Life Cycle Based Research In Food and Agriculture

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LIFE CYCLE ASSESSMENT (LCA)

LCA is a method for environmental assessment of products ("functions")
We identify the environmental impact of the product from raw material to waste.
The Phases of Life Cycle Assessment

- Goal and Scope Definition
- Inventory
- Categorisation
- Interpretation
Functional Unit!
Organic Potato Cultivation

Transport

Packing Company

Distribution

Retailer

Transport

Household

Production

Waste Management

Production of seeds, fertilizers etc.

1.7 kg

1 kg of boiled peeled potatoes
Allocation of environmental impact

Fishery

Cod  By-catch

Dairy cows

Milk  Meat

Very common in agriculture!
Systems expansion – a method to avoid allocation

DAIRY COW

MILK

MEAT

BEEF COW

MEAT

DAIRY COW

MILK
LCA and Environmental Impact Assessment

- $\text{CO}_2$: 1 g CO$_2$-equiv. / g CO$_2$
- $\text{CH}_4$: 21 g CO$_2$-equiv. / g CH$_4$
- $\text{N}_2\text{O}$: 310 g CO$_2$-equiv. / g N$_2$O

Global Warming Potentials

[g CO$_2$-equiv. per kg product]
Impact Categories

Resource use
Energy use
Water use
Land use
Climate change
Photooxidant formation
Ozone depletion
Acidification
Eutrophication
Toxicity
LCA, research case studies

- Bread
- Ketchup
- Baby foods (carrot puree, cereal based drink)
- Milk production (farming)
- Dairy processing (Cleaning)
- Cheese
- Cod
LCA, contract studies

• Vegetable oils
• Milk
• Beef
• Pork
• Poultry
• Hamburger bread
• Potatoes
• Lettuce
General results

• Primary production (agriculture, fishery) is often very important, especially for foods of animal origin

• Eutrophication is the most important environmental effect for foods, followed by energy use

• Toxicity is very difficult to assess

• Food systems have specific environmental impacts, since the production is performed in open systems

• The function of foods is difficult to define
General results (continued)

• Agriculture (Eutrophication, Energy, pesticides)
• Industry (Energy)
• Packaging production (Energy, acidification)
• Truck transport (Energy, Acidification)
• Retail (Energy)
• Households (Energy, Acidification)
• ”Post-consumption” (Eutrophication, Energy)
Conclusions from using LCA on food products

- The method provides a snapshot of the system
- A very good accounting of a products environmental impact
- A static presentation
- But, improvement analysis needs to be developed
Development based on LCA
- Two main lines

1. Modelling of future systems

2. Environmental assessment of changes in the production system (technological, organizational, product development etc.)
Environmental assessment of changes in the production system (1)

• Driving forces / need for development: How should the environmental impact of changes be evaluated?
  – New technology
  – New products
  – New production organisation

• Systems approach, using LCA methodology
Example: Zero discharge dairy, reducing emissions from dairies by:

- New measurement- and control technology
- Filtration and reuse of waters and wastage
- An environmental assessment using LCA was performed for the improvements suggested within the project
Environmental assessment of changes in the production system (3)

• Different perspectives how to assess the change, e.g. less wastage in a dairy:
  – More products produced
    • Less environmental impact per produced unit
    • How does this affect other products on the market?
  – Less raw material needed
    • What happens with the surplus land etc?
Environmental assessment of changes in the production system (4)

Today’s system
- More raw milk
  - Dairy
  - More feed
  - More waste water

New system
- Less raw milk
  - Dairy
  - Less feed
  - Less waste water
Environmental assessment of changes in the production system (5)

• Two scenarios were analysed using a simulation model based on LCA methodology
  – A combination of the most promising new technology and knowledge from the project, “technical development”
  – A changed production planning scheme, “fewer deliveries”.
Global Warming

- Today's system:
  - Soy meal: 2,000 kg CO₂-equiv./week
  - Extra milk: 5,000 kg CO₂-equiv./week
  - Cleaning: 1,000 kg CO₂-equiv./week

- Technical development:
  - Soy meal: 1,000 kg CO₂-equiv./week
  - Extra milk: 1,000 kg CO₂-equiv./week
  - Cleaning: 1,000 kg CO₂-equiv./week

- Fewer deliveries:
  - Soy meal: 1,000 kg CO₂-equiv./week
  - Extra milk: 1,000 kg CO₂-equiv./week
  - Cleaning: 1,000 kg CO₂-equiv./week
Modelling of future systems (1)

• Questions:
  – What environmental impact will future systems have?
  – How could more sustainable supply chains look?

• Modelling to perform ”LCA for future systems”

• Food Chain 21 project, modelling of future supply chains for:
  – Dairy
  – Potato
  – Wheat
  – Meat
That’s it, what’s next?

• LCA is a very useful tool, or approach, when analysing food systems, but more “basic” development is needed
  – Ecosystem effects, e.g. of fishery and grazing animals
  – Toxicity (both eco- and human toxicity)
  – Land use

• Analysis of future systems can use LCA as a concept but the scenario methodology needs to be further developed
  – What are the functions of food?
  – How design scenarios for entire food systems?
  – How will changes in production affect the market?