Life cycle assessment of feed ingredients

Improving sustainability of the livestock sector is essential. Life cycle assessment (LCA) studies have shown that feed production accounts for 70% of the carbon footprint of animal products which makes it an important element to account for when considering mitigation options. Improved knowledge of the environmental impact of feed ingredients is fundamental to instigate a positive change.

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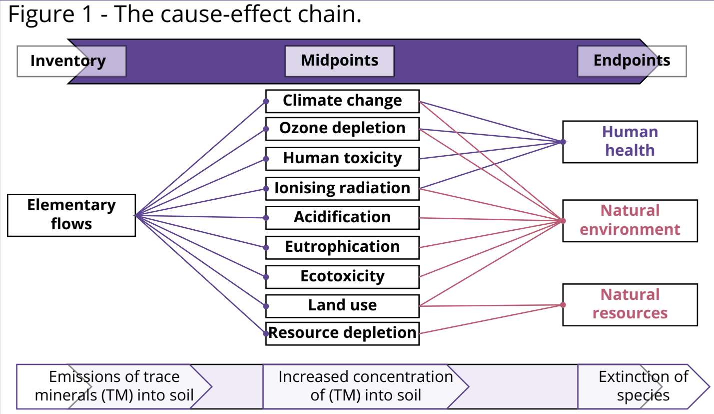
The idea of a comprehensive environmental LCA was conceived in the USA in the late 1960s/early 1970s. In 1969, the Coca Cola Company commissioned the first LCA study to examine the complete environmental impact of a package, focusing on sustaining the use of high value recyclable materials and reusable packages. Around 1973, the interest turned to energy mainly due to the oil crisis. In 1988, interest returned to solid waste, but this was quickly replaced by a more balanced concern about the areas of resource use and environmental emissions. In 1991, concerns over the inappropriate use of LCAs to make marketing claims by product manufacturers, led to the development of the LCA standards in the International Standards Organization (ISO) 14000 series. In 2002, the United Nations Environment Programme (UNEP) joined forces with the Society of Environmental Toxicology and Chemistry (SETAC) to launch the Life Cycle Initiative, an international partnership to improve the supporting tools through better data and indicators.

Four phases of an LCA study

As required by ISO 14040, four phases are involved in an LCA study and they include: (i) goal and scope definition, (ii) inventory analysis, (iii) impact assessment, and (iv) interpretation. The results of an LCA study can be calculated using different impact assessment methods, which give different detail levels of the cause-effect chain. Considering the cause-effect chain for a trace mineral, a midpoint method looks at a point in the cause-effect chain, i.e., the increased concentration of trace minerals in soil, while an endpoint method looks at environmental impact at the end of this cause-effect chain, i.e., the extinction of species due to the emission of such a mineral (*Figure 1*).

Among midpoint and endpoint approaches, the environmental effect of system inputs can be expressed into different LCA impact categories. Some of them have been widely addressed since the first LCA studies, such as climate change or carbon footprint. Over the years, other categories raised environmental concerns, such as acidification, eutrophication, and energy use. Others were neglected for several years but are currently being highlighted, such as toxicity-related issues. Whatever the impact category considered, the knowledge of the environmental impact of the process and/or products is important to achieve a global sustainable development. That is why

Figure 1 - The cause-effect chain.



environmental footprint (EF) initiatives have been developed worldwide to move towards a sustainable economy.

Strategies to improve sustainability

In the past, traditional environmental themes, such as protecting species and improving the air/water quality were the major environmental concerns facing the world. Nowadays, more systematic approaches that consider the links between various themes and their global dimension are required. A multi-stakeholder initiative named LEAP (Livestock Environmental Assessment and Performance Partnership) has been created by FAO. It develops guidance and methodology for understanding the environmental performance of livestock supply chains, in order to shape evidence-based policy measures and business strategies. In 2016, LEAP published a guideline for the assessment of environmental performance of animal feeds supply chains, based on LCA. Feed additives, such as minerals, are considered as feed ingredients in these guidelines; however, detailed guidance regarding their production is outside its scope. Early this year in Europe, the product environmental footprint category rules (PEFCR) was approved by the EU commission. The EU feed industry was the first sector to have its PEFCR, based on LEAP guidelines. It provides a more detailed and comprehensive technical guidance on how to conduct a PEF study, with the objective of delivering more sustainable consumption and production, by ensuring more environmental friendly products on the EU market.

Besides that, PEFCR presented the LCA results for one ton of animal feed, representing the average composition of feed ingredients consumed by the EU feed industry from 2009 to 2013. Among the impact categories covered by PEF results, the toxicity-related ones (terrestrial, freshwater and marine) were excluded from the LCA, due to the lower robustness of ecotoxicity models. However, applicants who want to calculate the PEF profile of their product in compliance with PEFCR requirements are encouraged to include the characterised results for all impact categories (including toxicity). The PEF initiative provided solid information on plant- and animal-based feed ingredients. However, for feed additives such as minerals, enzymes, vitamins or amino acids, the models of their production process is still being improved. It is expected that LEAP will develop in the near future recommendations on how to model the production of these particular feed ingredients, which may have a significant contribution to some environmental impacts although they are incorporated at a very low level in the diet.

Feed industry's environmental footprint

The feed industry is committed to contributing to the generation of high quality data on feed additives. In line with this, an LCA was developed for the potentiated zinc oxide source named HiZox (Animine, France). To represent the contribution of trace mineral sources on EF of complete feed, a diet based on the composition of the virtual feed proposed by PEFCR was created. The results show that cereals and oilseeds (48% and 28% of total feed composition, respectively) contribute the most to EF on climate change, acidification and eutrophication, energy demand, and terrestrial ecotoxicity, due to the use of fertilisers, pesticides, and transportation network for their production (*Figure 2*).

Even if trace minerals represented only 0.78% of total feed ingredients consumed in Europe, they showed the highest contribution to freshwater and marine ecotoxicity, due to their high toxicity potential when emitted into soils and waters, and to metal depletion, due to the fact that they are non-renewable resources. This high contribution demonstrates the importance of the sustainable use of trace minerals in terms of source and dose used in animal nutrition. Nevertheless, there is still room for methodological improvement in the evaluation of their impacts: (i) move the system boundaries from 'at feed factory gate' to beyond animal production, accounting the EF of disposing animal wastes. (ii) improve the robustness of ecotoxicity models. (iii) account for the chemical form of trace mineral sources in animal wastes on LCA. The SUMINAPP Project funded by EU H2020 (www.suminapp.eu) expects to fill these three gaps by providing a new ecotoxicity assessment approach, from feed to excreta, using new LCA ecotoxicity characterisation factors informed from experimental results.

Figure 2 - Contribution of feed ingredients to environmental footprint.