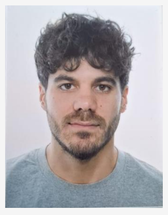
Evaluating manure impact methodologies within Life Cycle Assessments (LCA) of livestock systems and products



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Contribution of different sources to livestock GHG emissions

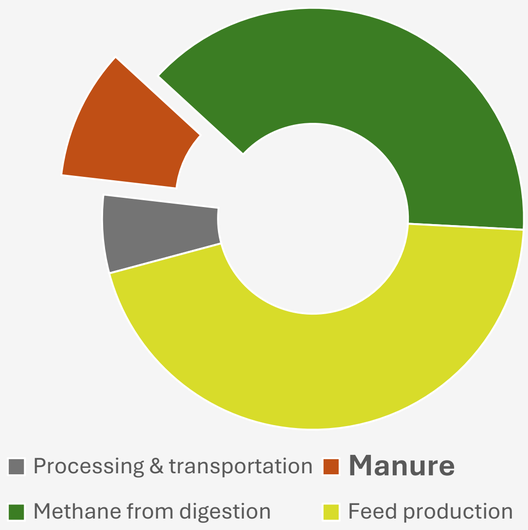

Image 1. Contribution of different sources to greenhouse gas emissions in livestock systems. Manure management represent approximately 10% of total GHG emissions.

INTRODUCTION

Manure enhances soil fertility, but its management generates GHG, mainly methane (CH_4) and nitrous oxide (N_2O). Life Cycle Assessment (LCA) is essential to quantify these in livestock systems, yet current methods for manure-related emissions limits comparability and accuracy. Here, a harmonization of LCA methods for manure emissions in livestock systems and production chain, was carried out:

i. assessing current LCA methodologies;
ii. identifying key emission drivers,
iii. supporting sustainable livestock systems,
iv. providing recommendations for LCA practitioners.

METHODS

From 29,151 papers screened, 263 were retained, including 48 on manure emissions in LCA. Using a modified Delphi method, experts defined criteria to assess livestock GHG methods, ranking by complexity and data needs, through workshops.

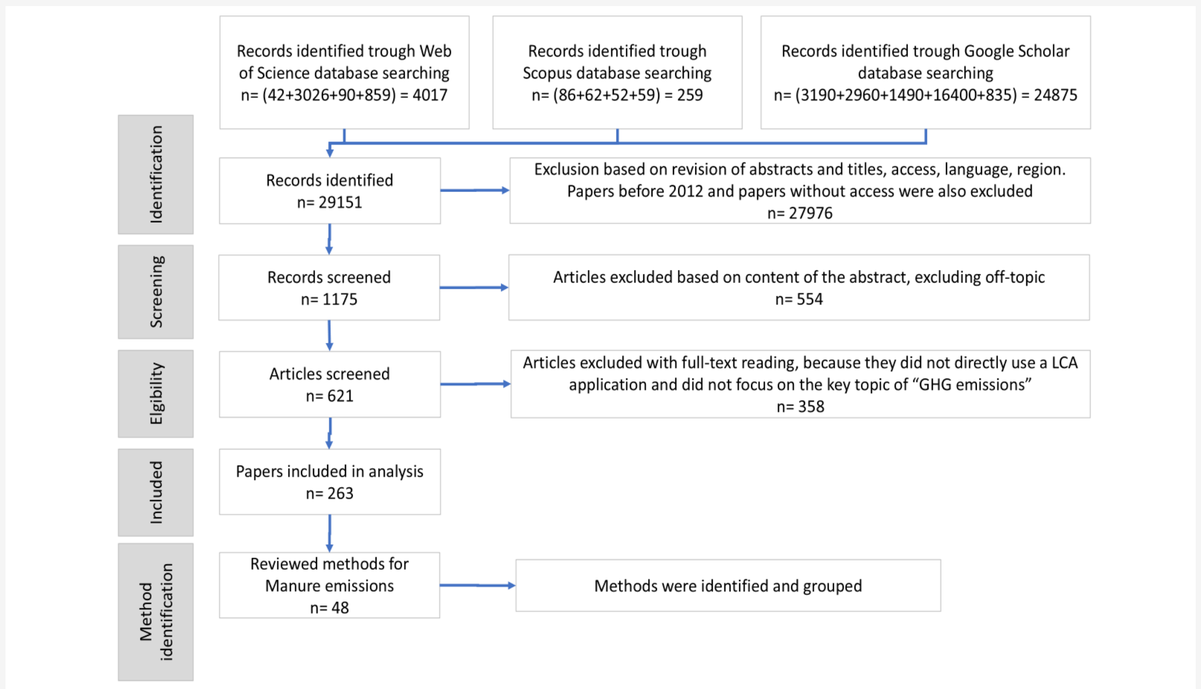

Figure 1: Methodological steps of the literature search process for manure emission estimation in LCA of crop-livestock systems

RESULTS

IPCC Tier 1 methods dominate for their simplicity, while Tier 2–3 offer higher accuracy through system-specific parameters but require extensive data, limiting applicability. Inconsistencies in system boundaries, emission factors, and nitrogen modelling further hinder comparability across LCA studies

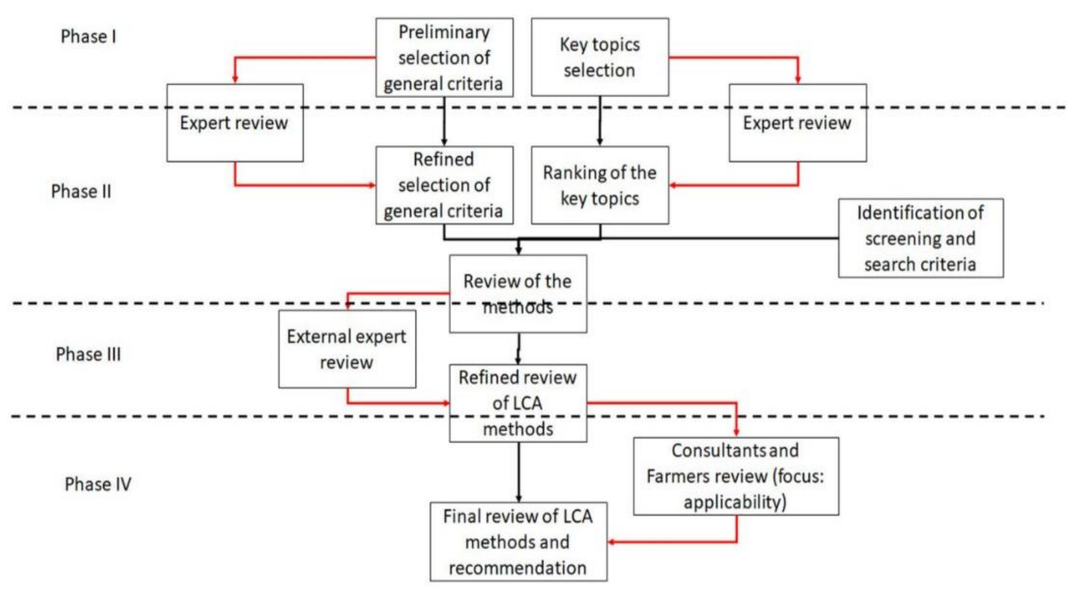

Figure 2: Flow chart for the modified Delphi method approached adopted in this research

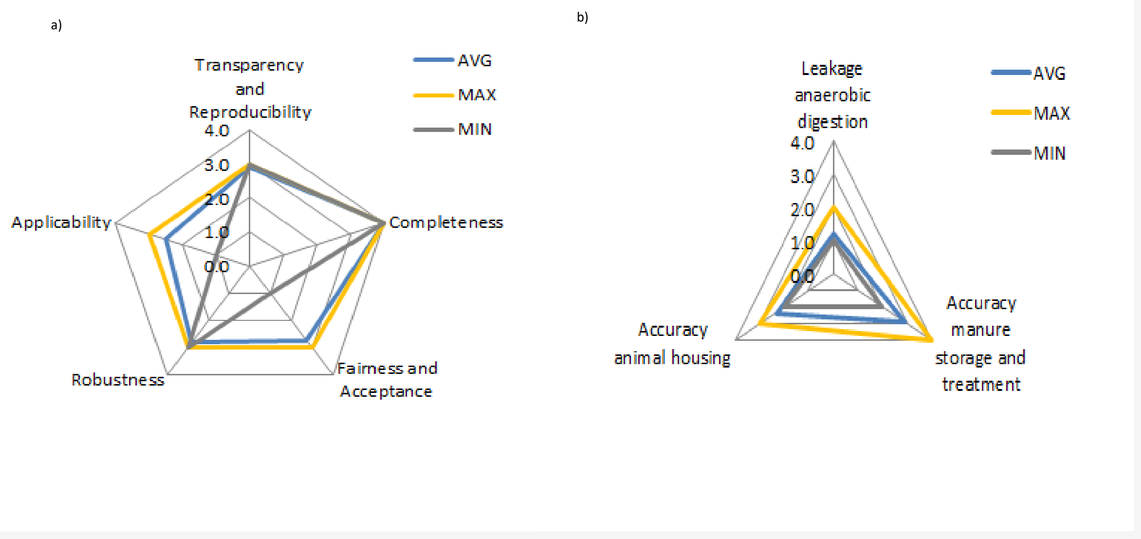

Figure 3: General Criteria Average Scores (a), Specific Criteria Average Scores (b) for manure emissions (housing and storage)

CONCLUSIONS

- Harmonizing LCA methods for livestock reveals an accuracy–applicability trade-off; methods choice should be aligned with study goals, data availability, and practitioner expertise.
- For manure GHGs, Tier 2 (manure- and housing-specific) methods generally offer higher accuracy than IPCC Tier 1, but require more data.
- All LCAs should state method limitations and include an uncertainty analysis.

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