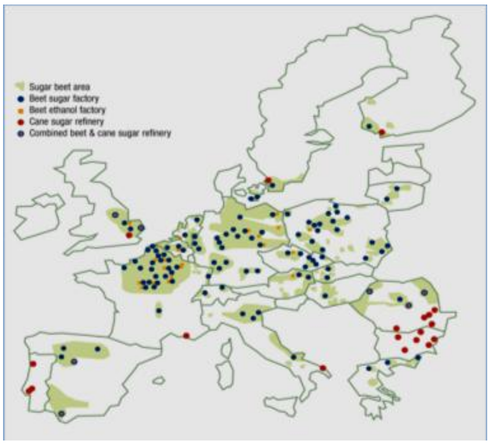
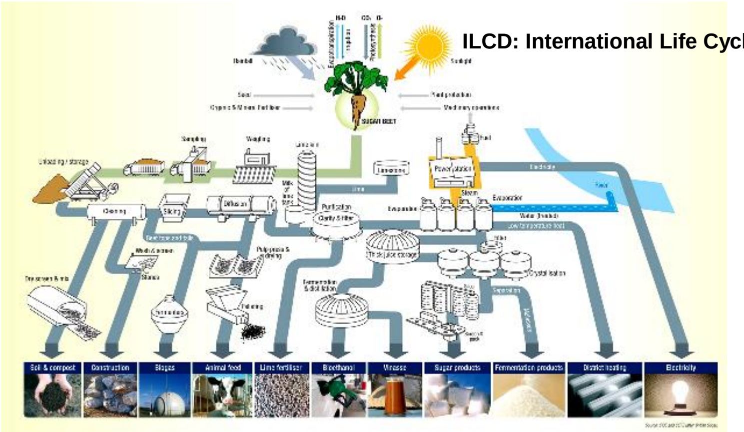
A Life Cycle Assessment* of beet sugar in the European Union

LCA : Life Cycle Assessment

PCR : Product Category Rule

ILCD: International Life Cycle Data System





Context and Policy Environment

Sustainability issues and environmental management have gained an increasing amount of attention in corporate strategy development in the last decade. In parallel the European Commission is developing the Product Environmental Footprint (PEF link), a methodology to measure the environmental performance throughout the lifecycle of products to provide the consumer with relevant information on the products they buy under the Single Market for Green Products Initiative..

This highlights the need for individual sectors to establish their own scientifically reliable, practical and harmonized codes of practice and methodological guidelines to assess the environmental performance of their processes for supplying products and services. These sectorial guidelines are called Product Category Rules. With this study, CEFS provides an insider view, on what the significant environmental impacts of beet sugar production in the EU are & the method best suited for allocating specific impacts to the products of sugar beet processing.

Methodology

Data on sugar beet cultivation, transport and processing used were collected from 11 sugar companies and 18 countries (years 2008-2013) Depending on the year, the data covered 89-96% of the total harvested area in Europe and approximately 90% of EU beet sugar production (CEFS Sugar Statistics,2013).

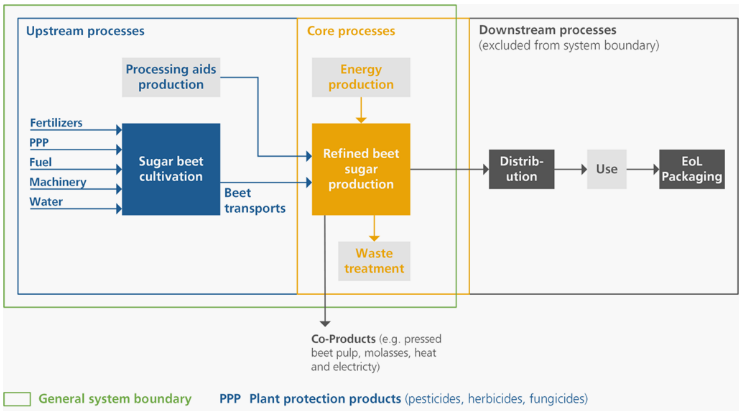


Figure 1: System Boundaries of the study – cradle to gate

A hotspot analysis was run over 15 environmental impacts via the testing of 4 different LCIA methodologies (ILCD, ReCiPe, Eco-scarcity and Impact 200+). In order to derive methodological recommendations for the appropriate allocation method, the consultant performed a sensitivity analysis on the 11 products comparing 6 allocation methods and substitution according to in ISO 14040. The functional unit chosen by the consultant was one tonne of white beet sugar of average quality.

Results

The collected data indicated considerable variations in beet yields per country that ranged from 39 to 101 tonnes per hectare. This was explained by the variation in soil fertility as well as climate and weather conditions across beet growing regions in Europe. The hotspot analysis showed that sugar beet cultivation phase had the largest share of total environmental impacts, due to soil emissions, field work activities as well as the use of mineral fertilizers. The sugar factory came second in the share of total environmental impacts where the majority of total impacts were related to the supply and consumption of energy sources for the generation of process heat and electricity.

Only four of the 15 environmental impacts turned out to be significant for production of one tonne of EU beet sugar, because for most of the impacts tested, the overall impact was very small: the average of the total impacts of the 4 LCIA methods, approximately 2/3 of the total aggregated impacts were attributed to the impact categories “Climate Change” (27%), “Resource Depletion” (13%), “Land use” (13%) and particulate matter

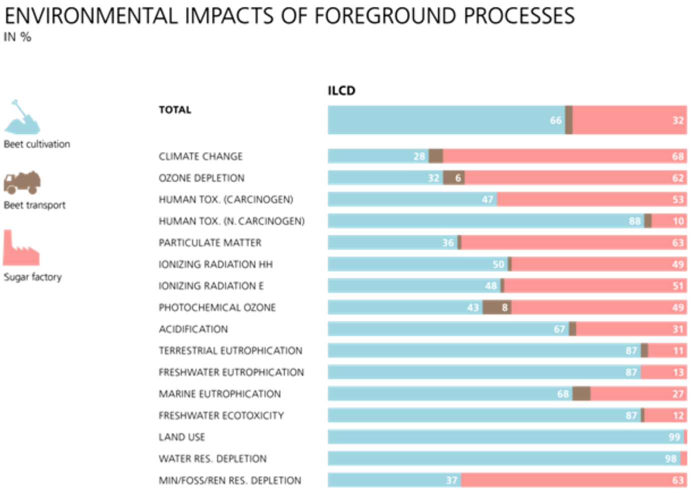


Figure 2: Environmental impacts distributed in foreground processes

(12%). Despite being standardized in a set of international guidelines such as the ISO14040 and the ILCD handbook, the study showed that different LCA methodologies when applied to the same product and using the same dataset often lead to considerably different results in terms of determining the significant impact categories for beet sugar production.

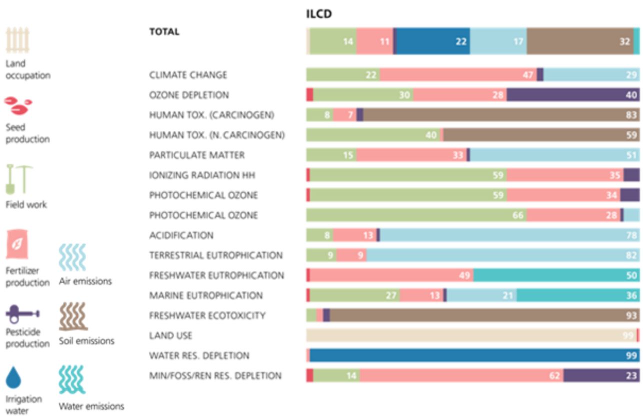


Figure 3: Environmental impacts for beet cultivation

Especially in the case of the ILCD method (recommended by the European Commission in their Product Environmental Footprint methodology) four relevant environmental impacts for provision of EU beet sugar could be identified: Climate Change (22%), Ecotoxicity (15%), Human Toxicity (17%) and Water Resource Depletion (15%). However, water resource depletion was identified only to be relevant, when irrigation water was used in beet cultivation. Significant impacts for ecotoxicity and human toxicity were found due to Mercury and Chromium VI emissions from the disposal of spoils from coal and lignite mining. The data for heavy metals emissions were taken from the Ecoinvent database. It is also worth mentioning that the contribution of pesticide use in sugar beet cultivation to human toxicity (i.e. carcinogenic effects) and ecotoxicity (i.e. freshwater) was only 2% respectively, which in consequence means that the way pesticides are used in EU sugar beet cultivation has no significant environmental impact.

The 11 products from the sugar factory were found to be another crucial aspect when distributing environmental impacts. The net environmental impact of white beet sugar was found to directly depend on the chosen methodology for allocating the environmental impacts to the different products such as beet pulp, ethanol and molasses. Depending on the allocation methodology, the share of environmental impacts distributed to beet sugar ranged from 91% (allocation by sucrose content) to 29% (mass allocation).In the case of substitution the distribution of environmental impacts was dependent on the choice of the substitutes. The net environmental impact distributed to the white sugar when using substitution was close to zero (27%) or even negative (-145%). As a result, energy allocation was chosen as the appropriate methodology as it covered the entire product range of beet sugar production, carbonation lime being the only exception. Specifically the substitution method (credit for lime fertilizer) was proposed for carbonation lime.

Recommendations and Future work

The study was representative for the factory as the 6 factory setups only differ in terms of the product range) but it could not capture the variability of the cultivation scenarios in Europe. Moreover LCAs focus only on environmental sustainability and therefore cannot be recommended as trustworthy indicators of overall sustainability as they do not capture the social and economic pillars of sustainability.

Data availability both primary data (e.g. company data) and available independent databases (e.g. Ecoinvent) affects final results in terms of accuracy. This is a sign that data quality requirements and handling of data gaps are prominent issues to be tackled at EU level in order to increase the quality, reliability and flexibility of LCA results to suit different production processes. Despite being standardized in a set of international guidelines such as the ISO14040 and the ILCD handbook, the study showed that different LCA methodologies when applied to the same product and using the same dataset often lead to considerably different results in terms of determining the significant impact categories for beet sugar production. This was especially evident when applying the ILCD method, as it places a large focus on human toxicity because of emissions from coal mining. The use of coal in the EU beet sugar industry is only about ¼ of the process fuel demand therefore it is recommended that the European Commission discusses the methodological maturity and reliability for the impact categories ecotoxicity and human toxicity as well as the representativeness of the emissions data when using databases for secondary data such as Ecoinvent. Finally, allocation of environment impacts to the different products from beet sugar production should be made according to their energy content. The EU sugar association will use the conclusions of the study, especially those on the allocation methodology to develop a Product Category Rule for EU beet sugar. This sectorial guideline will be used in the testing of the European Commission's Product Environmental Footprint methodology in alignment with the PCRs of other primary food processing industries.

* Life-Cycle-Assessment (LCA) is defined as the assessment of the environmental impacts of a given product throughout its lifespan. LCA can be used for evaluating the environmental performance of a product or a service as well as comparing the environmental performance of similar products in order to be able to choose the least burdensome.