0.145	0.165	0.0256	1.87
	Spinning		2.0222	0.8225	1.658	1.890	0.2930	21.37
<i>Subtotal</i>							0.3667	26.75
Fabric Production	Beam	Slash	0.6144	0.8225	0.504	0.560	0.0868	6.33
	Dry (Warp)							
	Weaving		2.8972	0.8225	2.376	2.640	0.4092	29.85
	Prep & Continuous Dyeing		1.2592	0.8225	1.033	1.148	0.1779	12.98
<i>Subtotal</i>	Sanforising		1.2186	0.8225	0.999	1.110	0.1720	12.55
							0.8459	61.71
T-shirt Production	Energy	Consumption	1.5180[3]	0.8220[4]	1.020	1.020	0.1581	11.53
<i>Subtotal</i>							0.1581	11.53
Total							1.3706	100.00

¹ adjusted to the material yield

² adjusted to the functional unit (FU)

2 Pedigree scores by process

Table S2 Pedigree scoring of activity data (AD) and emission factors (EF) for selected processes.

Process	Type	Unit	P	C	T	G	R	Source
Yarn Production								
Blowing	AD	kW h/kg	1.10	1.05	1.20	1.02	1.20	[1]
	EF	kgCO ₂ /kWh	1.00	1.00	1.00	1.02	1.00	[2]
Carding	AD	kW h/kg	1.10	1.05	1.20	1.02	1.20	[1]
	EF	kgCO ₂ /kWh	1.00	1.00	1.00	1.02	1.00	[2]
Drawing	AD	kW h/kg	1.10	1.05	1.20	1.02	1.20	[1]
	EF	kgCO ₂ /kWh	1.00	1.00	1.00	1.02	1.00	[2]
Roving	AD	kW h/kg	1.10	1.05	1.20	1.02	1.20	[1]
	EF	kgCO ₂ /kWh	1.00	1.00	1.00	1.02	1.00	[2]
Spinning	AD	kW h/kg	1.10	1.05	1.20	1.02	1.20	[1]
	EF	kgCO ₂ /kWh	1.00	1.00	1.00	1.02	1.00	[2]
Fabric Production								
Beam Slash Dry (Warp)	AD	kW h/kg	1.10	1.05	1.20	1.02	1.20	[1]
	EF	kgCO ₂ /kWh	1.00	1.00	1.00	1.02	1.00	[2]
Weaving	AD	kW h/kg	1.10	1.05	1.20	1.02	1.20	[1]
	EF	kgCO ₂ /kWh	1.00	1.00	1.00	1.02	1.00	[2]
Prep & Continuous Dyeing	AD	kW h/kg	1.10	1.05	1.20	1.02	1.20	[1]
	EF	kgCO ₂ /kWh	1.00	1.00	1.00	1.02	1.00	[2]
Sanforising	AD	kW h/kg	1.10	1.05	1.20	1.02	1.20	[1]
	EF	kgCO ₂ /kWh	1.00	1.00	1.00	1.02	1.00	[2]
T-shirt Production								
Energy consumption	AD	kW h/kg	1.10	1.05	1.20	1.02	1.00	[3]
	EF	kgCO ₂ /kWh	1.10	1.00	1.10	1.02	1.00	[4]

P = precision, C = completeness, T = temporal representativeness, G = geographical representativeness, R = technological representativeness.

India EF rows use national grid CO₂ intensities for the stated period; sewing (T-shirt production) EF uses China-specific values.

Uncertainty factors follow the GHG Protocol pedigree matrix framework applied in this study.

References

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