Environmental Impacts of Organic Products in a Life Cycle Perspective

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1st International Seminar "Organic Food Processing"

IFOAM 2000 – The World Grows Organic

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Literature

JUNGBLUTH, N., TIETJE, O., SCHOLZ, R. 2000: "Food Purchases: Impacts from the Consumers' Point of View Investigated with a Modular LCA." In Int. J. LCA, Vol. **5** (3): 134-142, www.uns.umnw.ethz.ch/~jungblu/publication.html.

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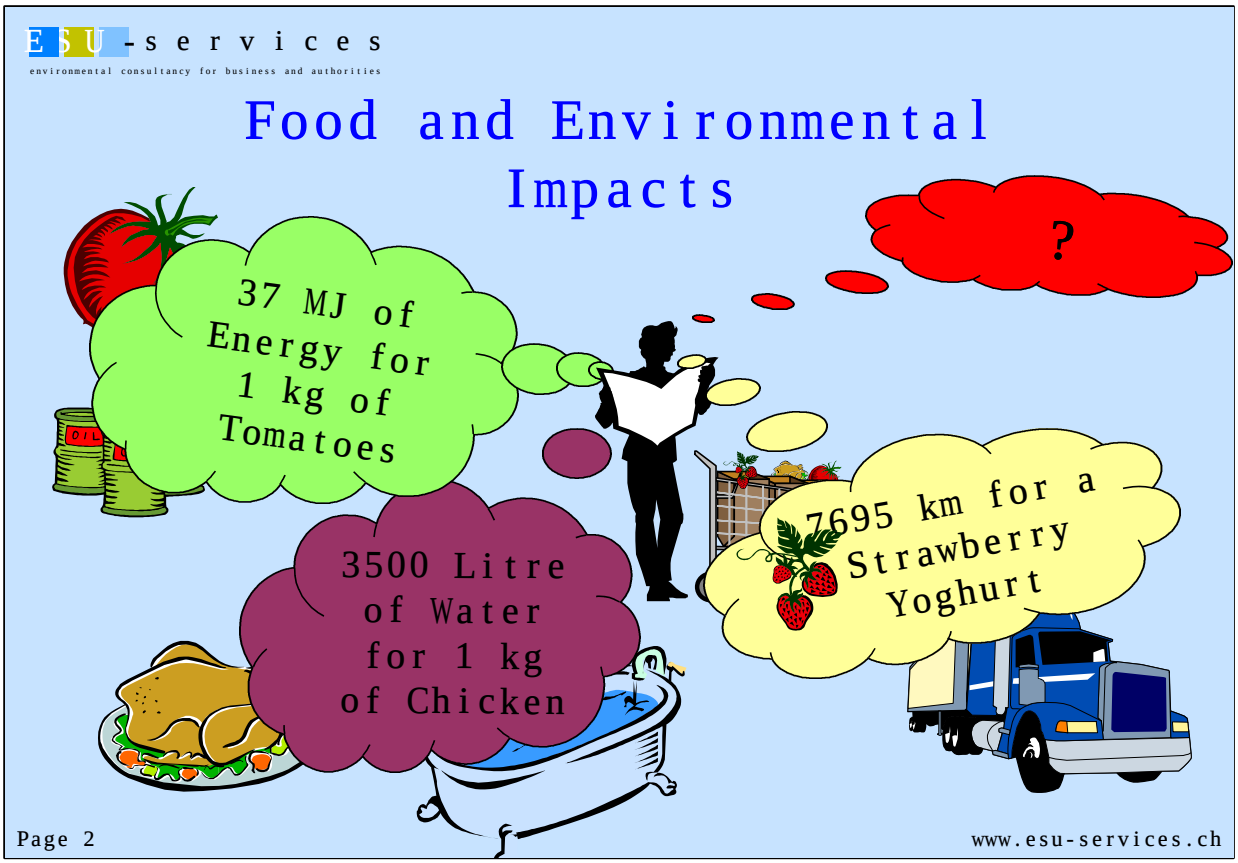
Links

LCA-network food http://www.sik.se/sik/affomr/miljo/lcanetf.html



Different information regarding the environmental impacts of food purchases are discussed in the public. ...

One can read for example that thirty-seven mega joule of energy are used to produce one kg of tomatoes. Or, newspapers publish the fact that the different ingredients of a strawberry yoghurt are transported over a summed distance of over 7000 kilometres. Another survey shows that the amount of water used to produce one kilogram of chicken is about 3500 litres.

All these information show different possibilities for an environmentally sound behaviour. But in reality it seems to be difficult for the consumer to order these hints and to assess the relevance of different types of information.

This confusion from the consumers' point of view was the starting point for my dissertation. Today i will present some results from this work.

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Contents

- Research questions and goals
- Review of life cycle assessment for food products
- The method of a modular life cycle assessment (LCA)
- Results of this LCA
- Conclusions for different actors

My presentation consists of the following parts:

First I will give a short introduction for the environmental valuation method life cycle assessment (LCA) and review research results. Then I will present my research questions and goals for the life cycle assessment. In the next step the approach of “A modular life cycle assessment” is introduced.

The results of the modular LCA are shown in the third part of the lecture. Conclusions for different actors are drawn out of these results.

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Research Questions and Goals

- What is a good environmental choice from the consumers' point of view when purchasing vegetables and meat?
- Which options for environmental improvements do other actors of the food chain have?

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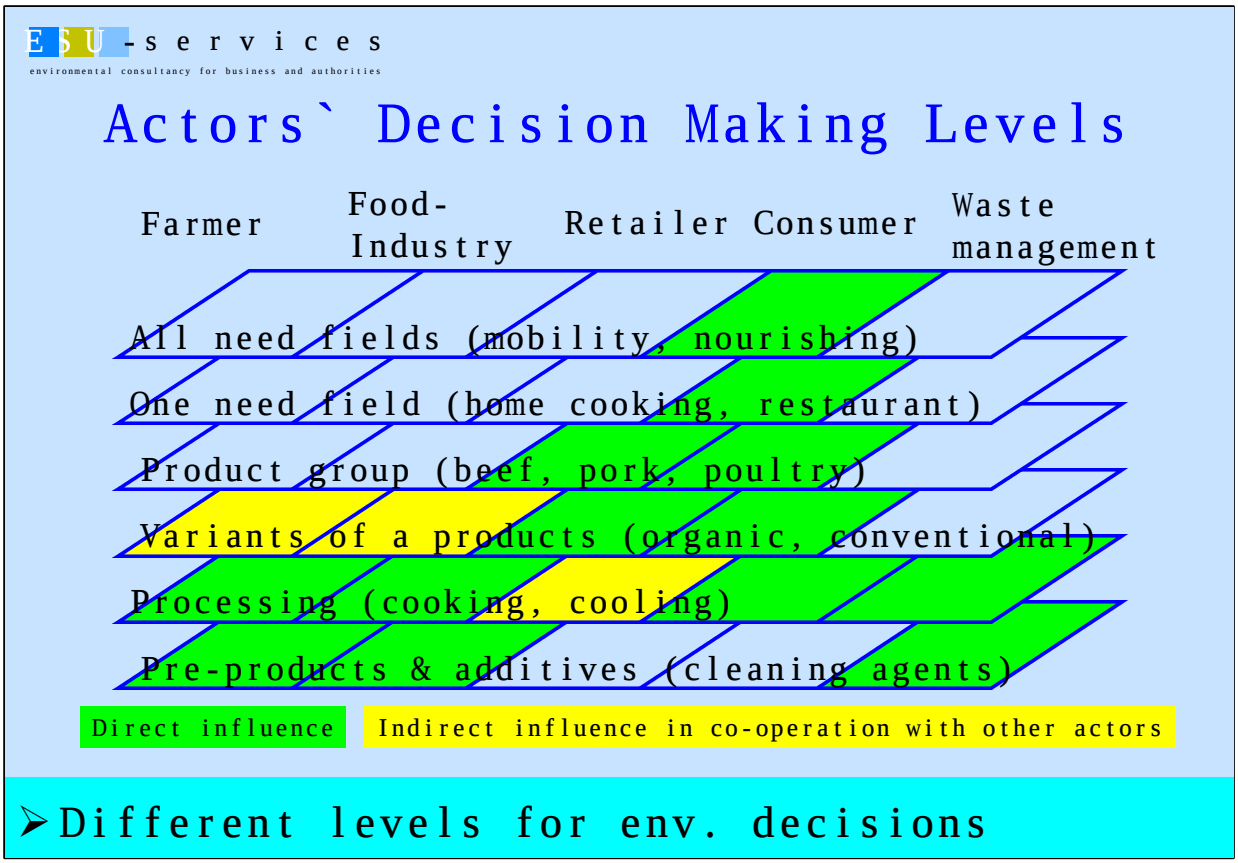
Starting from the confusion about environmentally sound behaviour my research addresses the following questions:

What are the possibilities for an ecological behaviour from the consumers' point of view? The answer should consider all relevant stages in the life cycle, it should show a range of environmental impacts relevant for this life cycle and it should be simple enough to be communicated to consumers.

Today i will also focus on the options of other actors in the food chain.



In this table, we identify the levels of decision-making at which the different actors have possibilities for environmentally relevant actions. They assume that consumers have the widest range of possibilities open to them to behave in an environmentally sound manner.

A consumer can decide to shift money from one field of need (e.g. mobility, nourishing) to another. This might be environmentally relevant if one spends, for example, less on travelling, but more on eating in an organic-food restaurant. Within the need field of nourishing one can decide, for example, to eat mainly in fast-food restaurants or to consume only vegetarian food. Closely related is the level of decision among different product groups (vegetables, meat). In one product group (e.g. meat), one can choose to buy more pork or more beef. Decisions within one product category (e.g. cabbage) with different products (e.g. cauliflower, red cabbage, etc.) are very similar. Often the choices among variants of a product (e.g. organic or conventionally grown carrots) are more relevant for consumers. If the decision has been made for one product, there is still a possibly relevant choice, e.g. for a certain packaging. The consumer can also decide about the processing (e.g. cooling, cooking) of a product in the household. All levels of decision-making are relevant for the overall environmental impacts of individual consumption patterns.

Other actors in the food chain do not have such a variety of environmentally relevant decisions. They are more dependent on the market and on decisions of cooperating actors. Decisions about processing, pre-products or additives are mainly relevant for the producing or processing actors (food industry). An ice-cream producer can decide for example about the use of certain raw materials, or reduce the amount of energy used in the factory, but he or she normally does not consider producing beer instead of ice cream due to environmental reasons.

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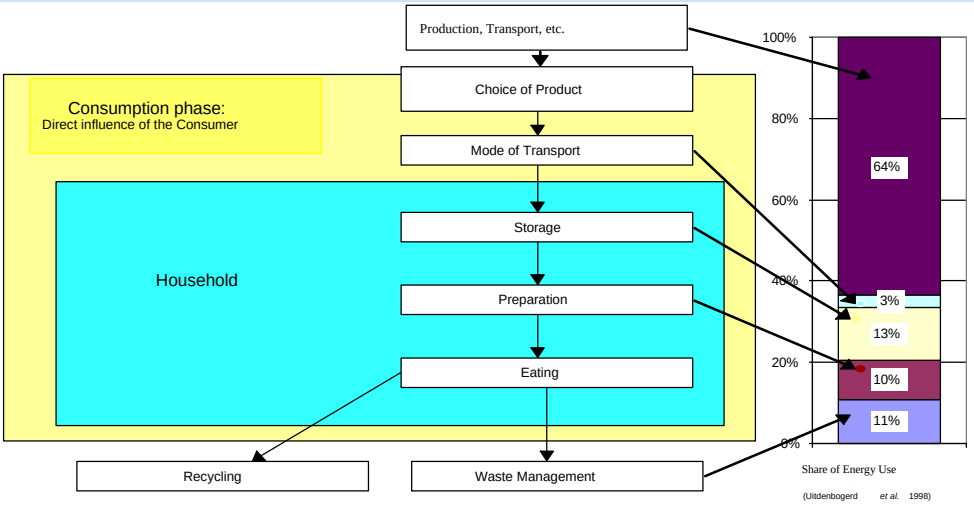
Consumer Choices in the Life Cycle of Food Products



➢ Pre-consumption dominates the energy use

The following figure illustrates the possible decisions from a consumer's point of view in a life cycle perspective. A first choice is to look at the energy use in different stages in the life cycle of average food consumption. About two thirds energy use arise already during the production of the food until it reaches the shopping basket of the consumer. About one fourth of it takes directly place during the consumption phase. At the end the consumer makes a decision about the waste management for packaging or food wastes.

The graphic shows that it is very important to look at the production stage when discussing the environmental impacts due to food consumption.

Different levels of decision making exist for the consumer while judging the impacts of production. One can choose for example between a normal and a vegetarian diet. Or the consumer can try to buy products with the most environmentally friendly packaging material.

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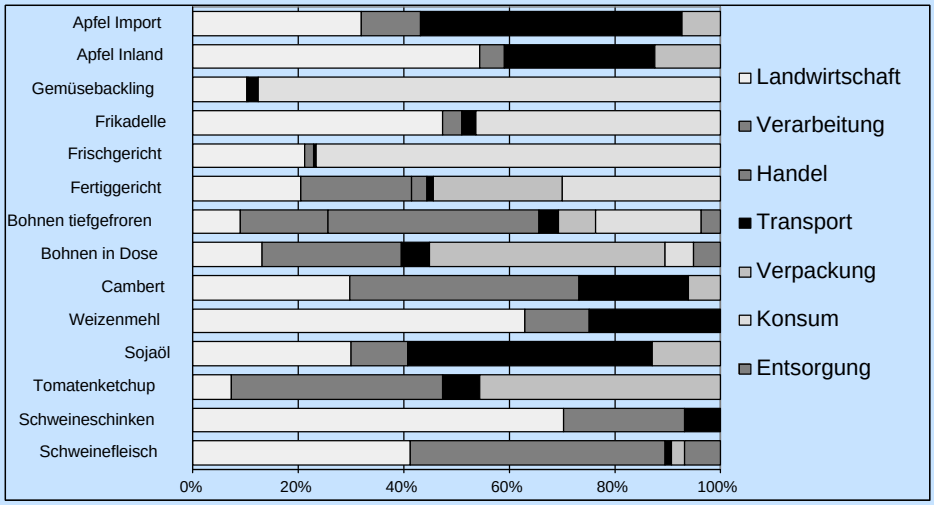
Energy Use in Production



➢ All stages of production might be important

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This figure shows an overview for the energy use investigated in different studies. The energy use in different stages of food production varies among different products. It is not possible to outline the important stages for the life cycle in general.

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Environmental Impacts of Agricultural Production

- In agriculture many impacts are independent of the energy use:
  - Eutrophication and acidification due to fertiliser use
  - Impacts on biodiversity due to land use and pesticide application

➢ Different types of environmental impacts must be accounted for

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Many studies on food consumption use energy as a screening indicator which is widely accepted. But, LCA's for food products show that this is not a useful approach in case of agricultural products. A lot of environmental impacts are independent of energy use. These are the emissions due to the use of manure, dung and other fertilisers, the land use and the impacts of pesticides. Thus a more detailed approach is necessary.

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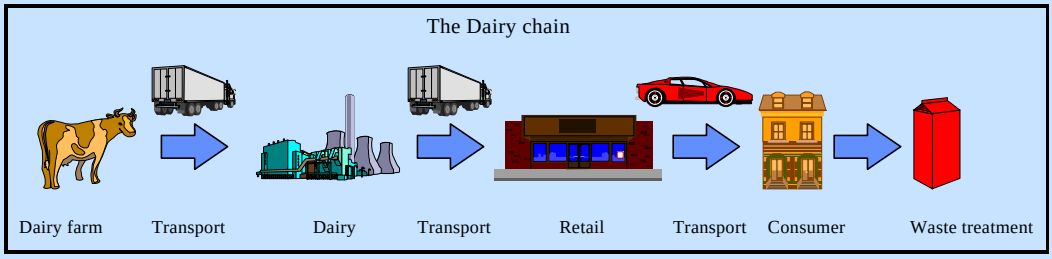
Life Cycle Assessment for Food Products



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➢ LCA looks from cradle to grave

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The method life cycle assessment has been standardised through ISO 14040 Norm. In consists of four different steps.

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Results of LCA Studies for Organic Agriculture and Food Products

- Organic agriculture shows in most cases lowerer impacts than conventional production, but in some cases higher impacts that integrated production
- Regionalism is not a sure way of environmental improvement due to varying impacts of transportation and conditions for production

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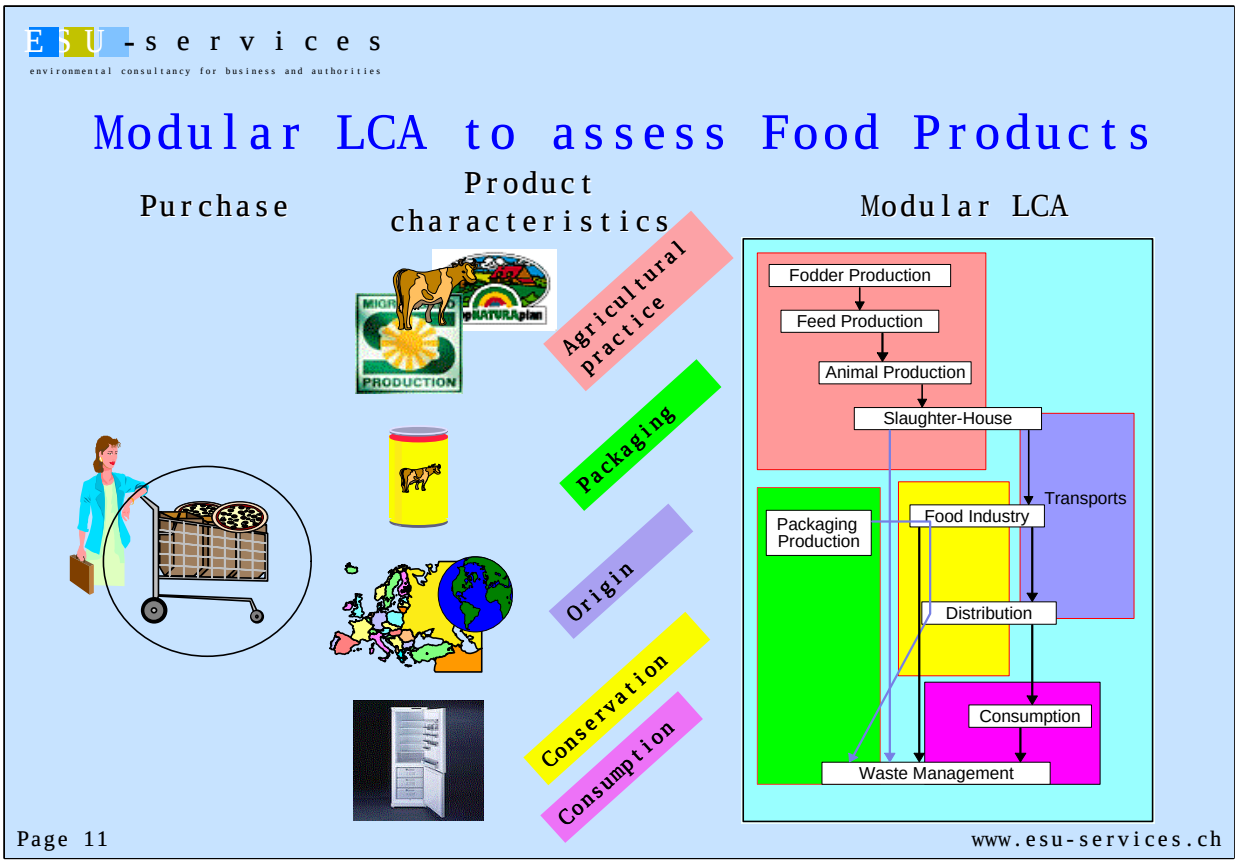
Some LCA studies have been executed for single products, agricultural production techniques and food products. The comparison of organic production with other production methods depends on certain normative settings during the survey, e.g. functional unit for comparison (area or product), indicators for environmental impacts considered (e.g. energy, toxicity, or land use).

Regional products are not in every case better than imported products, because the impacts of transportation depend strongly on the transport mode (ship transport has relative low impacts). Better natural production conditions in other countries might outweigh the impacts of transportation. It has to be kept in mind that not only the transport of end products, but also the transport of intermediate products e.g. fodder might contribute significantly to the total environmental burden.



Now I come to the question of how to evaluate the environmental impacts in the necessity field of nourishing. Vegetables and meat had been chosen as the products to be investigated in detail.

It is impossible to calculate a separate LCA for each product which can be purchased in a shop. Thus in first step, the main product characteristics relevant for the environmental impacts have been identified. These are the type of agricultural practice, the packaging, the transport from the area of origin and the type of conservation. For a full life cycle perspective consumption should be considered.

The figure shows the modular LCA approach as it has been developed within the research project. This simplified approach is designed to match the important characteristics identified.

The module “packaging” distinguishes for example between different typical materials. The life cycle-inventory considers the production and the waste management for the packaging necessary for one kilogram of product.

Five separate LCA’s have been performed for the characteristics of a range of food products. At the end the five single modules can be summed up to assess the total environmental burden of a product purchased.

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Inventory for the modular LCA

- Use of existing LCA studies as far as possible
- Agricultural inventory based on economic data
- Simplifications at all stages

➢ Easy environmental assessment with a modular LCA for a range of food products

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The life cycle inventory for this LCA has been simplified as far as possible. A lot of information could be gained from single works of research and LCA studies for single food products. These studies were used to identify the main stages in the life cycle and to gain information on emission factors, allocation procedures, etc.

•The inventory for the agricultural stage has been based on economic data on the use of fertilisers, pesticides and machinery in Switzerland.

•For packaging and transports existing LCA studies could be used for the inventory.

•Difficult to model was the processing of food products. Not many LCA studies exist in this field. And if they exist, they often do not give the full details of the inventory due to reasons of secrecy.

•Environmental impacts of the consumption stage depend strongly on the individual behaviour. Thus they could be calculated only roughly.

The main goal of the study is to show the relevance of the different characteristics. Due to the necessary simplification, the modular LCA can not replace a detailed LCA on specific questions, e.g. the pro and contra of organic production.

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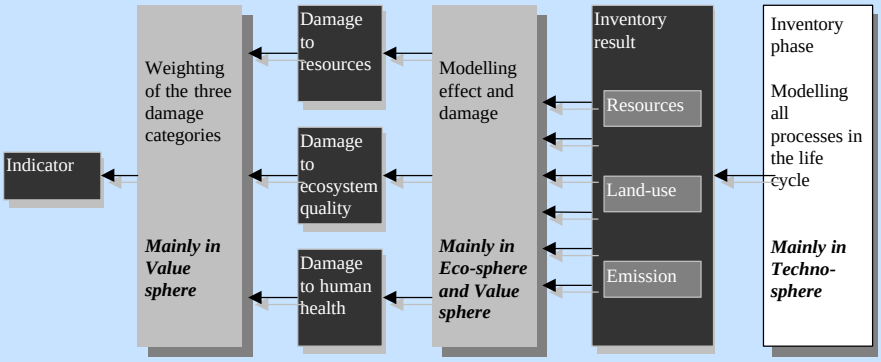
Impact Assessment: Eco-indicator 99



- Models damages instead of damage potentials
- Considers, e.g. greenhouse gasses, pesticides, land use, resource use
- Acidification and eutrophication are not fully modelled
- Direct impacts on the field are not modelled in detail

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The goal for the impact assessment has been to show the impacts as simple and as accurate as possible, according to the state of the art in LCA methodology. It was necessary to use a one-score impact assessment in order to compare easily different product characteristics. Even if the short comings of such an approach are widely discussed, it does not seem possible to evaluate different impact categories for a wide range of vegetables and meat. The results of the life cycle inventory have been summarised with the Eco-indicator 99.

This figure explains the general approach for the Eco-indicator 99. The indicator for a given emission is calculated in different steps.

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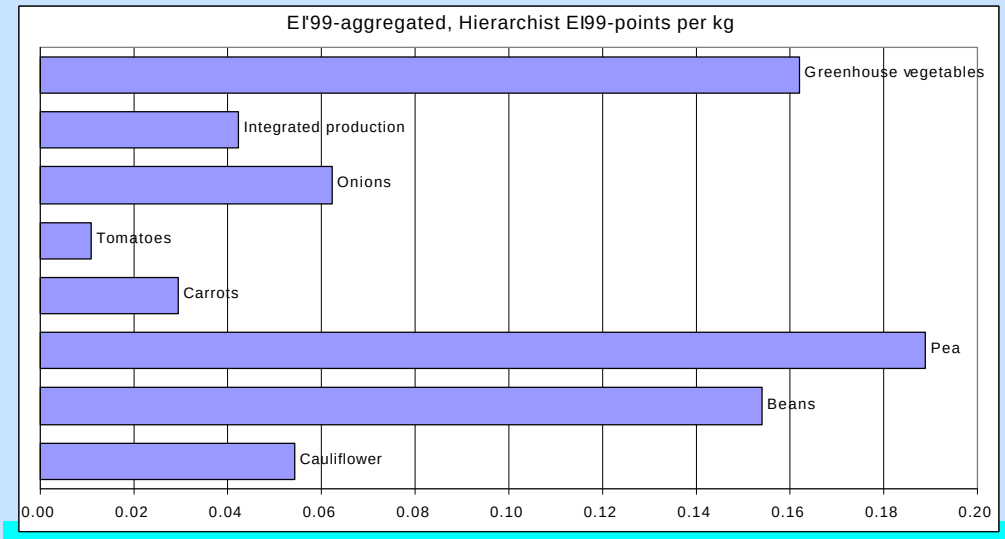
Organic Agricultural Production



- High differences between different (organic) products

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The impacts of agricultural production vary among different products. Thus the choice of input for the processing might also be a way to reduce the environmental impacts. The impacts depend mainly on land use, energy consumption for fertilizers and machinery and the emissions caused by this energy use.

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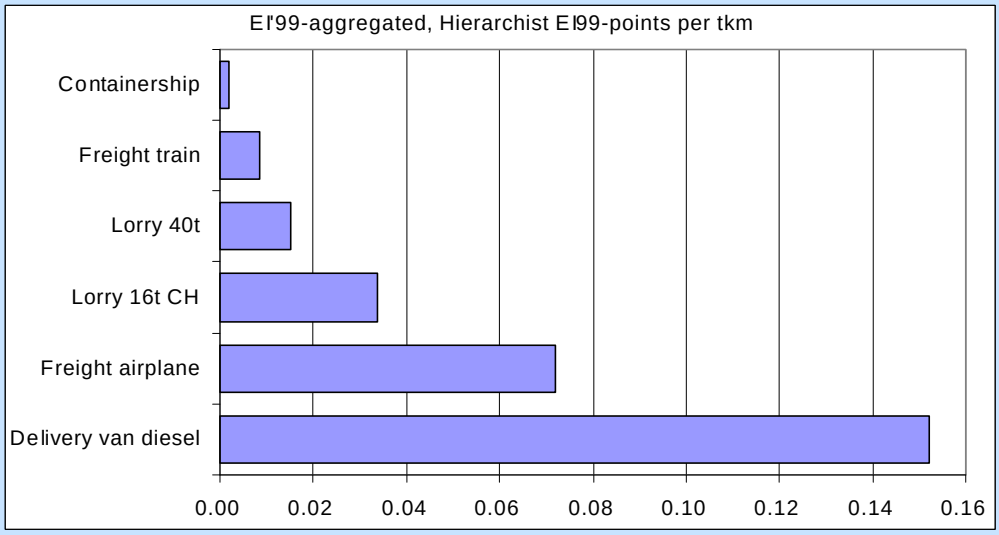
Different Transport Modes



➢ Carrier and distance are important

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The extend of environmental impacts due to transportation depends not only on the distance of transportation, but also on the type of transport mode used for it. Small lorries show much higher impacts per tonne-kilometre than large ones. Transports by air cause higher environmental impacts than transports by ship.

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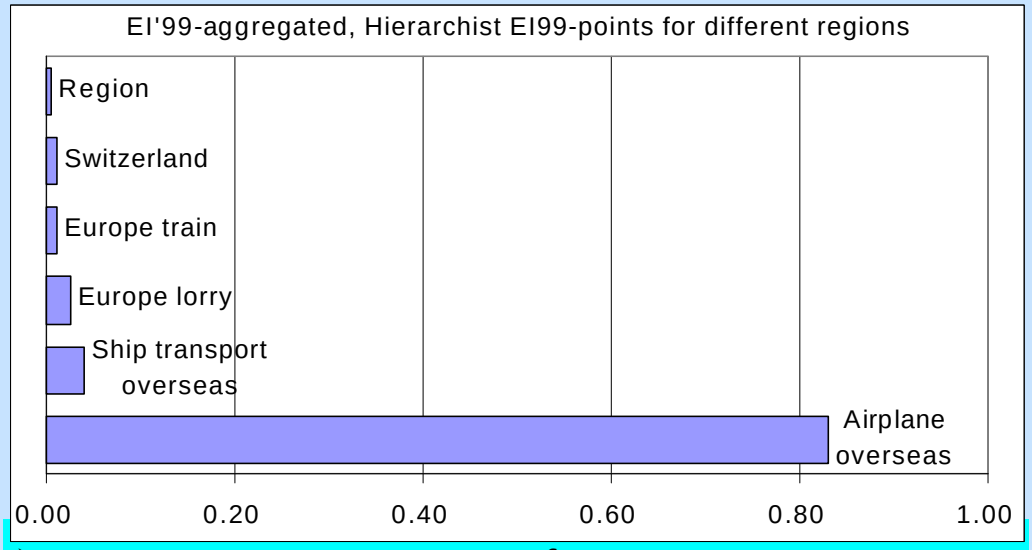
Transports from Production Place



- No air transports for organic products

This figure shows an evaluation of the environmental impacts due to transports from different regions of origin. The highest impacts are caused by products flown in.

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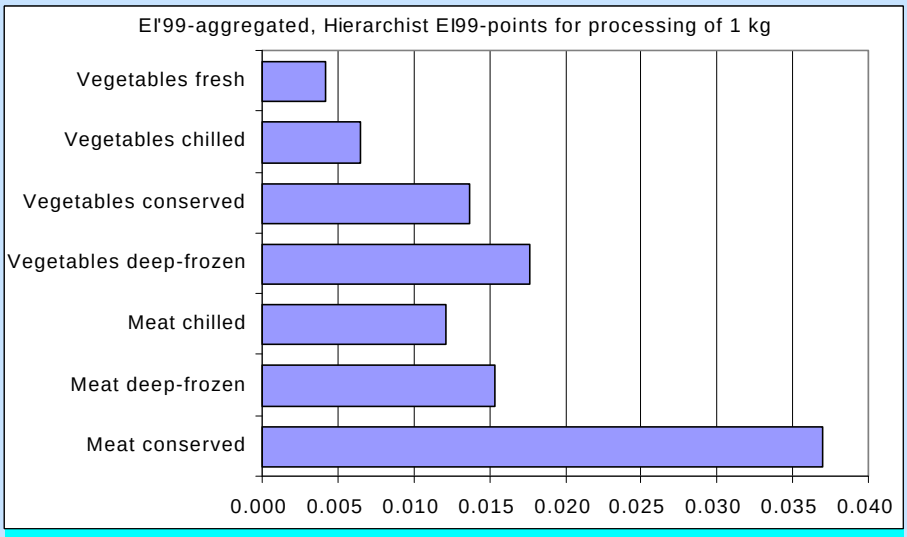
Impacts from Processing



- Processing must be discussed in detail

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The figure shows the impacts of different types of food processing per kilogram. The impacts rise from fresh over chilled and deep-frozen products to the conserved ones. Main impacts arise from direct energy use and water disposal.

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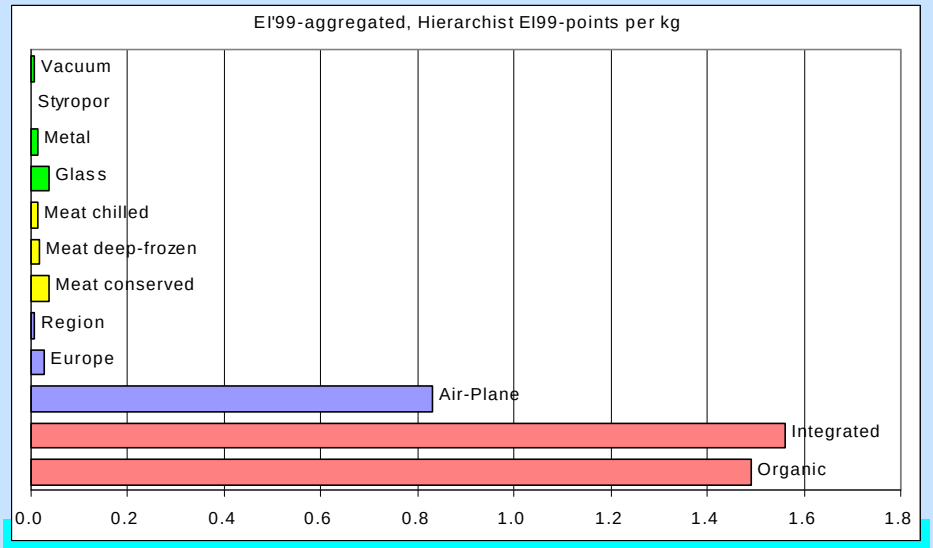
Eco-indicator 99 for Meat



➢ Total impacts are dominated by agricultural production

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This figure shows the EI99 for the modules investigated for the purchases of meat. The overall impact is dominated by the agricultural production. Differences from the consumers' point of view arise mainly from differences among meat from organic and from integrated production. The import of fresh meat from overseas by air adds significantly to environmental impacts. Other product characteristics, such as packaging, conservation method and consumption, are of minor importance.

The impacts of animal production vary considerable for different types of meat. Poultry and pork show the lowest impacts while grazing animals show the highest. This point would merit clarification through a full LCA because, from a top-down assessment, it does not seem to make sense to produce more pork instead of meat from grazing animals in Switzerland. The LCA performed here neither does consider the amount and the type of land available nor constraints due to this for different types of animal production.

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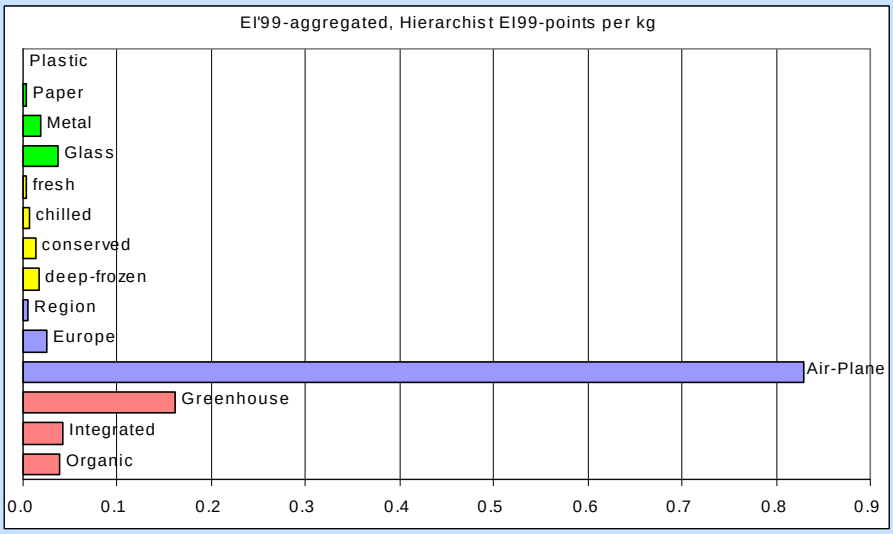
Eco-indicator 99 for Vegetables



➢ All characteristics are important

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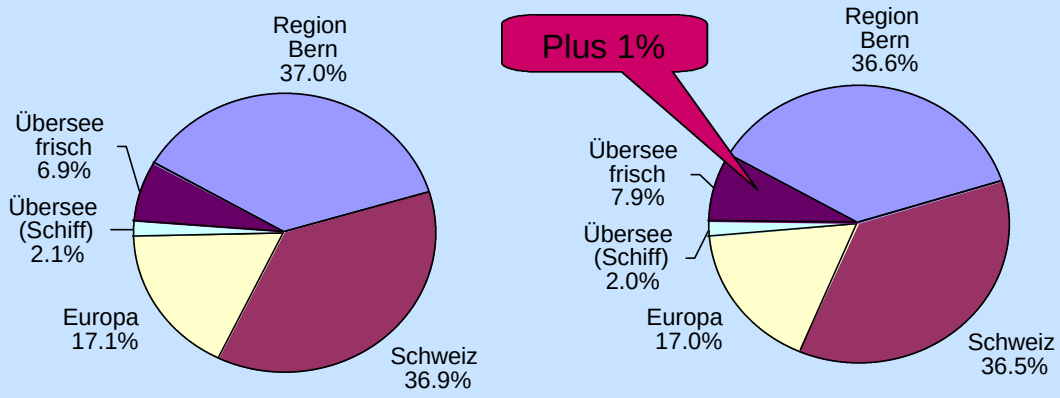
The following slide shows Eco-indicator 99 scores for the different modules investigated for vegetable purchases. In this case, all characteristics make relevant contributions to the environmental impacts of a purchase. The comparison shows a little bit lower scores for organic products compared to products from integrated production. Greenhouse production has much higher impacts than open-air production.

The more energy intensive processing stages contribute to the total environmental impacts. The consumption stage adds significant impacts to the inventory. The region of production and corresponding transports are important, especially if vegetables are flown in from overseas. Packaging, which has gained a lot of public awareness in the past, does not add much to the total environmental scores (with the exception of a glass jar or metal packaging for conserved products) and is thus irrelevant to the consumers' decisions (for this example of vegetables).

Marginal Change of Consumption Patterns

- Which influence has a marginal change of consumption patterns for the average purchases?



Zur Gewichtung von Handlungshinweisen wurde der Frage nachgegangen, welchen Einfluss eine kleine Veränderung im Einkaufsverhalten auf die verursachten Umweltbelastungen hat.

Als Beispiel zeigt diese Folie die Zusammensetzung des durchschnittlichen Warenkorbs für die verschiedenen Ausprägungen des Merkmals Herkunft. Der Hauptteil der Produkte kam aus der Schweiz. Etwa 17% der Produkte waren aus Europa. Obwohl nur etwa 7% der Produkte frisch aus Übersee eingeführt wurden trägt diese Ausprägung 82% zu den Umweltauswirkungen des Merkmals Herkunft bei.

Für die Modellierung der Handlungshinweise wurden die Prozentanteile des durchschnittlichen Einkaufs (linker Kreis) für die verschiedenen Merkmale und Ausprägungen variert. Der rechte Kreis zeigt hierzu ein Beispiel in dem der Anteil der Ausprägung „Übersee frisch“ für das Merkmal Herkunft variert wurde.

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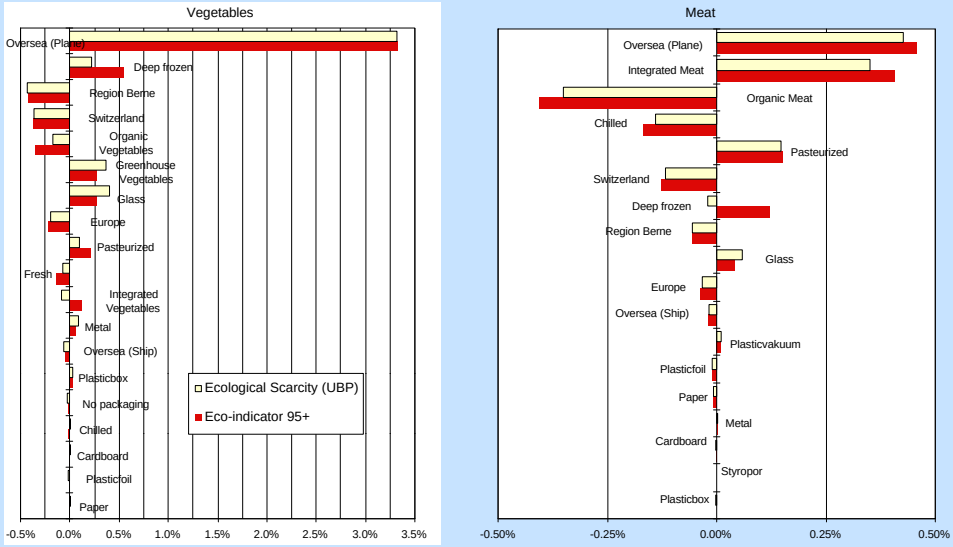
Marginal Change of Consumption Patterns



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Consumers will normally not buy the least polluting products only. However, they can adapt their behaviour and buy more of the environmentally friendly ones. Starting from the average purchases investigated in a diary study, different options for these changes have been compared. The figure gives the increase or decrease of environmental impacts that result from demanding the indicated peculiarity of a characteristic 1% more. One can see from the figure that, e.g. if the share of organic products is increased by one percent, the average impact (valued with Eco-indicator 95+) of a vegetable purchase will decline 0.4%. It has been assumed here that the shares of the products with other peculiarities for this characteristic are changed accordingly. A peculiarity whose bar points to the right should be bought less in order to minimise the environmental impacts.

The change in environmental impacts resulting from a marginal change of purchasing patterns helps to rank the different recommendations for consumers. Fig. 7 can be read as a ranking list of the most important strategies for an environmentally sounder behaviour when purchasing vegetables or meat. The highest change for a meat or a vegetable purchase results from avoiding fresh products flown in from overseas. Less than 10% of the products bought by the consumers in our sample belonged to this category, but they account for over 80% of the environmental burden due to transportation.

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Conclusions for Food Products

- All stages of the life cycle should be considered for ecological product labels
- Air transport and greenhouse production should be clearly forbidden for organic labels
- Transport logistics should be optimised

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Some conclusions can be drawn for the produces, manufactures and consumers of organic food products. Large differences exist between the products with the lowest and the highest environmental impact. Purchases of a certain amount of meat may differ by a factor of eight in the environmental impacts caused.

The highest impact for vegetable purchases is due to a product flown in from overseas. But also products from Europe may differ by a factor of two in the environmental burden.

All product characteristics must be taken into account while judging the environmental performance. Some of the environmentally important product characteristics are not easy to assess by the consumers. These characteristics should be declared on the product packaging or may be integrated in existing guidelines for labels.

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Conclusions for Food Products

- Further research is needed for impacts of different processing steps
- Label criteria for processing should set guidelines for energy use, wastes and effluents
- Packaging is of minor importance for some product groups

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Not much research work has been found on impacts of food processing. It is necessary to establish a background database for different processing stages. Energy use and effluents should be monitored separatly for different processing stages.

For vegetables and meat, packaging is of minor importance. But, results for one product group do not hold true for another product group with another life cycle.

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Granted,
my car consumes a lot
... But, Your
Californian asparagus
needs also 5 liters
per kg!

Download of the Ph.d. thesis
www.uns.umnw.ethz.ch/~jungblu/dis.html

Calculate the environmental impacts
of Your food consumption
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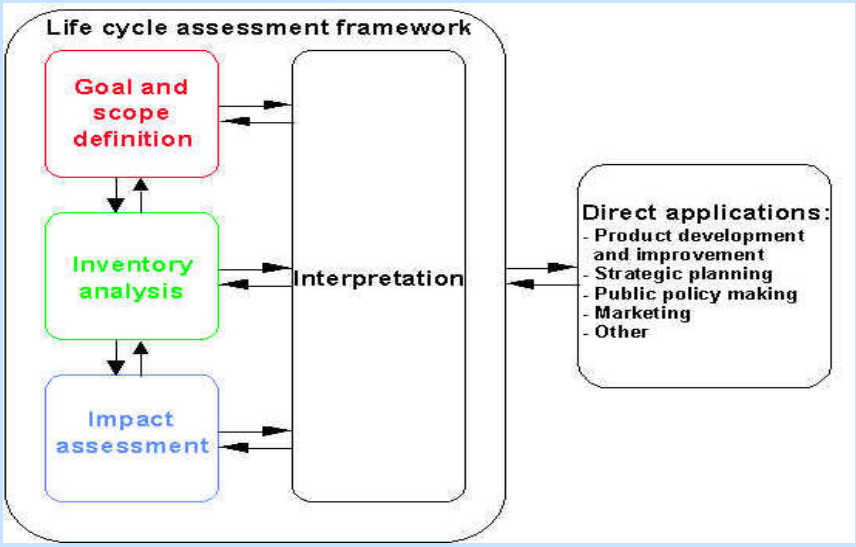
Life Cycle Assessment (LCA) ISO-14040 Norm



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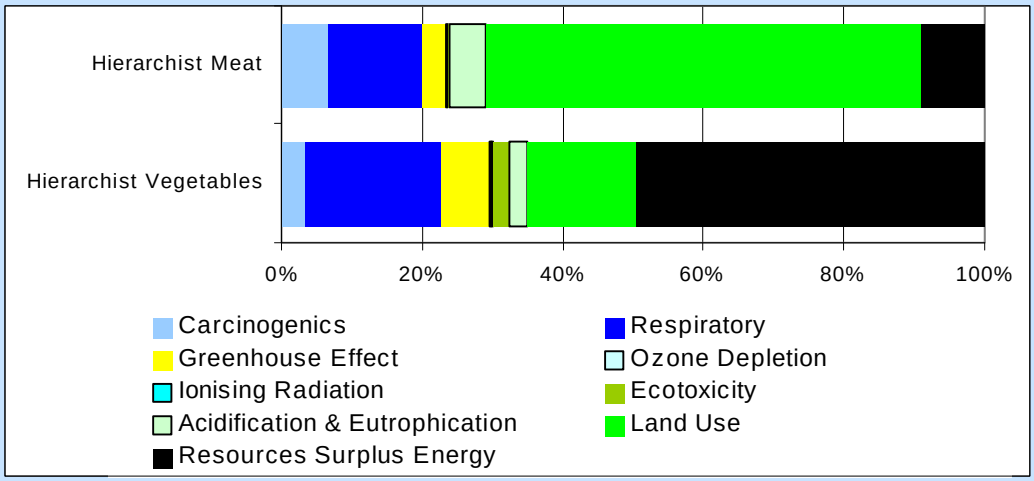
Share of EI99 Damage Categories



The figure shows the share of different damage categories for an average purchase of meat or vegetables. For meat the most important impacts are due to land use. For vegetables the use of energy resources and emissions of particles and CO2 are important. Acidification is also an important damage category.