Fact Sheet 9 in the Series: Tough Questions about Beef Sustainability

Can different LCA studies be compared?

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Life Cycle Assessment (LCA) is a well-established tool that was first developed in the 1960s to evaluate potential environmental impacts arising from the production and consumption of goods and services. LCA procedures are defined in the 14040 series of International Organization for Standardization standards (ISO). The main standard, 14044, defines four iterative stages (indicated by the bidirectional arrows in **Figure 1**) in performance of a LCA. These are the goal and scope definition, life cycle inventory data collection, life cycle impact assessment, and interpretation.[1] In defining the goal and scope of a study, a LCA practitioner must specify the reasons for conducting the study and the intended audience. Reasons for conducting a LCA include:

- Hotspot analysis to identify stages or activities in a supply chain, which contribute significantly to environmental impacts;
- Support for internal decisions to identify improvement opportunities or establish a baseline or benchmark;
- Direct comparison of products (either for procurement or marketing), which may or may not be disclosed to the public.

Defining the goal and scope requires specifying the functional unit, system boundaries, impact assessment categories, and cut-off criteria. Specifying the functional unit of the study is a crucial aspect of the goal and scope. The definition of the functional unit should answer the question: how much of the product is required to provide what function for a specific period of time? System boundaries should include all life cycle stages from extraction of raw materials to the final disposition of the product and its packaging at the end of its life. This will enable identification of burden shifting along the supply chain. The standard also specifies that a full complement of impact categories

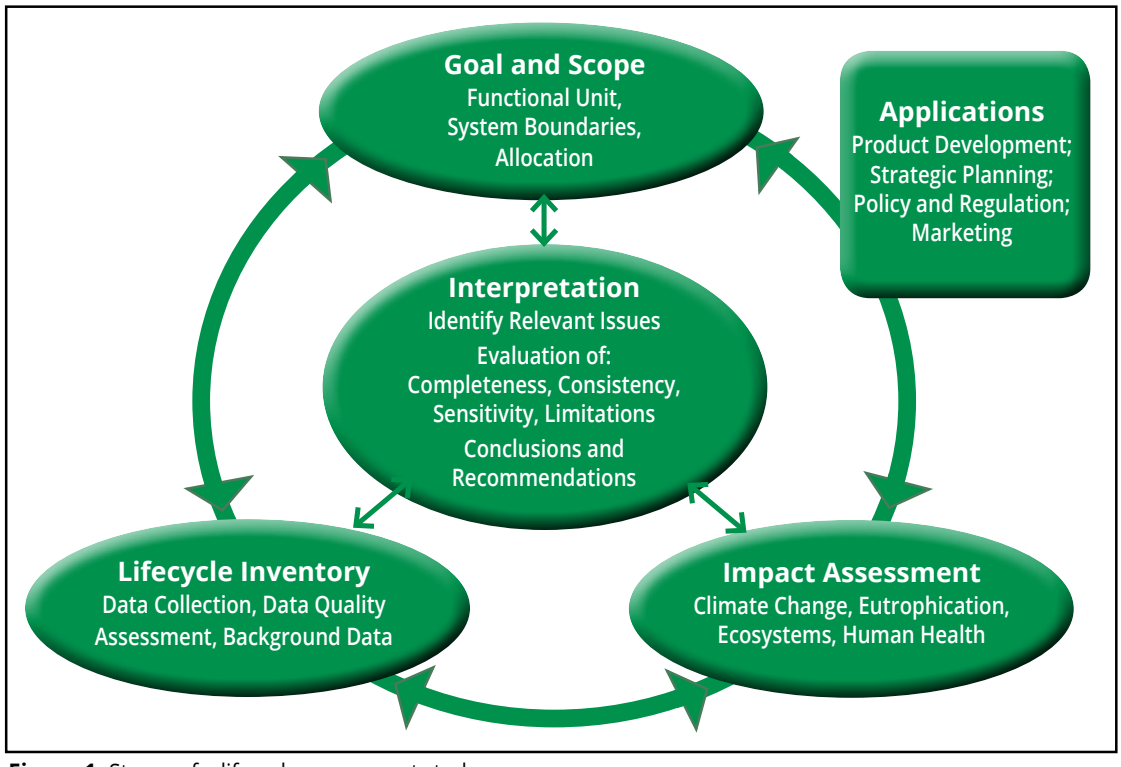

Figure 1. Stages of a lifecycle assessment study.

be considered for the express purpose of enabling the identification of trade-offs among impacts, in particular for comparative studies.

The ISO standards provide broad guidance on performing a LCA and also rules for comparative studies. ISO and the ILCD (*General Guide for LCA — Detailed Guidance* published by the European Union) handbook mandate, for both assertive and non-assertive comparative studies, application of the same functional unit, system boundary, and allocation procedures; to have same data quality and completeness/cut-off (in%) for mass and energy requirements; and to apply the same Life Cycle Impact Asessment (LCIA) methods.[1,2] These criteria are equally important and should be fully evaluated when comparing LCAs from different authors.

As an example, if 2 studies of exterior paint are to be compared, and they have reported functional units of 1 gallon of paint, it may not be possible to make a direct comparison. The primary function of paint may be to protect exterior surfaces, and if the paints' lifetimes are different, then a volumetric functional unit will not capture this difference in function, as one paint may require 2 applications separated by a period of years to achieve the same protection as the other paint. Stated another way: comparison of a specific volume of a high-quality to a low-quality paint may not satisfy the requirement of comparable functional units.

Because many reasons exist to perform a LCA and different ways exist to define function, as well as choices to include or exclude certain aspects (such as infrastructure), our ability to make straight forward, direct comparisons between LCAs performed by different research groups is compromised. Despite the challenges of comparing different LCAs, a need to make such comparisons frequently exists. Recently, meta-analysis of LCA[3,4] has become more common. Meta-analysis is a harmonization process to adjust parameters from different LCAs to ensure methodological consistency to enable comparison. The purpose of the meta-analysis is to provide decision-makers with a more robust understanding of conflicting studies in the literature, or more simply, to compare results of two studies of similar products with the same function produced with different technologies or from different geographic regions. For example, the National Renewable Energy Laboratory has performed the Lifecycle Assessment Harmonization Project,*

*http://www.nrel.gov/analysis/sustain_lca_method.html

which provides additional more detailed guidance on the process undertaken for electricity generation. Additionally, comparison can be strengthened by assessing conclusions and recommendations from different studies.

Based on the preceding description of the stages of a LCA, it is clear what kinds of information are needed, at a minimum, to ensure comparability of two studies: corresponding functional units and system boundaries. In food and agriculture LCAs, numerous functional units have been used. Some common choices include: live or as-harvested weight, at the farm gate for livestock and crops respectively. These may be expressed on a per animal basis or per kg basis. If sufficient information is not provided in the study to allow conversion of the units to correspond, then comparison will not be possible. The guidelines developed by the U.N. Food and Agriculture Organization's Livestock Environmental Assessment and Performance (LEAP) Partnership provide information on specification of functional units with sufficient detail to enable these types of conversion.[5,6] An example of a well characterized functional unit is from the Phase I: More Sustainable Beef Optimization Project.[7] In this assessment, the loss in the beef supply chain is described as leading to the chosen functional unit of lean meat consumed (**Table 1**), enabling other users to compare results they may have for the farm gate production.

Table 1. Dressing weight and value chain losses.

Dressing	59%
Harvesting (fat, bone and shrink)	33%
Retail phase (fat, bone, shrink)	4%
Consumer phase (cooking loss, spoilage, plate waste)	20%
Total loss from live weight at farm gate	70%

For crop production, the moisture content should (but may not) be specified. Other possible functional units for livestock include carcass weight or edible cuts at the packer plant gate. Some studies will report a functional unit of carcass weight at the farm gate – this choice represents two errors which should be corrected. The first is that valuable co-products are produced (non-edible offal, etc) in processing and an allocation to these co-products may be missing if carcass weight is used at the farm gate; the second error is that energy and other resources expended in the processing stage, and burdens associated

with these activities, are excluded at the farm gate. Additional considerations regarding the harmonization of system boundaries include activities which may be excluded in one study or another. In particular, it is common in many studies - but not all - to exclude capital goods (infrastructure).

After harmonization of the functional unit and system boundaries, attention must be given to impact methods used in the studies. Many impact assessment frameworks are available, and each adheres to the ISO standard requirement of a direct causal link between emission and impact. However, various methods can use different estimation techniques even for similar categories. Therefore, it is critically important that the impact methods used in the studies being compared are the same – unless only a qualitative directional comparison is required. Even for evaluation of climate change, which is likely the most commonly reported impact category, care must be taken to ensure that the same global warming potentials (GWP) were used in the studies being compared. The 100-year GWP has changed in the past 20 years; for example, the 100 year GWP for methane was 21 (1996); 25 (2006) and is currently 28 (2013).

Bottom Line: **LCAs can be compared; however, significant care should be exercised in conducting the comparison or inappropriate conclusions may be reached.**

Literature Cited

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