Supply chain planning with sustainability considerations: a multi-objective modeling approach

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Publication date:
2012

Supply chain planning with sustainability considerations: a multi-objective modeling approach

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AIMS

- To develop a a modelling framework for combining supply chain planning and environmental sustainability assessment
- To illustrate how environmental sustainability assessments of logistic activities can be improved by supply chain planning input
- To show that supply chain planning can in turn make use of the results from environmental sustainability assessments.
- To assess a new food processing technology

CONCLUSIONS

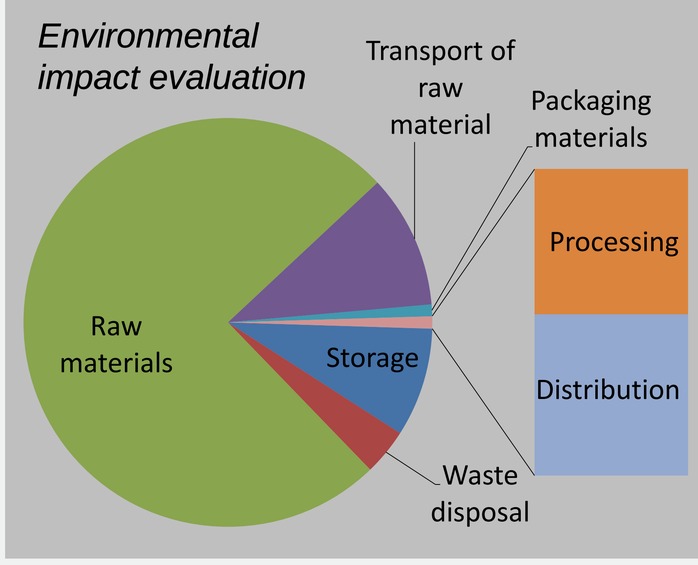
- Model able to present a comprehensive overview of economic considerations and environmental impacts in supply chains
- Trade-offs easier to quantify and illustrate.
- Especially beneficial in the design of supply chains, and the introduction of new technologies or product concepts
- Case results: minor increase of impacts in production, but significant savings upstream in the supply chain (i.e. identification of trade-offs).

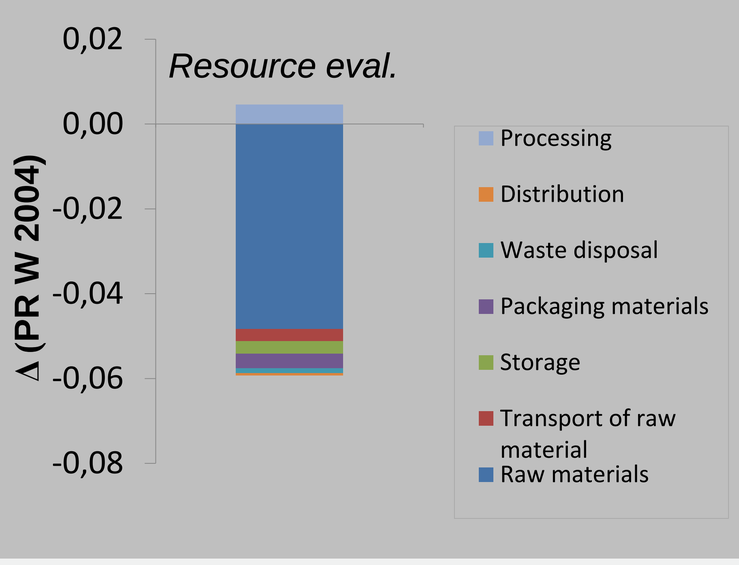
ILLUSTRATIVE RESULTS

General LCIA results (see below):
- Raw materials impact dominant
- Processing and distribution only minor impact *(EDIP 1997)*

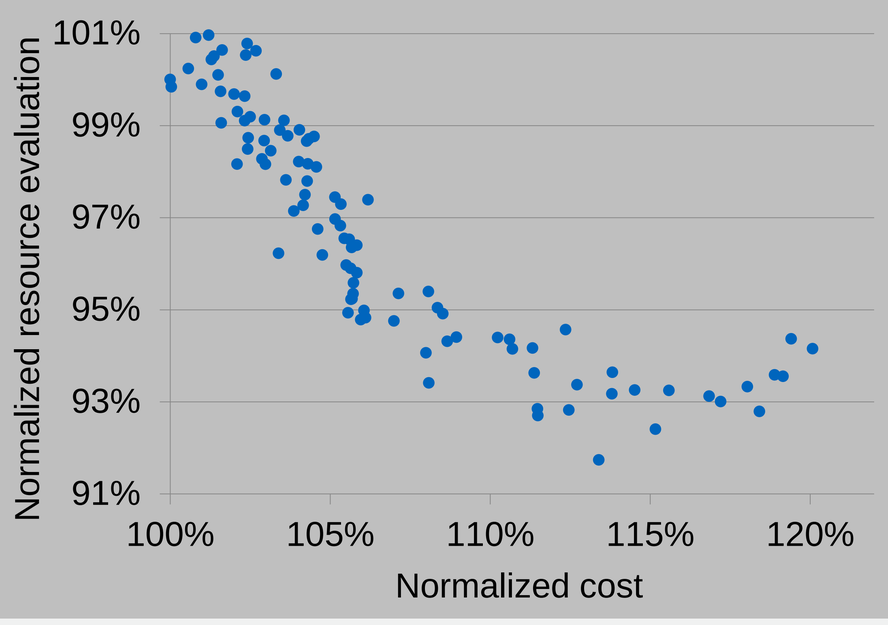
Alternative supply chain scenario:
- Different processing method: Using superchilling in stead of chilling
- New production & distribution plan

Δ-LCA (see right) show us:
- Increased energy intensivity in food processing more than compensated





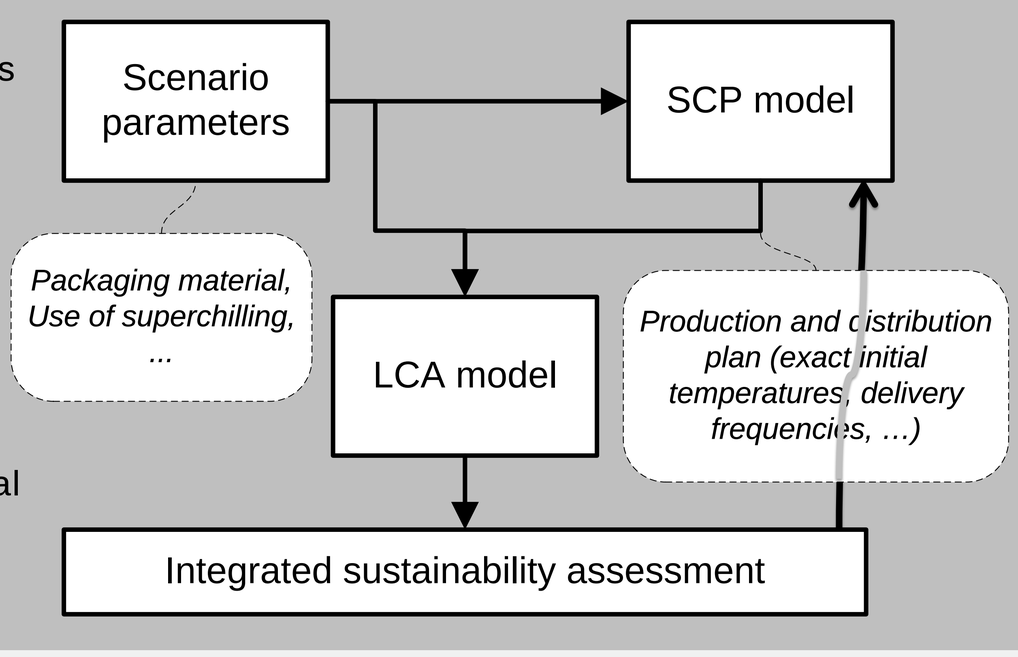
Multi-objective modelling (see below):
- Generation of scenarios (ε-constraint method)
- Range of solutions, taking into account economic and environmental objectives (below: costs vs. resource depletion potential)
  - Mix of different processing options used
  - Mix of different packaging options used
- Can be used to estimate Pareto curve
- Visualization of trade-offs
  - ~8% decrease in resource depletion potential requires ~15% cost increase in the supply chain



METHOD

Scenario development:
- Distribution of meal elements
- Several processing and packaging options, most importantly:
  - Chilling vs. superchilling
  - Cardboard vs. polystyrene

Integrated assessment:
- LCA results partially provide SCP model parameterization in terms of the environmental performance measures.
- SCP in turn generates new supply chain planning



Supply Chain Planning (SCP):
- Integer programming model[1]
- Economic and environmental objectives
- Detailed modelling of thermodynamic behaviour of the food products
- Software: OPL 6.0 + CPLEX 11.1

Life Cycle Assessment (LCA):
- Product system model[2] of production and distribution components
- Several tailor-made submodels, especially to do detailed modelling of distribution phase based on SCP input
- Gives feedback to SCP model
- Software: GABI 4 + EcoInvent 2.0

References: 1- Wang, Y., Akkerman, R., Grunow, M. (2011), *Supply chain planning for super chilled food products*, SSRN Working Paper Series (available at http://ssrn.com/abstract=1923948).
[2] Wang, Y., Akkerman, R., Birkved, M., Grunow, M. (2011), *Supply chain planning with sustainability considerations: an integrative framework*, 18th EurOMA Conference, July 3-6, 2011, Cambridge, UK.

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