Identifying criteria for harmonizing life cycle assessments of crop-livestock systems and interactions

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Introduction

Food production is responsible for 26% of all greenhouse gases (GHGs), and for 70% of land-use globally (Poore and Nemecek, 2018; Goglio et al., 2023). Thus, the contribution of livestock to a sustainable circular bioeconomy and agroecology, its interaction and dependence on cropping and grassland systems should therefore be further investigated (Goglio et al., 2023). Participatory approaches have been successful in assessing design and innovation in agriculture (Mullender et al., 2020); while LCA in assessing environmental impacts of agricultural systems and products. However, LCA methodology needs to be improved with regard to C sequestration and GHGs, crop-livestock interactions, feed-food-fuel competition, biodiversity, and circular economy aspects. There has been no robust attempt to develop an evaluation framework for the assessment of methods addressing these issues (Goglio et al., 2023). Here this gap was addressed through a participatory expert consultation approach focussing on the life cycle inventory accounting for crop-livestock systems.

Materials and Methods

A participatory harmonization approach was adopted to identify key topics and evaluation criteria for LCAs of crop-livestock systems (Mullender et al., 2020). These criteria for LCA methods of livestock systems were identified through a literature review and 29 workshops with experts (n=21) on LCA, GHGs, biodiversity, nutrition and animal welfare, across academia and farmer advisory boards from 14 countries. Two anonymous surveys were carried out and results were discussed to identify key topics and general criteria for LCA methodology. Here results on the general criteria and specific criteria for GHG, biodiversity and circular economy issues were discussed.

Results

For the general criteria, the "Credible" (RACER) and the "Transparency and Reproducibility" (JRC ILCD) general criteria received the highest median score (10), followed by "Completeness" (JRC PEFCR), "Fairness and Acceptance" (JRC ILCD), "Accuracy/Robustness/Data Quality" (ACTA), "FAO LEAP criterion" and "Robust" (RACER) with a median value of 8. These were prioritised through follow-up workshops (n=7): "Transparency and Reproducibility", "Completeness", "Fairness and Acceptance", "Robustness" and "Accuracy".

In several workshops (n=19) among the LCA experts, accuracy was retained as specific assessment criteria in the LCA of crop-livestock systems for circular economy. For biodiversity, predictability, inclusion of invasive and vulnerable species, functional biodiversity, accuracy and comprehensiveness in the assessment of species richness and diversity and accuracy in landscape continuity were identified. Finally, for GHGs, these were the identified criteria: adaptability to soil types, land uses, climate and accuracy in soil C and N_2O emissions estimation. For manure emissions and storage, the inclusion of methane leakage in anaerobic digestion; accuracy in GHG estimation for manure storage and treatment, animal housing and enteric fermentation were retained.

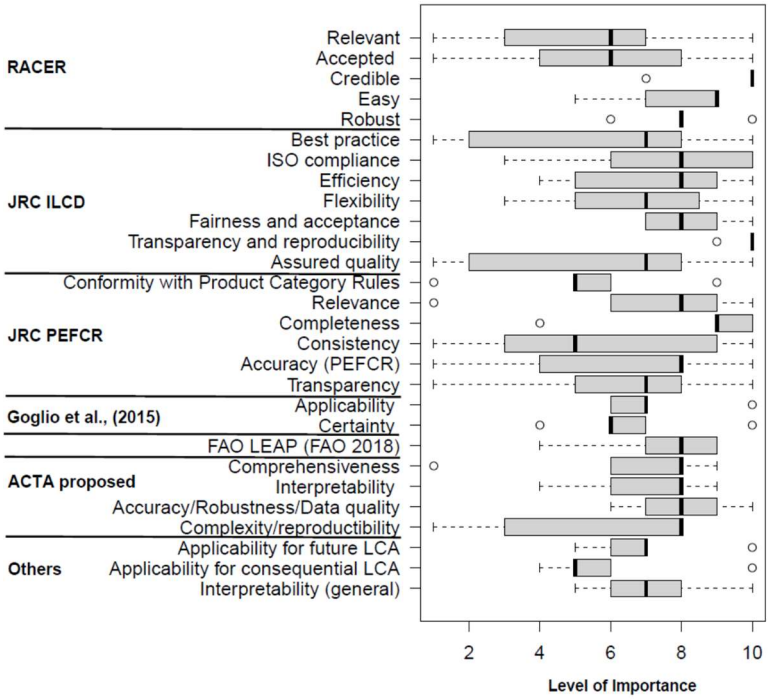

Figure 1 Box plot of the LCA expert responses to identify general criteria for the assessment of LCA methods for crop-livestock systems and product from different LCA frameworks (RACER; JRC ILCD; JRC PEFCR; Goglio et al., 2015; FAO LEAP; proposed by ACTA). The boxes indicate the 1st and 3rd quartiles, dark lines indicate the median. Error bars indicate the maximum and minimum values. Outliers responses more than 1.5 times the inter-quartile range away from the box are shown with hollow circles. High value indicates a high level of importance and a low value indicates a low level of importance. (Goglio et al., 2023)

Conclusions

This harmonization approach addressed the need for improved methods and indicators in the LCA of crop-livestock systems across GHGs, circular economy, and biodiversity, prominent in the public domain. Through a participatory research, several general criteria were identified providing a robust framework to assess LCA methodologies for crop-livestock systems and products.

Literature

Goglio P. et al. 2023. Defining common criteria for harmonizing life cycle assessments of livestock systems. Clean. Prod. Let. 4, 100035.

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