Life Cycle Assessment of a 100% Australian-Cotton T-Shirt

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Life Cycle Assessment

- Includes production of raw materials, product assembly, use and disposal
- Includes environmental impact from producing inputs (petrol, buildings, fertilisers, etc)
- Identifies environmental hotspots
- Quantitative and scientific basis
The Study

• Main Focus:
  – GHG emissions
  – Fossil fuel depletion

• Goals:
  – Market communication
  – Identify GHG reduction possibilities in the production and manufacturing chain
Environmental Categories

• Climate Change -> Direct GHG emissions
  – Soil N$_2$O emissions
  – Cattle CH$_4$ emissions (if applicable)
  – Plant and soil decomposition (CO$_2$)

• Fossil Fuel Depletion
  – Burning of fuel for machinery (production and manufacturing)
  – Burning of coal to produce electricity
  – Use of crude oil as input material (fertilisers, polyester)
Other Environmental Categories

• Ozone Layer Depletion
  – Emission of CFCs or other ozone depleting substances

• Mineral Resources Depletion
  – Depletion of phosphorus
  – Depletion of uranium
Cotton Production Carbon Footprint

- Carbon Footprint: 3.3 kg CO$_2$e/kg cotton
On-Farm GHG Emissions

• Assume Standard N fertiliser 200 kg N/ha
  + 0.101 kg CO$_2$e/kg cotton

• On-farm use of fuel
  + 0.15 kg CO$_2$e/kg cotton

• Cotton plant absorbs CO$_2$
  - 0.567 kg CO$_2$e/kg cotton

Net On-farm Emissions are -0.279 kg CO$_2$e/kg cotton
Polyester Production

• Why is polyester worse for the environment?
  – Synthetisation requires significant amounts of energy
  – Based on Xylene -> Crude Oil
  – Oil extraction and export very energy-demanding and contaminating
Polyester Carbon Footprint

• Carbon Footprint: 20 kg CO₂e/kg polyester
Cotton vs. Polyester

- Overall, cotton is better for the environment than polyester
- Estimated GHG emissions from production:
  - Cotton: 4 kg CO$_2$e/t-shirt
  - Polyester: 5kg CO$_2$e/t-shirt
The Textile Manufacturing Phase

- Contributes 12.5 kg CO$_{2}$e/kg textile
The Use Phase

- Dominates the Life Cycle -> 75 wash-dry operations
  - 96% of whole of life-cycle impact (277 kg CO$_2$e/t-shirt)
Reliability of Results

• High reliability
  – Specific and accurate sources
  – Use of reliable LCA databases

• Need to understand the goal of the study
  – Not about how much better cotton is
    but about which product is clearly better
  – Figures of GHG emissions are approximate
How to make cotton production greener

- Improve fertiliser efficiency and management
- Reduce diesel consumption

Which by-products offer more biofuel production?
Future Research

• Improve accuracy
• Assess other environmental categories
  – Water use (water depletion, water contamination...)
  – Land use (biodiversity, soil salinisation...)
• GHG reduction options
• How to maximise environmental benefits from cotton by-products