Energy consumption and environmental impacts in the biscuits supply chain

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Outline

• Introduction

• Methodology

• Results

• Conclusions
UK Biscuit market

• Expected **sales of £ 3.17 bn** by the end of 2018

• **Growth of 19%** between 2013-2018 is expected

• **86% of the UK population** are frequent buyers of biscuits
Motivation and purpose of research

• Motivation
  – To help make biscuits supply chains more sustainable

• Purpose
  – To evaluate environmental sustainability of biscuits and identify opportunities for improvements across their life cycle
Biscuits sub-sectors

- Healthier biscuits: 23%
- Every day biscuits: 22%
- Chocolate containing: 17%
- Crackers: 14%
# Biscuit sub-sectors and products considered

<table>
<thead>
<tr>
<th>Biscuits sub-sectors</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEALTHIER BISCUITS</td>
<td>Low fat/sugar biscuits</td>
</tr>
<tr>
<td>EVERY DAY BISCUITS</td>
<td>Semi-sweet biscuits</td>
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<tr>
<td></td>
<td>Cream sandwich biscuits</td>
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<tr>
<td>CHOCOLATE CONTAINING BISCUITS</td>
<td>Chocolate-coated biscuits</td>
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<td></td>
<td>Chocolate cream sandwich biscuits</td>
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<tr>
<td>CRACKERS</td>
<td>Crackers</td>
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Methodology: Life cycle assessment

**Goal**: Primary energy demand, global warming potential and water footprint of biscuits produced and consumed in the UK.

**System boundary**: Cradle to grave

**Unit of analysis** *(functional unit)*: 1 kg of packaged biscuits for consumption at home.
The life cycle of biscuits

Production processes
- Primary processing [Mixing, forming, baking, cooling]
- Secondary processing [Mixing, creaming, sandwich building, coating]

Distribution centre

Retail

Consumption

End-of-life

Energy

Water

Raising agent

Packaging

TR: Transport
Primary energy demand (PED)

- **Manufacturing**: 31-47%
- **Raw materials production**: 26-47%
- **Transport**: 13-15%
Global warming potential

- Raw materials production: 41-61%
- Manufacturing: 24-38%
- Transport: 11-15%
Water footprint

<table>
<thead>
<tr>
<th>Product</th>
<th>Water Footprint [l/kg]</th>
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<tbody>
<tr>
<td>Crackers</td>
<td>27</td>
</tr>
<tr>
<td>Low fat</td>
<td>26</td>
</tr>
<tr>
<td>Semi-sweet</td>
<td>27</td>
</tr>
<tr>
<td>Chocolate coated</td>
<td>12</td>
</tr>
<tr>
<td>Chocolate cream</td>
<td>11</td>
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<tr>
<td>Vanilla cream</td>
<td>11</td>
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</table>
Land use change for chocolate-coated biscuits

- LUC increases GWP by ~86%
- Cocoa contributes 32% to GWP and palm oil 16%

GWP [kg CO2 eq./kg]

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<thead>
<tr>
<th></th>
<th>No land use change</th>
<th>Land use change</th>
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</thead>
<tbody>
<tr>
<td>Waste management</td>
<td></td>
<td></td>
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<tr>
<td>Transport</td>
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<tr>
<td>Consumption</td>
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<td>Retail</td>
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<tr>
<td>Distribution centre</td>
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<tr>
<td>Packaging</td>
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</tbody>
</table>

- GWP without LUC: 1.81 kg CO2 eq./kg
- GWP with LUC: 3.36 kg CO2 eq./kg
Contribution analysis for chocolate-coated biscuits

Energy consumption
- RAW MATERIAL PRODUCTION: 47%
- MANUFACTURING: 31%
- PACKAGING: 8%
- TRANSPORT: 13%

Global warming potential
- RAW MATERIAL PRODUCTION: 61%
- MANUFACTURING: 24%
- PACKAGING: 4%
- TRANSPORT: 11%

Water footprint
- RAW MATERIAL PRODUCTION: 61%
- MANUFACTURING: 24%
- PACKAGING: 4%
- TRANSPORT: 11%
Energy contribution analysis for chocolate-coated biscuits

- Wheat cultivation: 5%
- Palm oil production: 10%
- Palm kernel oil: 9%
- Milk powder production: 14%
- Manufacturing processes: 36%
- Primary packaging: 6%
- Transport: 8%
- Raw materials
Improvement opportunities

• **Raw materials**
  – **Wheat cultivation**: Improved agricultural practices
  – **Palm oil production**: Co-composting of palm oil residues or combined heat and power plan; improved agricultural practices
  – **Milk powder production**: Reduction of energy use, raw milk production improvement
  – **Sugar reduction** in recipes

• **Manufacturing**
  – **Energy reduction**: Energy efficiency
  – **Water reduction**: Water reuse through closed-loops
Acknowledgements

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