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Flexible, efficient and consistent agricultural inventory modelling with SALCA

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1. INTRODUCTION

Agricultural production dominates the environmental impacts of the food sector. Agricultural systems strongly rely on the use of natural resources, their impacts are highly variable and the production units (farms) are numerous. A specific framework, versatile methods and efficient tools are thus needed to adequately assess the environmental impacts of agricultural systems in an LCA context and to capture their variability. The models should be sufficiently detailed to answer specific questions related to agricultural management and food production, yet at the same time deal with limited data availability. Here, we present the completely revised Swiss Agricultural Life Cycle Assessment (SALCA) concept and method.

2. METHODS

The SALCA concept comprises rules for the definition of system boundaries, functional unit and allocation, emission models for gaseous N, nitrate leaching, P emissions to water, soil erosion, pesticides, heavy metals, emissions from animal production, a life cycle inventory (LCI) database, calculation tools, impact assessment methods for soil quality and biodiversity and concepts for analysis, interpretation and communication (Nemecek *et al*. 2023). Here, we focus on the inventory modelling, interlinkage of models and show the potentials for various applications. The models are calculated at the crop, field, animal group and farm levels (Figure 1) and are integrated in a consistent and harmonised framework. This offers a great flexibility and the potential to be applied in many different contexts.

SALCA has a modular structure (Figure 2), which allows to manage its complexity and to exchange models, if needed for an application in a different context. By exchanging intermediate calculation results between the models, the consistency of the results is ensured. For example, changes in feed conversion efficiency will have effects on the nutrient, heavy metal and organic substance contents in manure and affect N and P emissions, heavy metal balances and soil quality. Since the models partly share the same input data, this alleviates the burden of data collection. SALCA takes specific characteristics of agriculture into account, which allows a detailed comparison of different production methods or systems.

3. RESULTS AND DISCUSSION

The same model system can be used at different levels to answer various questions: crops and their products (e.g. comparing crop management at different intensity levels), cropping systems (e.g. evaluating different weed management strategies), animal husbandry and animal products (e.g. comparing several dairy production systems), food and feed products (e.g. comparing domestic production to imports), farms and product groups, agrifood sector and food systems (e.g. evaluating different extensification strategies). The SALCA methodology has also been a backbone of the LCI databases ecoinvent, AGRIBALYSE and the World Food LCA database.

The strengths of SALCA lie in its comprehensiveness, specificity to agriculture, harmonisation, broad applicability, consistency, comparability, flexibility and modularity. Using a standardised tool offers opportunities for testing and ensures the comparability of the results across studies. The extensive data demand and the high complexity, however, limit the application of SALCA to experts. The geographical scope is limited to Central and Western Europe, with a special focus on Switzerland. However, due to the modular and flexible design, an adaptation to other contexts is feasible with reasonable effort.

4. CONCLUSIONS

SALCA enables answering a wide range of research questions related to environmental assessment and is applicable in different contexts. A further development would be the inclusion of the social and economic dimensions to perform a full sustainability analysis in the SALCAsustain framework.

5. REFERENCES

Nemecek T., Roesch A., Bystricky M., Jeanneret P., Lansche L., Stüssi M., Gaillard G., 2023. Swiss Agricultural Life Cycle Assessment: A method to assess the emissions and environmental impacts of agricultural systems and products. Int. J LCA. https://doi.org/10.1007/s11367-023-02255-w

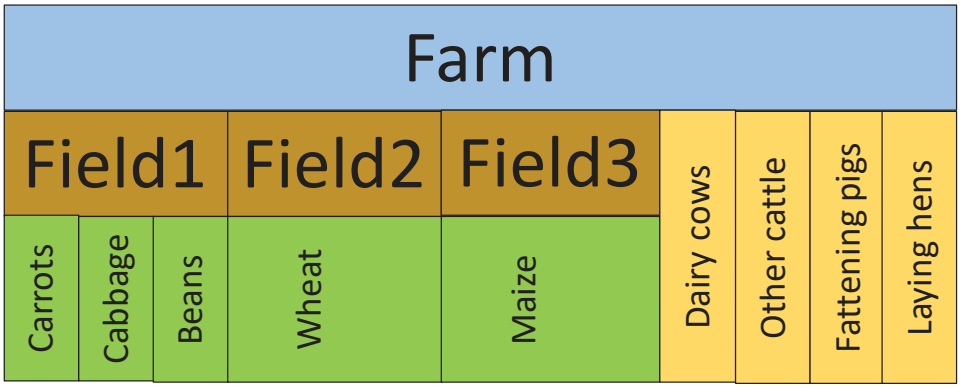

Figure 1. Schematic representation of the four levels of organisation of SALCA (illustrative example). Green = crops; yellow = animal group.

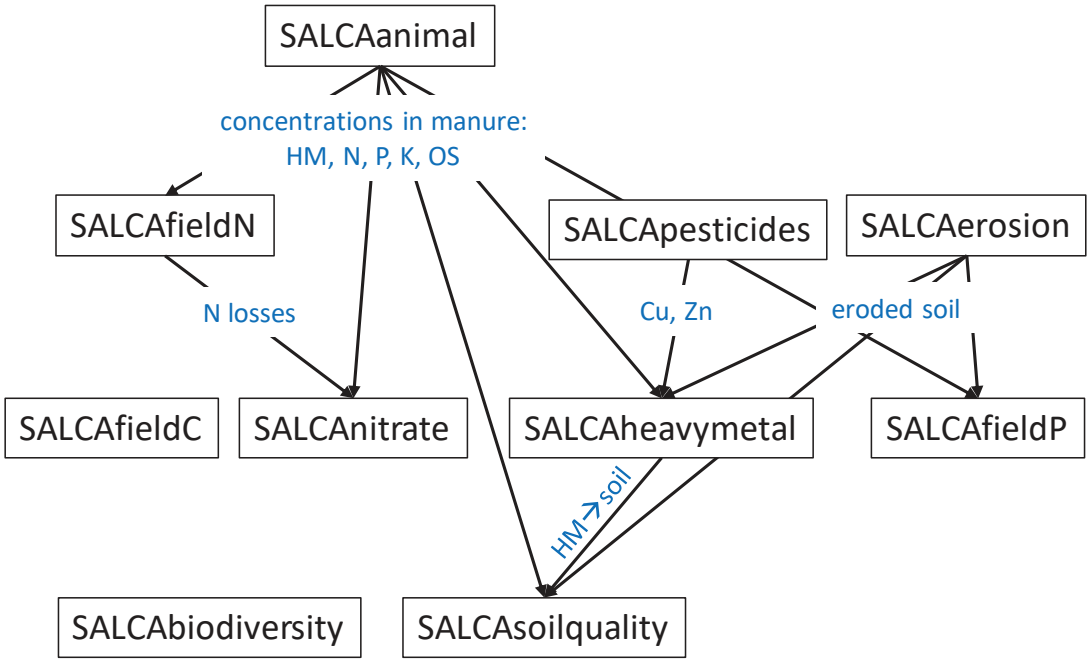

Figure 2. Data flow among the SALCA models. HM = heavy metals, OS = organic substance.