

# LCA OF BIODEGRADABLE MULTILAYER FILM FROM BIOPOLYMERS

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# INTRODUCTION

- Conventional plastics
  - Consumption of non-renewable resources
  - Impact upon waste disposal
- Increasing interest in ‘green’ biodegradable materials



# INTRODUCTION

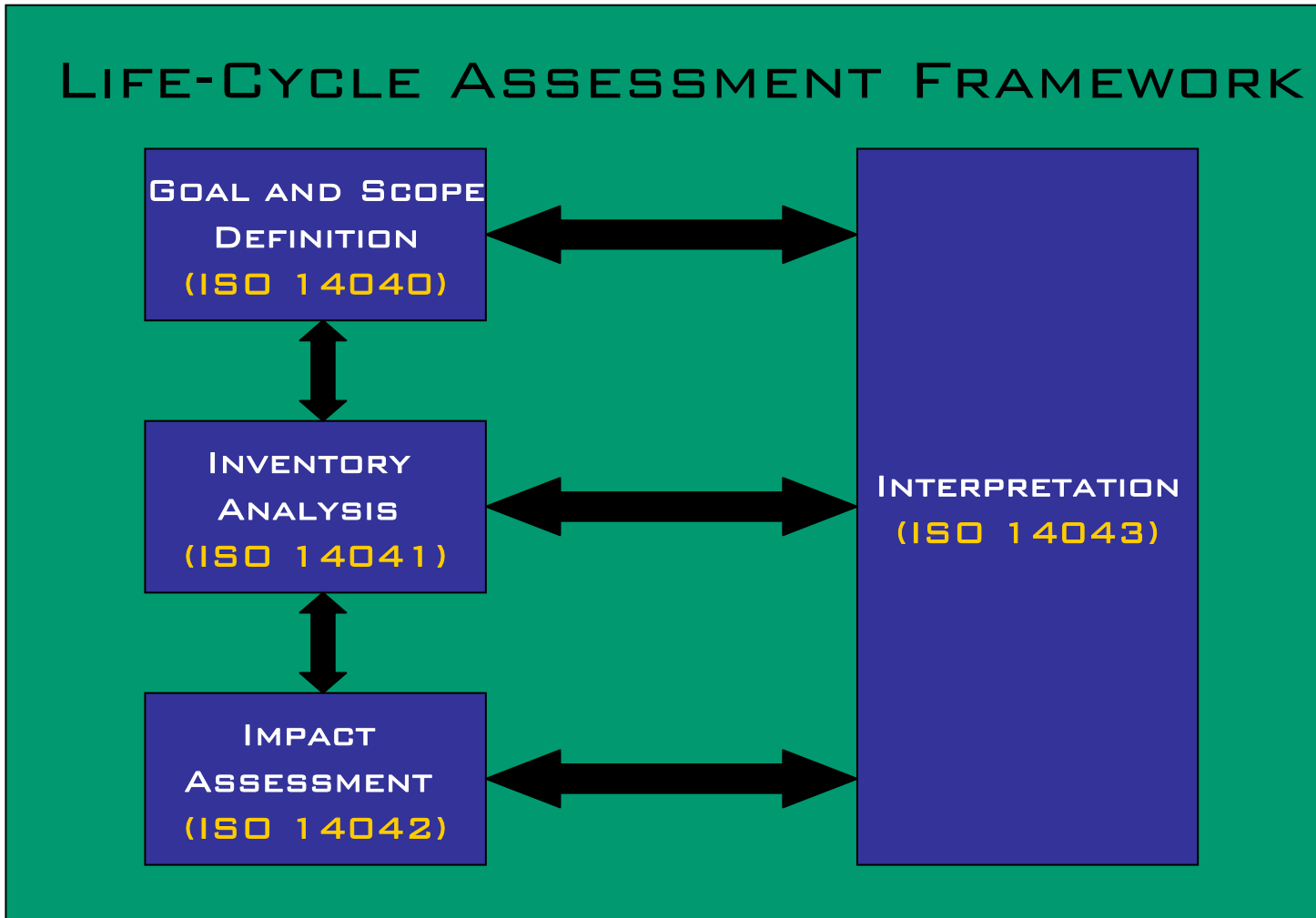
- Conventional film
  - Non biodegradable
  - Multiple layers
    - Outer layers: mechanical properties
    - Inner layers: gas barrier
- New **100% biodegradable** multilayer film
  - Used in food packaging
  - PLA-Starch-PLA



- Environmental impact assessment of biodegradable and conventional multilayer film
  - LCA methodology (EN-ISO 14040-14043)
- Aspects that require further research from an environmental viewpoint



# GOAL, SCOPE & FUNCTIONAL UNIT



# GOAL, SCOPE & FUNCTIONAL UNIT

- **Functional unit: 1 m<sup>2</sup> of packaging film**
  - 25-200-50 for the biodegradable multilayer film (55% starch, 10% PCL and 32% PLA)
  - 130-20-130 for the conventional multilayer film (91% PP and 9% for PA6)



# LIFE CYCLE INVENTORY (LCI)

- **Materials extraction**

- The inventory data used for PP and PA6 was provided by PlasticsEurope
- The life cycle inventory data for PLA were extracted from Vink *et al.* (2003)
- The environmental impacts of the different starches are obtained from the life cycle inventory by Dinkel *et al.* (1996) and Müller-Samann *et al.* (2003)
- Others: PCL, lauroyl chloride, N<sub>2</sub>O emissions



# LIFE CYCLE INVENTORY (LCI)

- **Film processing**

- Co-extrusion of the starch compound with dehumidified PLA
- Thermoforming to produce the packaging
- Energy model used was obtained from the Union for the Co-ordination of Production and Transmission of Electricity (UCPTE) for Europe
- Manufacturing of conventional and biodegradable film was tested at a pilot plant owned by AIMPLAS

- **Transport**

- Not considered unless it is very specialized (PLA, PCL)



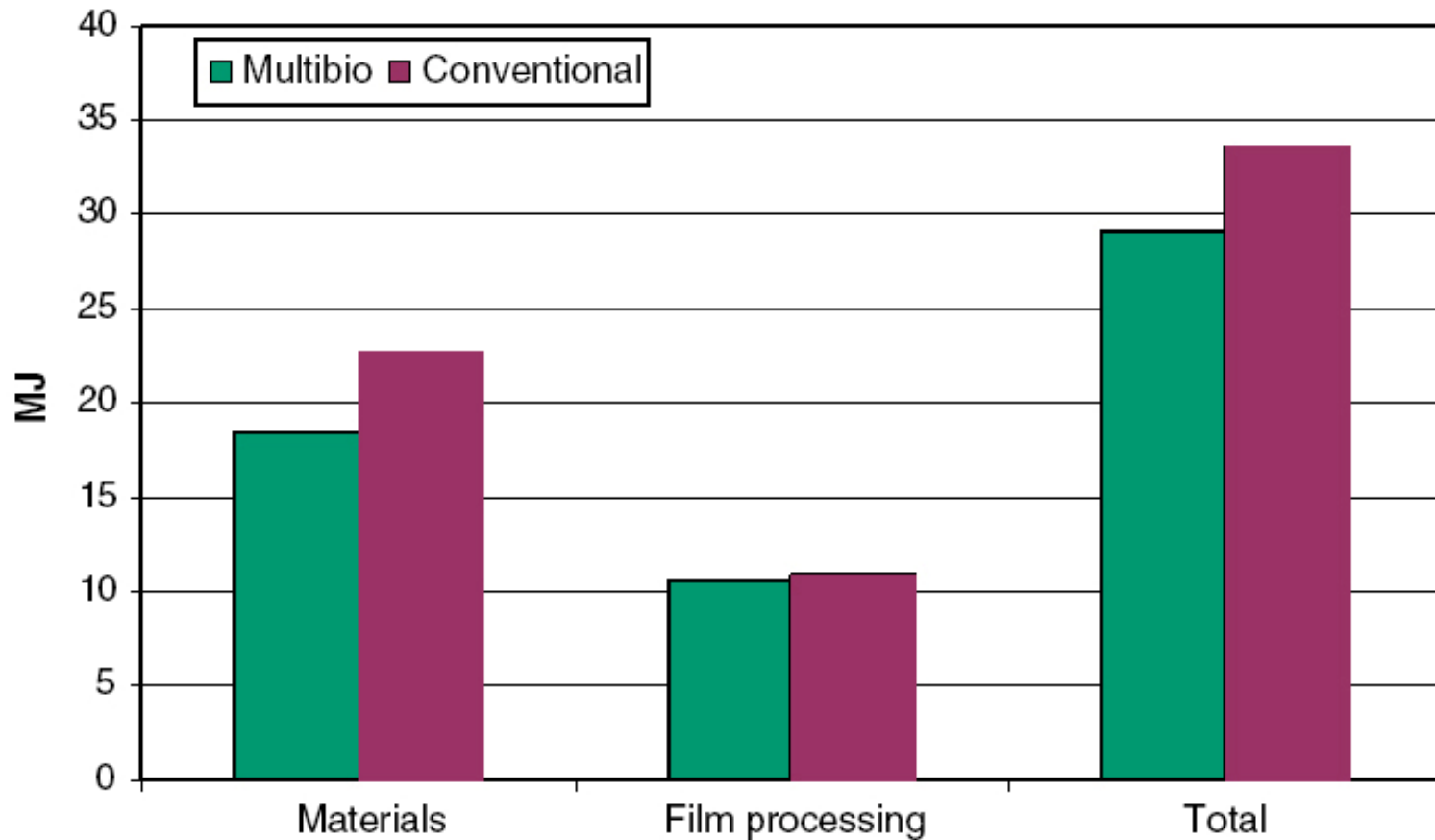
- **Impact categories selection**

- Fossil energy depletion
- Eutrophication
- Acidification
- Climate change



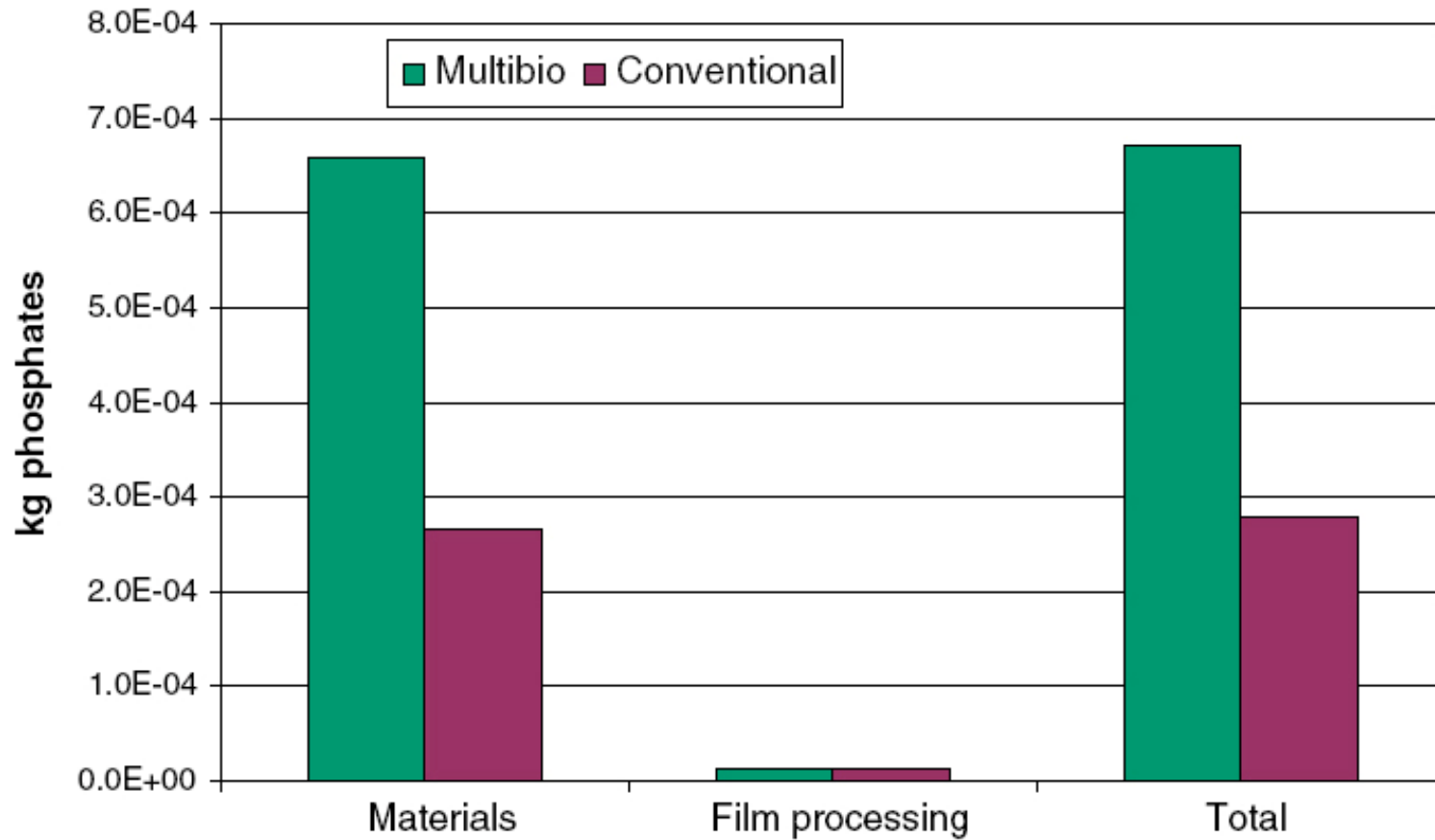
# BIODEGRADABLE FILM VS. CONVENTIONAL FILM

- Fossil energy depletion



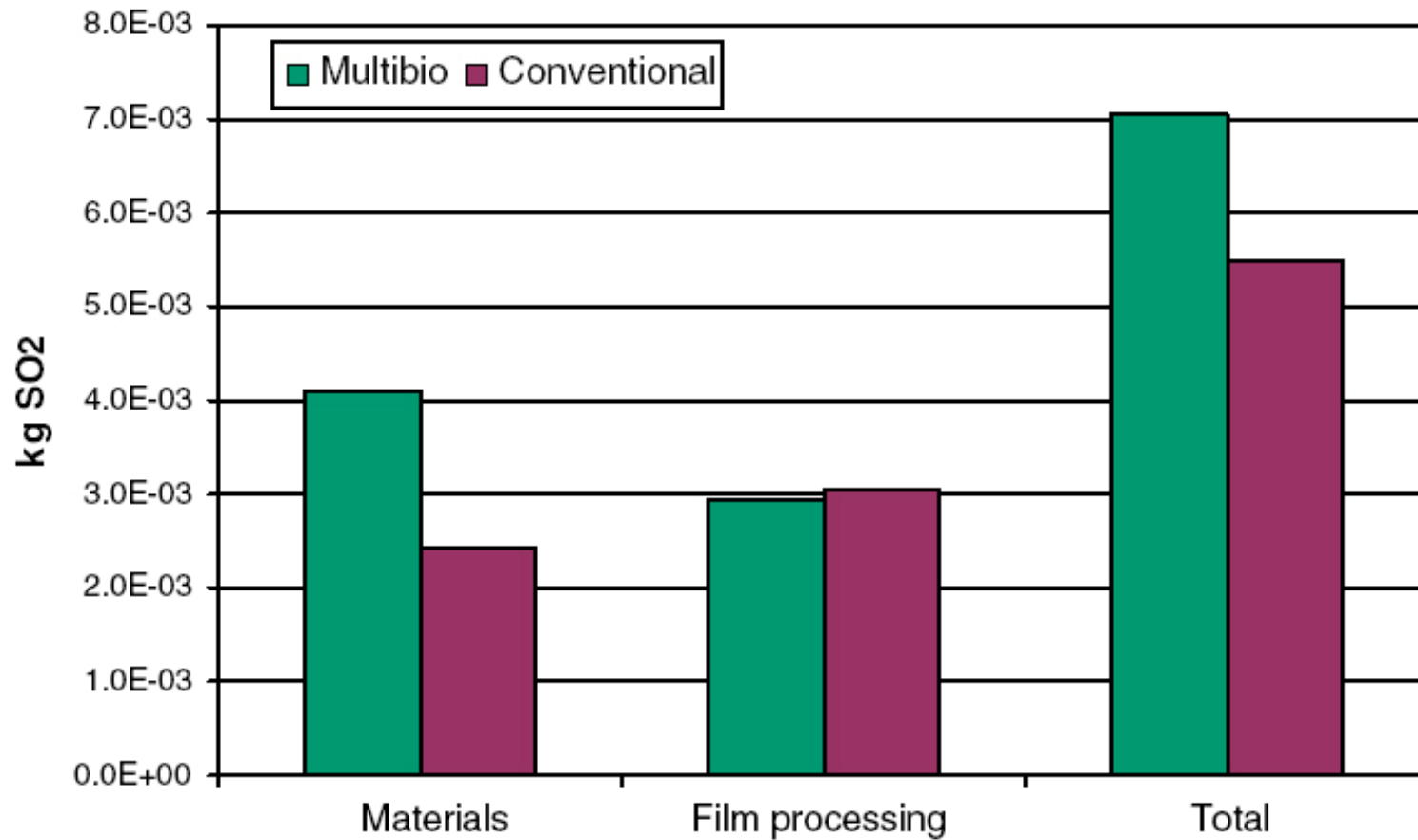
# BIODEGRADABLE FILM VS. CONVENTIONAL FILM

- Eutrophication



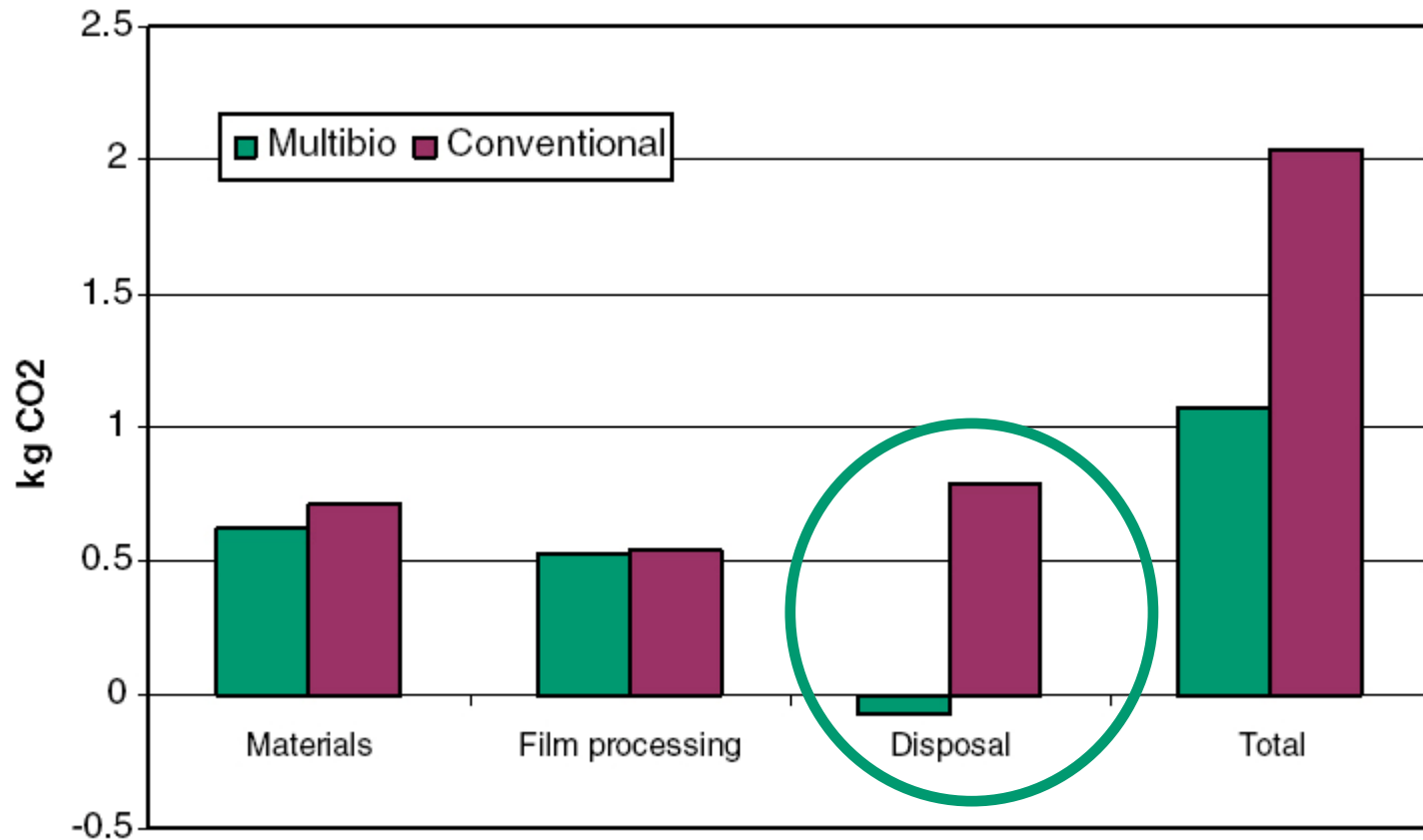
# BIODEGRADABLE FILM VS. CONVENTIONAL FILM

- Acidification



# BIODEGRADABLE FILM VS. CONVENTIONAL FILM

- Global warming



# DISPOSAL ASSESSMENT

- Focused on the global warming impact category ( $\text{CO}_2$ ,  $\text{CH}_4$ ; Smith *et al.* 2001)
- Three scenarios:
  - Incineration without energy recovery
  - Landfilling without gas control
  - Composting in simple windrow systems



- **Incineration**

- The incineration of conventional plastics makes a net positive contribution to global warming (GWP=1)
- The incineration of biobased materials as short-cycle carbon compounds is neutral in global warming terms (GWP=0)
- Emissions of nitrous oxide from incinerators were estimated at 0.05 kg/t

# DISPOSAL ASSESSMENT

- **Landfilling**

- Anaerobic conditions
- Landfill gas (50% methane and 50% carbon dioxide)
- Carbon dioxide is assumed to be all short-cycle



- **Composting**

- Composting is the aerobic degradation of waste to produce compost, which can be used as a soil improver
- Substitution of other products
  - Plant growing media (e.g. peat)
  - Organic fertilizers (only in part)
- Conventional film stays undegraded
  - Negative visual impact



# DISPOSAL ASSESSMENT

- GHG emissions by composting scenario**

1 m <sup>2</sup>	GHG (kg of CO <sub>2</sub> eq.)					
	Weight (kg)	% C	% DDOC	Incineration	Landfill	Composting
Conventional	0.2566	84	0	0.794	0.002	–
Multibio	0.3	59	30	0.007	0.363	–0.074
Multibio	0.3	59	50	0.007	1.036	–0.064



# CONCLUSIONS

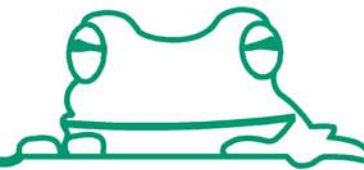
- The production of multilayer film with petrochemical polymers exhibits a higher environmental impact than the production of biodegradable multilayer film
  - Global warming is the most significant impact category. The performance of the Multibio multilayer film compares favourably to that of conventional multilayer film in this category.
  - Eutrophication is the least significant impact category, so even though the Multibio multilayer film does not perform as well in this category, it still outperforms conventional film globally.



# CONCLUSIONS

- The environmental impact of biodegradable film is not unrelated to disposal methods
  - Biodegradable film has a better environmental performance when incinerated or composted (up to 90% improvement in GHG emissions)
- The environmental impact of biodegradable plastics is likely to improve in the future





# THANK YOU!

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