SALCAfuture: developing an expert system for life cycle assessments of agricultural products and farms

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Introduction

Primary agricultural production plays a significant role in supplying the population with food, but also causes various desirable and undesirable environmental impacts. Agricultural systems are located at the interface of environment, nature and technology, are characterised by numerous interactions with these areas and are thus complex and stochastic. Estimating the environmental impacts of these systems therefore requires a large amount of data, specific models for calculating direct emissions and characterising environmental impacts as well as high-quality background databases. In order to be able to manage these elements together, efficient calculation tools are needed. We have been working on the development of such a tool over the last years, which we present herewith. This article describes: i), the process of development of an expert system for conducting life cycle assessments for agricultural products and farms in the context of research projects (SALCAfuture) and ii) the main goals and implemented functionalities.

Rationale and objective of the work

The main goal of the SALCAfuture project was to develop an IT-supported expert system for life cycle assessments of agricultural products and farms that allows collection of primary data and precise inventory modelling and assessments at different levels of agricultural production (farm, animal husbandry, plot, crop). Another important goal was to cover all relevant environmental aspects, viz. the use of natural resources (energy, land, water) and numerous environmental impacts (climate change, acidification, eutrophication, human toxicity, biodiversity, soil quality). Furthermore, a high level of scientific quality, transparency and reproducibility shall be reached.

Approach and methodology

SALCAfuture was designed as a project involving experts from different disciplines: i) experts from IT and data management for the implementation of the software solution; ii) experts from different agronomic and natural science disciplines (e.g. carbon and nitrogen cycle, crop production, animal husbandry, agricultural engineering, soil science, pesticides etc) for the implementation of the models for calculating direct emissions and iii) experts in agricultural LCA for developing the data collection interface, calculation workflow and quality control procedure.

Results and discussion

The resulting software has been designed as a combination of two significantly different parts interacting with each other. The first part is a flexible framework that enables data collection, emission calculation and the compilation of calculation results for a wide range of applications. The second part contains the necessary background data, modules for data preparation, plausibility check and emission calculation. Support from IT-specialists is needed to manage the framework, whereas the second part can be self-managed by the research team.

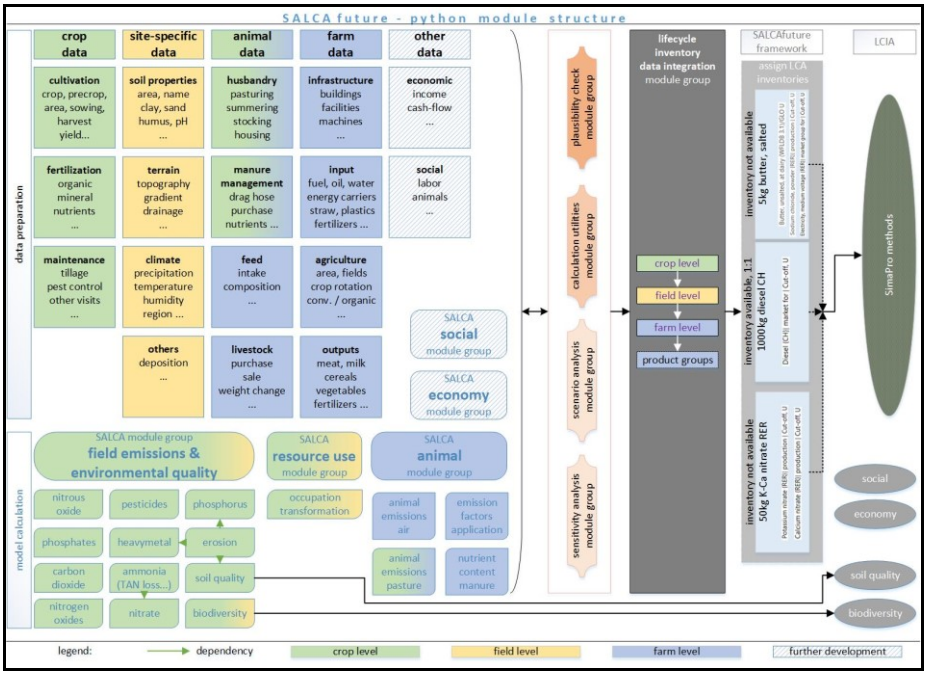

Figure 1: Schematic representation of the modular approach for data collection, processing, and emission calculation of SALCAfuture

Figure 1 shows a schematic representation of the modular approach as well as of theworkflow implemented in SALCAfuture. As first step of the workflow, a LCA specialist creates project-specific data entry forms, which can be accessed via a web application. Afterward, the IT system validates the entered data according to predefined rules to ensure high data quality. The collected data is then available for calculations and analyses via a programming interface. Modules specially developed by LCA experts calculate the direct emissions of the production system under consideration. The calculation models used in the modules are essentially updated versions of the SALCA emission models (Gaillard and Nemecek 2009). Different procedures are applied to allocate inputs and outputs at different stages of assessment. The IT system also provides various interfaces for importing resp. exporting data into resp. from the system. The export is used, among other things, to transfer the calculated values to SimaPro, where life cycle inventories (LCI) are completed by linking them to Ecoinvent V3.8 (Wernet et al 2016) as background database and finally calculating the environmental impacts.

Conclusion

SALCAfuture is an expert tool for the preparation of life cycle assessments for agricultural products, food and farms in the context of research projects. SALCAfuture makes it possible to efficiently calculate the environmental impacts. The main strength of SALCAfuture lie, in its flexibility and in the possibility to map different hierarchical levels of agricultural production precisely and differentiated with regard to their environmental impacts (farm, field, crop, livestock) while considering all relevant emissions.

References

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