Life cycle assessment of imported agricultural products – impacts due to deforestation and burning of residues

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Abstract
Life cycle assessment (LCA) of imported oil plants like soybeans or plant oils, e.g. palm oil, is an important issue in many studies for food products and animal production. Quite often, imported products are assessed with the same data as national products. Country specific aspects for the location of production might thus be forgotten.

In an ecoinvent project for the investigation of biofuels several agricultural products have been investigated. The aim of this project was to investigate data for biomass production, conversion to biofuels and use for transport services. The production of fuels like ethanol, rape seed methyl ether, BTL (biomass-to-liquid), etc. is investigated in a way consistent with the existing ecoinvent datasets.

The findings from this project are quite interesting also for studies on food products. The presentation highlights the relevant methodological issues for global biofuel production, like accounting for CO_2 emissions due to land transformation and clear cutting of tropical rain forests. Results from the LCA study for soybeans and oil produced in Brazil and the US, sugar produced in Brazil as well as for palm oil production in Malaysia are presented. The assessment shows that CO_2 and particle emissions due to deforestation and burning of harvesting residues might form an important part of environmental impacts throughout the life cycle. Especially the issue of deforestation should be taken into account for countries with increasing agricultural production area.

Keywords: imported food products, ecoinvent, life cycle inventory, deforestation

1. INTRODUCTION

The extent of environmental impacts of food products depends on various factors, e.g., agricultural technique, transport distance or packaging.

In an ecoinvent project, biofuels from several agricultural products have been investigated [1]. The aim of this project is to investigate data for biomass production, conversion to biofuels and use for transport services. The production of fuels like ethanol, rape seed methyl ether, BTL (biomass-to-liquid), etc. is investigated in a way consistent with the existing ecoinvent datasets [2]. Different types of fuels are compared in a second part of the project [3].

Life cycle assessment (LCA) of imported oil plants like soybeans or plant oils, e.g. palm oil, is also an important issue in many LCA studies for food products and animal production. Quite often imported products are assessed with the same data as national products. Country specific aspects for the location of production might thus be forgotten.

The presentation focuses on the methodology for integrating such aspects and on some examples.

2. METHODOLOGY

Several aspects of modelling have to be considered for the unsustainable use or deforestation of primary tropical forests and its following transformation to agricultural or forestry land. Due to the initial felling, carbon dioxide is released from burning and degradation of unused biomass. Later on, bounded carbon dioxide in the wood is released after its use. Thus it should be considered as a CO_2-release. A second source of CO_2-emissions is the release of carbon bound in the soil. The bounded carbon is degraded after the transformation i.e. to agricultural land. All CO_2-emissions due to land transformation from wood burning and degradation of carbon bound in soil are recorded with a new type of emissions.

The emissions must be allocated among first initial felling with the production of wood and the following use as agricultural or forestry land. Therefore a multi-output dataset is inventoried. First, the land is transformed to "forest, clear-cutting". If no better information is available, all carbon dioxide releases from burning of wood and degradation of soil-bounded carbon content are allocated to the use of the land for agriculture or forestry [1].

Forest and grassland conversion is the major cause for CO_2-emissions in Brazil. A total of 951 billion tonnes of CO_2 have been emitted in 1994. This equals 92.4% of the total CO_2-emissions in the country. Also other pollutants like carbon monoxide, methane, N_2O, etc. are released in important shares due to the land conversion activities. In Malaysia about 7.6 Mio. tonnes of CO_2 are released due to land conversion activities. This equals about 7.8% of the national CO_2 emissions in 1994.

In Malaysia about 150000 ha/a are provided for palm fruits. In Brazil about 2 Mio. ha/a are provided for soybeans. The total increase of area for one production period is considered for the production that takes place during the year 2005.

Among 151 to 190 tonnes of carbon per hectare are bound in the biomass above the ground. The degradation of this bounded carbon depends on the subsequent use of the area. All details are elaborated and described in an ecoinvent report [1].

3. RESULTS

3.1. Soybean production

Figure 1 shows the results for the indicator "greenhouse gas emissions". Without taking the emissions from clear cutting into account soy beans produced in Brazil would have about the same global warming potential as those produced in the USA and a much lower figure than these produced in Switzerland. The picture changes considerable, if the emissions from land transformation are taken into account. The emissions from soybeans produced in Brazil are more than doubled. A similar result can be found for soybean oil from Brazil and palm oil produced in Malaysia.

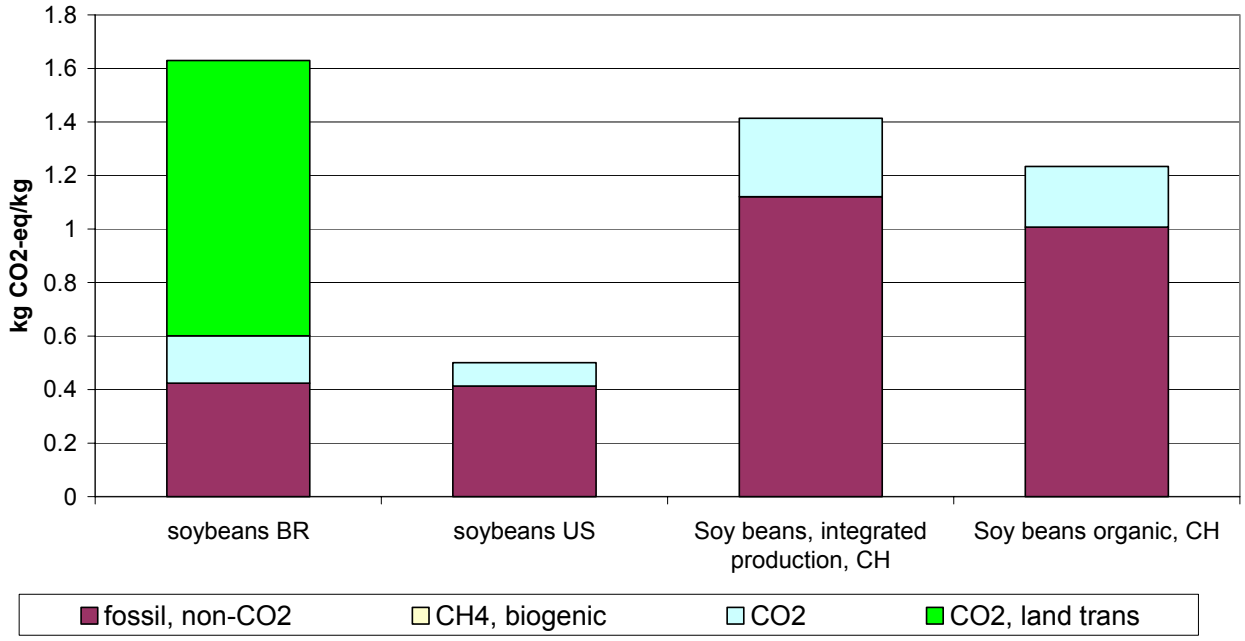

Figure 1 Emission of greenhouse gases for the production of 1 kg soybeans (kg CO2-eq/kg)

The effect of clear cutting the primary forest prior to soybean production is not only important for the release of greenhouse gases, but also for other environmental impacts. Wood residues are burned after clear cutting. During this combustion particles, CO and NMVOC are emitted. Figure 2 shows a life cycle impact assessment with the new Swiss ecological scarcity method [4]. In the case of soybeans produced in Brazil, particle and benzene emissions are quite important. The evaluation also shows further differences in the production patterns e.g. due to the use of different pesticides.

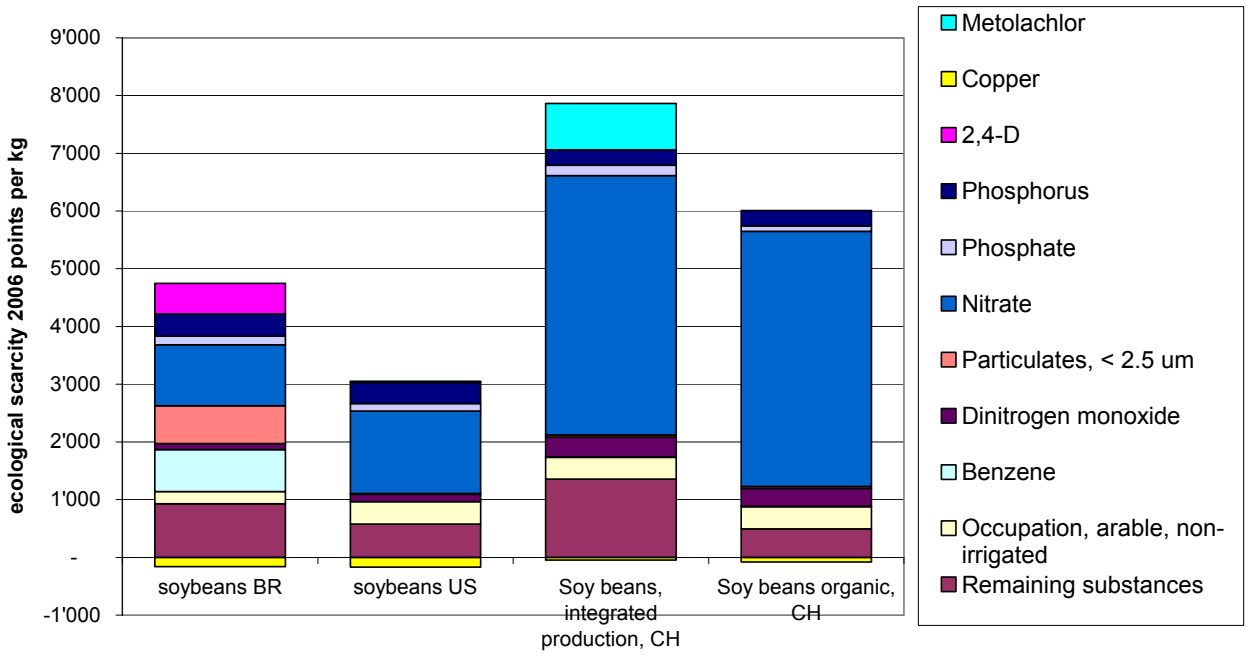

Figure 2 Life cycle impact assessment with the methodology ecological scarcity 2006 of the production of 1 kg soybeans (points per kg)

3.2. Sugar production

A second example shows important aspects of sugar production. In Brazil sugar cane residues are burned to simplify the manual labour of the cutting and harvesting. This leads again to the emission of particles, CO and NMVOC. The evaluation in Figure 3 investigates the respiratory effects with the methodology Eco-indicator 99 (H,A) [5]. The main regions for sugar cane cultivation are located in traditional agricultural areas in the back-country of Sao Paulo and far away from tropical rain forest. Thus, CO_2 emissions from land transformation are not important for the assessment.

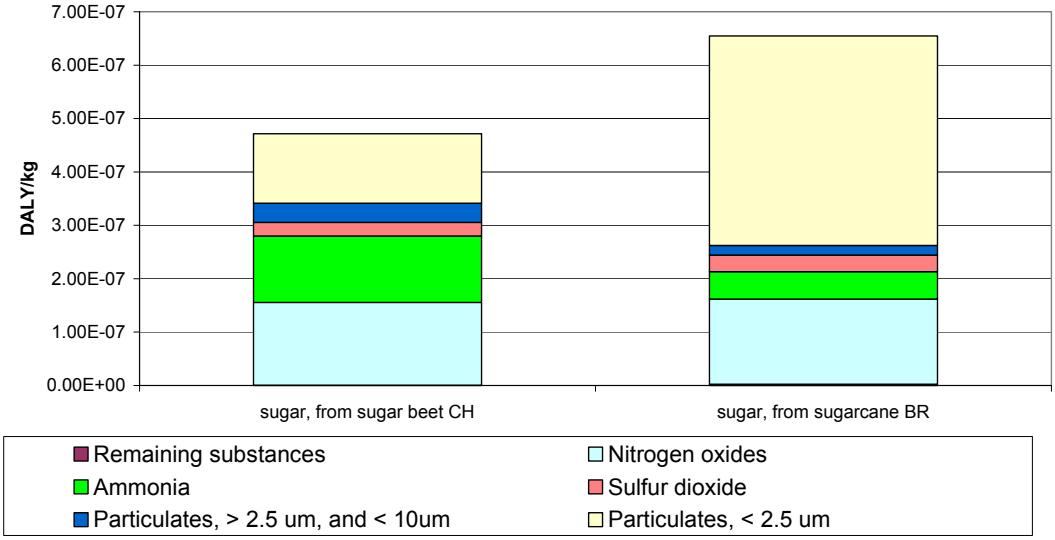

Figure 3 Life cycle impact assessment with the methodology Eco-indicator 99, respiratory effects due to inorganic substances (H,A) of the production of 1 kg sugar (points per kg)

4. CONCLUSIONS

The examples show that agricultural products must be investigated on a regional level. It is quite important to include region specific problems in the LCA. Such problems are e.g. the clear cutting of primary forests and the burning of residues. CO_2-emissions due to land transformation must be considered as an important contributor to global warming in LCA. The ecoinvent data v3.0 provide the necessary information for several agricultural products used for biofuels.

5. REFERENCES

1. Jungbluth N, Chudacoff M, Dauriat A, Dinkel F, et al., *Life Cycle Inventories of Bioenergy*. 2007, Final report ecoinvent No. xx (draft), ESU-services: Uster, CH.
2. Frischknecht R, Jungbluth N, Althaus H-J, Doka G, et al., *Overview and Methodology*. 2004, CD-ROM, Final report ecoinvent 2000 No. 1, Swiss Centre for Life Cycle Inventories: Dübendorf, CH. www.ecoinvent.org.
3. Zah R, Böni H, Gauch M, Hischier R, et al., *Ökobilanzierung von Bioenergie: Ökologische Bewertung*. 2007, Schlussbericht, Entwurf, Abteilung Technologie und Gesellschaft, Empa im Auftrag des Bundesamtes für Energie, des Bundesamtes für Umwelt und des Bundesamtes für Landwirtschaft: St. Gallen.
4. Frischknecht R, Steiner R, & Jungbluth N, *Methode der ökologischen Knappheit - Ökofaktoren 2006*. 2007, Schriftenreihe Umwelt (noch im Entwurf), Bundesamt für Umwelt (BAFU), ÖBU Schweizerische Vereinigung für ökologisch bewusste Unternehmungsführung: Bern.
5. Goedkoop M & Spriensma R, *The Eco-indicator 99: A damage oriented method for life cycle impact assessment*. 1999, Methodology Report, PRé Consultants: Amersfoort, The Netherlands.