LCA as Decision Support Tool in the Food & Feed Sector: R&D Case Studies

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Global food production is the largest pressure caused by humans on Earth, threatening local ecosystems and the stability of the overall system. This is demonstrated impressively on planetary boundaries model.[1] The agricultural and food sectors are globally responsible for the exceedance of approx. 50% of all boundary categories considered. Excessive nutrient inputs to terrestrial and aquatic ecosystems mean that the nitrogen and phosphorus cycles are of the greatest importance, followed by excessive land-use change and biodiversity loss caused by agriculture and food.[2]

Therefore, providing a growing global population with healthy diets from sustainable food systems is an immediate challenge. Alternative protein sources and a more resource-efficient production are urgently needed to respond to the increasing protein demand for a growing world`s population. This requires innovative, holistic approaches along the entire value chain as well as tools to evaluate and support the progress within research, development and production. The methodology of Life Cycle Assessment (LCA) offers a well-established and standardized approach to deal with the quantification of impacts through the entire life cycle of a product or service in various industrial domains.[3-6] Life Cycle Assessment has been used extensively for several years in order to assess agricultural systems, food processing and manufacturing activities, and to compare alternatives. Herein, two LCA case studies are presented, dealing with novel approaches for food supply by implementing the valorisation and upcycling of waste and side-streams, respectively. In both studies, LCA is used as decision support tool accompanying R&D activities in order to launch environmentally sustainable products.

CASE STUDY I

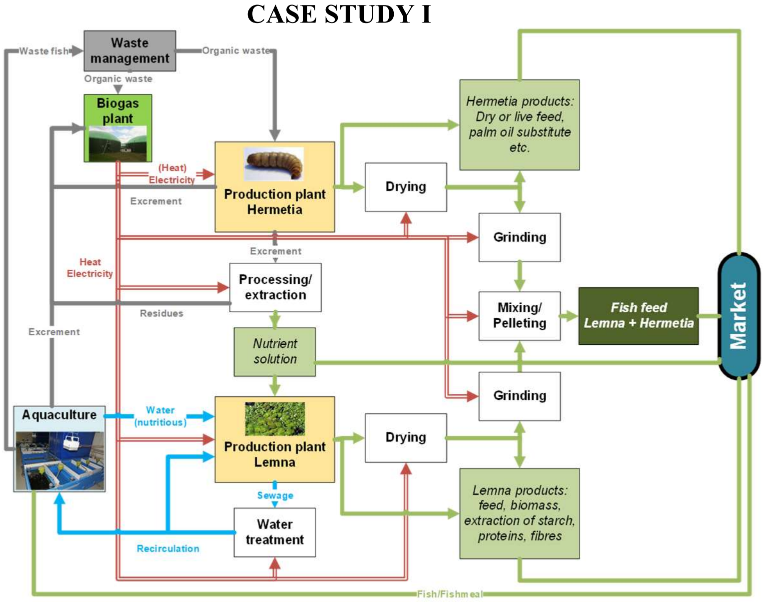

Figure 1. Production scheme of case study 1.

Fish and meat production and processing will grow drastically in the coming decades. The importance of the impacts of agricultural practices on water and land use, climate change and environmental degradation, such as eutrophication or terrestrial and marine acidification, is well acknowledged and has been exhibited by many studies. In this context, within the last years insects are repeatedly discussed as a future-oriented, sustainable source of protein for food industry, as the ecological, economic, physiological and ethical advantages outweigh those of meat. In aquacultural systems, insects are also gaining interest as feed to provide a sustainable alternative to the fishmeal paradox, whose production leads to a high consumption of resources and negative environmental impacts. Reducing the proportion of fish protein in favour of insect proteins in combination with vegetable feed components could significantly reduce environmental burdens. Within the scope of the project discussed herein, the production of fish feed from *Hermetia Illucens* larvae and *Lemna Minor* in an inline recirculating aquaponics model for urban sites was developed, optimized and scaled up, which efficiently combines waste and environmental service concepts in one production system. At the same time, the value chain produces high-quality, market-accessible raw materials for the food industry. All investigations were accompanied by comparative LCA as well as cost analyses to measure and compare ecological and economic effects in order to finally result in sustainable alternatives.

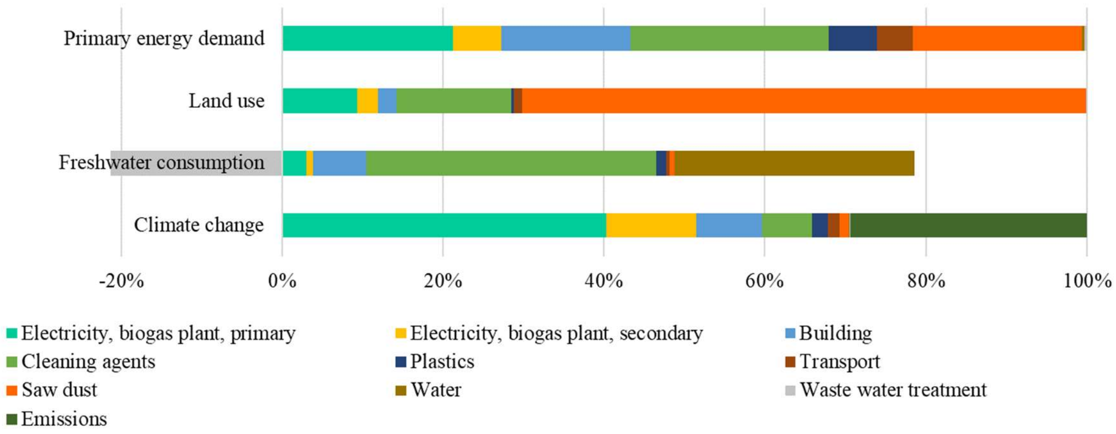

Figure 2. Determining ecological drivers and optimization potentials by applying LCA.

CASE STUDY II

Animal-derived protein contributes significantly to the production of greenhouse gases, intensifies pressure on land use, and can have negative health consequences.[7,8] In the EU, two-thirds of agricultural land is already in use to produce livestock, either for feed production or grazing, with increasing competitive pressure from feedstock demand for non-food applications such as biofuels. The increasing demand for food proteins can be met by utilisation of proteins from alternative and new sources which includes under-explored legumes and protein crops and fungi as well as side streams from food processing. In this context, Smart Protein, a new Horizon 2020 project funded by the European Commission, will develop protein products from plants, including fava beans, lentils, chickpeas, and quinoa – with a focus on improving their structure, taste, and flavor, but also strongly focus on the utilization of byproducts and residues, ingredients that are usually used for animal feed. Microbial biomass proteins will be created from edible fungi by up-cycling side streams from pasta (pasta residues), bread (bread crusts), and beer (spent yeast and malting rootlets). By taking account of LCA, but also cost-benefit and stakeholder analyses, Smart Protein will be able to benchmark against conventional protein food and agriculture approaches in order to evaluate its potential degree of competitiveness, sustainability and resilience, and thus to pave the way for enhanced protein production from plant and plant-based products, and encourage their uptake, in Europe. First LCA investigations will be presented.

References

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