Sustainable Food Logistics Management

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ESI 2014;
Workshop on OR in Agriculture and Forest Management

Content Sustainable (Food) Logistics Management

Concepts/methodology	Applications
1. How to assess Sustainability	1. Projects SCALE/SALSA
2. Trade-off between multiple objectives	2. Projects SALSA/Valorization
3. Closing loops / Circular economy	3. Projects Valorization of By-products
	4.(Stochastic applications)
Questions & discussion	Questions & discussion

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Sustainable Food Logistics Management

Management Science:
The Science of Better

Life Sciences:
To Improve the Quality of Life

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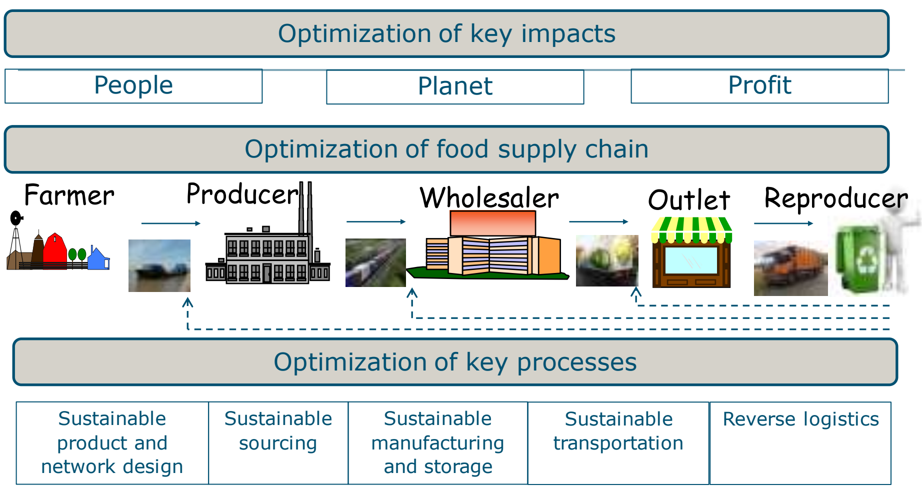
Framework Sustainable Food Logistics Management



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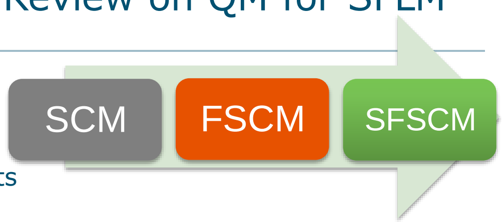
Sustainability & SCM

Sustainability:
Sustinere (latin): to maintain, endure

Triple Bottom Line:
Responsible management of environment, economy and society

Supply Chains/Networks: *Planning and management of all activities involved in sourcing, procurement, conversion and all* ***logistics management*** *activities (plan, implement and control efficient and effective forward and reverse flow and storage of goods, services and information between point of origin and point of consumption)*

Lessons learned from literature: Soysal et al. (2012): Review on QM for SFLM

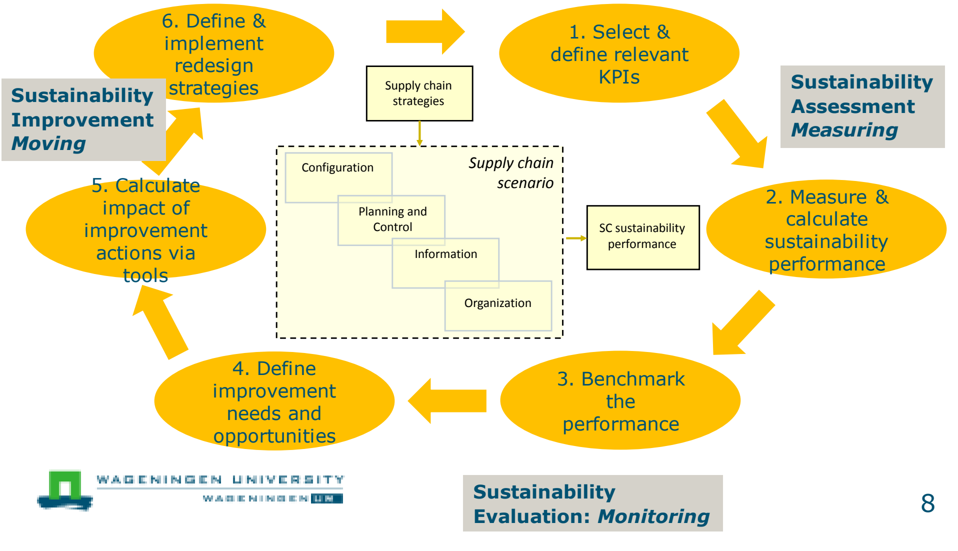


- FSC systems: complex
  - wide diversity products
  - many quality requirements
- Key logistic aims:
  - Cost reduction and improved responsiveness
  - Improved food quality and reduction of food waste
  - Improved sustainability and traceability
- Quantitative modelling challenges:
  - Variabilities, continuous quality degradation, multi indicators, multi objectives, system boundary

Reading materials / main authors

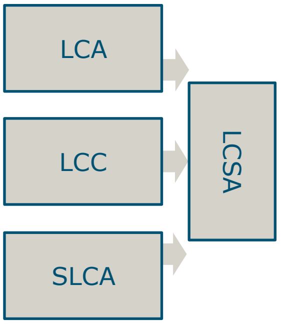
- Ahumada, O., Villalobos, J.R. (2009), Applications or planning models in the agri-food supply chain": a review, EJOR 196, 1: 1-20
- Akkerman, R., Farahani, P., Grunow, M. (2010), Quality, safety and sustainability in food distribution: a review of quantitative operations management approaches and challenges, OR Spectrum 32(4), 863-904
- Seuring, S., Muller, M. (2008), From a literature review to a conceptual framework for sustainable supply chain management, J Cleaner Prod 16(15): 1699-1710.
- Seuring, S., (2013), A review of modeling approaches for sustainable supply chain management, DSS 54(4), 1513-1520.
- Brandenburg, M. et al (2014): Quantitative models for sustainable supply chain management: developments and directions, EJOR 233, 299-312

Stepwise approach for sustainable supply chain management



From LCA to Life Cycle Sustainability Analysis (LCSA)

- Transdisciplinary integration framework of models from various disciplines for future LCA
- Covering all three dimensions of sustainability (people, planet, profit)
- Process LCA / EIO-LCA / hybrid LCA / LCC / SLCA
- From product oriented to sector/chain oriented to economy oriented
- Equilibrium models / optimization models / system dynamics models



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Quantifying sustainability

- *"Without a quantitative framework, sustainable development lacks a solid foundation on which to advance" (OECD)*
- *No internationally accepted standard defines what 'sustainable food production' essentially requires (FAO, 2012)*
- *Neither a commonly accepted set of indicators that have to be taken into account when measuring sustainability performance, nor widely accepted definitions of the minimum requirements that would allow a company to qualify as 'sustainable', exist" (FAO, 2012, p. 9)*
- *Different (types of) SC players with different roles in # chains, with potentially conflicting strategies have to agree on which metrics to use, with which data and deal with confidentiality issues (Hassini et al., 2012)*

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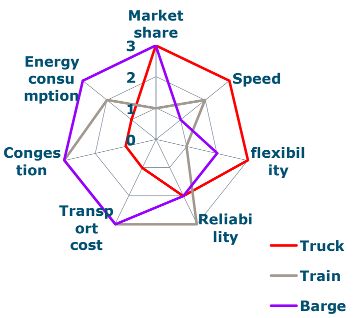
Indicators for People, Planet and Profit (3P) (adapted from United Nations)

Social	Environment	Economic
Employment	Food Miles	Material use
Quality of life	Water use	Percentage of food lost
Food Safety	Carbon intensity of energy	Transport efficiency
Nutritional value of food	Land usage	Output growth
Fair trade	Use of fertilisers	Added value
Share of food in consumption	Generated waste	Waste recycling/reuse

Measuring Sustainability

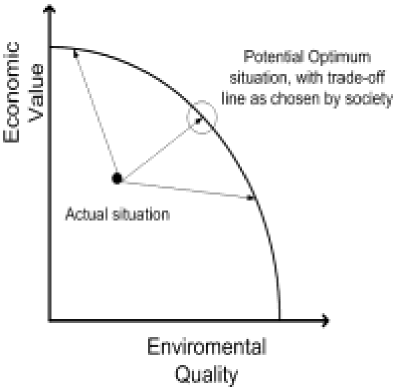
- Multi-dimensional sustainability standards:
- Scoreboards, Dashboards, Radar diagrams



Multi-objective programming (MOP)

- It helps to solve the problem of simultaneous optimisation of several objectives subject to a set of (linear) constraints.

Purpose:
Find set of Pareto optimal solutions; set of feasible solutions with the property that there is no other feasible solution that performs strictly better for at least 1 objective and the same of better for all objectives.



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Exercise: Bread chain

Minimize total costs & total CO_2 emissions

	Flour			Yeast			Salt	
Amount of required material (kg)	1000			23			18	
Suppliers	A	B	C	D	E	F	G	H
Costs (€/kg)	0.7	0.8	1	1.6	2	2.5	0.75	0.85
CO2 emitted (g/kg)	31	30	29	80	70	60	50	10

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Exercise: minimize costs

	Flour			Yeast			Salt	
Amount of required material (kg)	1000			23			18	
Suppliers	A	B	C	D	E	F	G	H
Costs (€/kg)	0.7	0.8	1	1.6	2	2.5	0.75	0.85
CO_2 emitted (g/kg)	31	30	29	80	70	60	50	10

Solution: Xa = 1000, Xd=23, Xg=18:Costs 750.30, Emissions: 33740

Exercise: minimize emissions

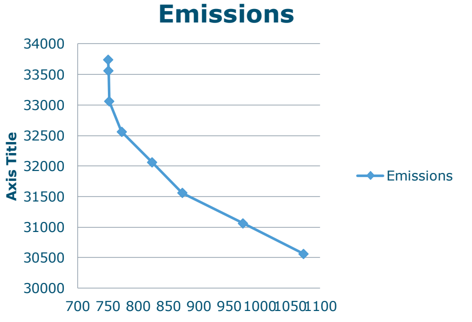
	Flour			Yeast			Salt	
Amount of required material (kg)	1000			23			18	
Suppliers	A	B	C	D	E	F	G	H
Costs (€/kg)	0.7	0.8	1	1.6	2	2.5	0.75	0.85
CO_2 emitted (g/kg)	31	30	29	80	70	60	50	10

Solution: Xc = 1000, Xf=23, Xh=18:Costs 1072.8, Emissions: 30560

E-Constraint method (Andersson, 1999)

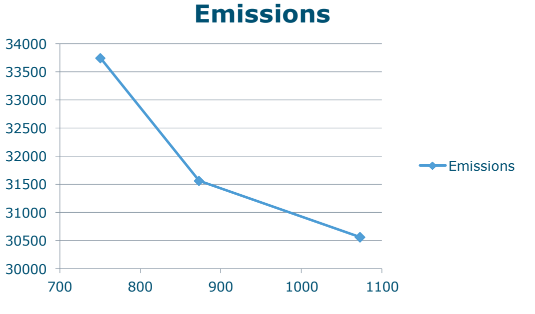
- Optimize one of the objectives while the others are specified as constraints:
- Min costs while emissions <= E_i
- E_i varies between E_min (30560) and E_max (33740)

$$\begin{aligned} &\min \ OF1 \\ &s.t. \\ &OF2 <= e \end{aligned}$$



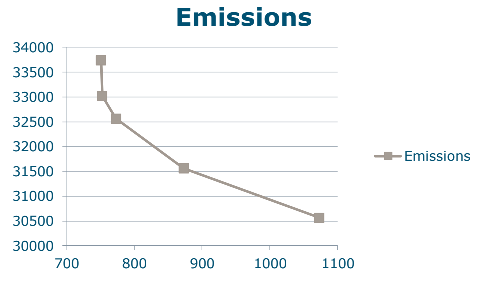
Weighing method

- Romero, C. Rehman. T. (2003), Ch4, MOP, In: Multiple criteria analysis for agricultural decisions, Elsevier.
- Combine the objectives into one single objective
- Min w1*Z1 + (1-w1)*Z2



Multigoal programming

- Min [gap to target_1; gap to target_2]
- Subject to:
  - Sum of all costs – G1 = 750 (C_min)
  - Sum of all emissions – G2 = 30000 (E_min)



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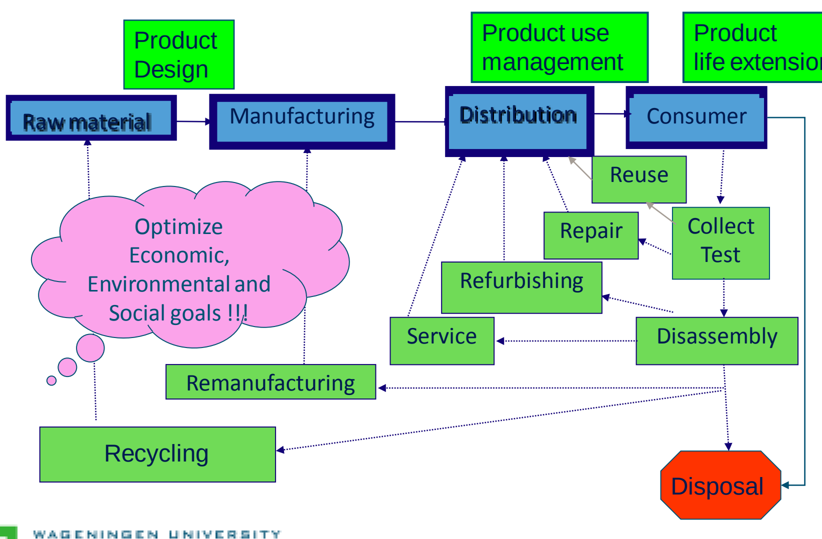
Sustainable Closed Loop Chains



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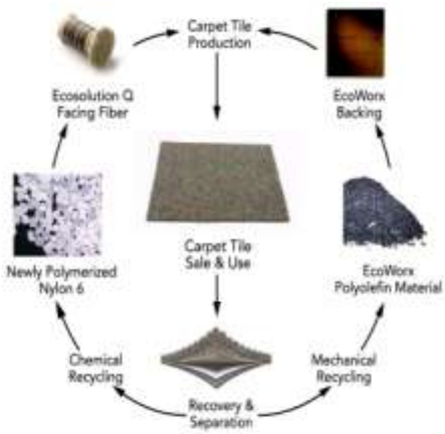
…from linear to circular economy...



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