How to reconcile eco-design and eco-labelling in LCI database construction? AGRIBALYSE experience and links with database harmonization initiatives

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ABSTRACT

Until recently, food Life Cycle Inventory (LCI) data were relatively rare. As more food LCI data sets are being released, we enter a new phase where, at the same time data coverage remains to be improved, but also data consistency and database harmonization become real challenges so that users can access LCI data covering the large diversity of agricultural systems and products.

In this article, we discuss how LCI databases should be built, considering the different kind of uses they serve. We argue that the databases that are more ecodesign/upstream oriented such as AGRIBALYSE, will go towards increasing modelling accuracy and complexity, whereas other databases that are more focused on downstream users and labelling schemes may prefer more simple approaches and models, and easier repeatability. We propose a solution that would enable combining these data with different scales and accuracy, so that harmonization does not lead to overall lower quality for users. This scheme could be used for instance in projects such as the Product Environmental Footprint (PEF).

Keywords: Food and Agriculture, Life Cycle Inventory, modeling scale

1. Introduction

AGRIBALYSE is a public Life Cycle Inventory (LCI) database containing data for a large number of French agricultural products (www.ademe.fr/agribalyse) (Colomb et al. 2015). It aims to promote both eco-design and eco-labelling in agricultural and food systems and is used by several hundreds of Life Cycle Assessment (LCA) practitioners in France and abroad.

LCA is a framework that requires its practitioners to adjust each study to its "goal and scope". However, for database providers the final use of the data is largely unknown. Therefore, most database developers do not claim any specific goal, or stick to very general ones such as "supporting eco-design and environmental information". As data quality improves and new methods for emission modelling are being developed, the question of harmonization of the AGRIBALYSE database with other LCI agri-food databases is raised. Indeed, the food system is largely globalised, and it is unlikely that a single LCI database will be able to cover the diversity of all production systems in all countries regarding soil, climate and socio-economic conditions. Consequently, in the interest of the LCA community, we are convinced that LCI databases should aim for complementarity and avoid overlaps in order to progressively improve coverage of agricultural systems worldwide.

Therefore in this paper we discuss

- which strategies can be implemented so that existing LCI databases can be used in a complementary way.
- whether it is feasible or not to use the same LCI databases to support contrasting goals such as environmental labelling schemes and eco-design strategies.

2. Users with different positions in the food life cycle

LCI databases such as AGRIBALYSE are used by different stakeholders along the food chain (Table 1) Their field of expertise and access to primary data also differ. The closer they are to the farm stage, the more sophisticated emission models they will want to implement and the more detail on agricultural production practices they will dispose of, and the more options concerning production practices they may want to consider. On the contrary, downstream players (retailers, restaurants etc.) are likely to be mainly interested in eco-labelling, where the focus is on the choice of foods rather than on the optimization of farming practices. They will prefer the implementation of relatively simple models to estimate pollutant emissions at farm level. Their priority is having the widest coverage for the foods they are using, and being able in a simple way to add new foods to account for their main characteristics (localisation, season of production, main labels on the market such as organic). These simple approaches can contribute to quickly enlarge databases for global coverage of main food products, supporting eco-labelling and changes towards more sustainable diets. However such data will not sustain the improvement of agricultural practices.

Table 1. Main aims of AGRIBALYSE data users along the food supply chain (not covering all possible use of LCI data).

Users	Aim	Level of detail required in LCI data
Agronomist/zoo-technician	Improve farming systems based on implementation of innovative agronomic practices, and by comparing to benchmark	+++
Food industry, food processing, R&D	Improve food products by modifying the ingredient composition/recipe	+ or ++
« Full production chain »	Implementation of a full eco-design strategy by a sector/branch, from farming practice to logistics and packaging, including communication.	++ to +++
Food industry, retailers	Communicate on improvement of a product compared to an existing/competing product or other benchmark.	+ or ++
Retailers	Environmental labelling scheme: providing the environmental performance data for a large range of food products	+ or ++
Nutritionists, NGOs	Work on sustainable diets at national scale, links between nutrition and environment.	+
Catering and restaurants	Working on sustainable diets and dishes for out of home catering	+
Research, policy makers	Studies on citizen's consumption footprints and prospective strategy, assessment of the effect of policy schemes	+
Research, policy makers, industry	Supporting new sectors based on environmental efficiency: example: compare bio-based products to fossil-based products	From ++ to +++

3. Agricultural production stage: being able to account for environmental improvement and eco-design strategies

The modification of agricultural systems and practices can strongly contribute to eco-design of food products, as the farm stage is a major hotspot for many impact categories. To begin with, an accurate picture of the most common production systems is necessary to provide a reliable benchmark for improvement solutions. National benchmarks are a good start, but not necessarily sufficient, especially for very large countries and in countries with high soil/climate diversity such as France. Once available, improvement options can be looked for.

Accurate accounting of the environmental consequences of changes in agricultural systems requires sophisticated, dynamic and data-intensive emission models. Indeed, many improvement options, especially those based on agro-ecological mechanisms, are designed at the cropping sequence scale rather than at the single crop scale (Willmann et al, 2012, Nemecek et al, 2008). To identify the most promising options, it is for instance paramount to be able to distinguish between different fertilization options (e.g. mineral, crop residues, manure, compost, digestate, sludge etc.), to accurately account for irrigation techniques, and to consider the consequences of farming practices in a given

environmental context (soil, climate, previous crop etc.). Similar reasoning applies to animal production, where it is crucial to accurately account for herd management (productivity, mortality, duration of fattening, time spent outdoors in pasture or yards, etc.), feeding strategies (composition of feeds, origin and production mode of feed ingredients, input levels and yields, etc.) and manure management systems (type of building and storage, biogas production) (Gac et al. 2007).
All these farming practices will affect emissions. Simple approaches such as IPCC Tier 1 and even Tier 2 will ignore many of the effects of these practices and potentially ignore improvement options to reduce direct emissions. For example, in the ECOALIM project (Wilfart et al, 2015), which was part of the AGRIBALYSE program, different models were tested to assess nitrate leaching for different scenarios: 1) no cover crop during the intercrop period following the crop under consideration, 2) presence of a cover crop or oilseed rape during this intercrop period. The IPCC tier 1 default emission factor ignored the reduction of nitrate leaching due to the cover crop (Fig. 1), which has been largely demonstrated by validated mechanistic models (Indigo: Bockstaller et al, 2008; Syst'N: Parnaudeau et al, 2012). While such mechanistic models are more sensitive to farming practices, their application, in particular at a large spatial scale, is also a lengthy and data-intensive process. The AGRIBALYSE model for nitrate leaching (Koch and Salou, 2015) was not the most accurate model at the field scale, but provided a satisfying ranking of the different situations and coherent average nitrate leaching values. This analysis is in line with recent publications (Peter et al. 2016, Ponsioen and van der Werf 2016), confirming that while more sophisticated emission models require more input parameters and consequently more data collection efforts, they also brings useful added value to identify and promote more sustainable agricultural practices. Once these solutions are clearly identified, then simplified indicators can be used in ecodesign strategies, ensuring significant environmental benefits.

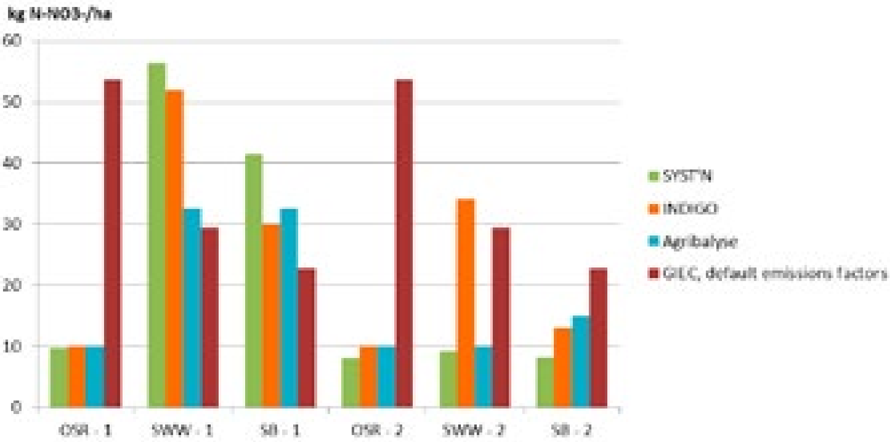

Figure 1. Estimated nitrate leaching by four models for a case study in western France (ECOALIM project). OSR: oilseed rape, SWW: soft winter wheat, SB: spring barley. Scenario 1: no cover crop, scenario 2: presence of cover crop.

4. Database harmonization, where to draw the line?

Since AGRIBALYSE wants to support eco-design of French farming systems, it tends to integrate detailed farmer production practice data and to implement increasingly sophisticated emission models. However, this degree of model sophistication may pose a problem for the integration of AGRIBALYSE LCIs in international databases/frameworks, such as the Product Environmental Footprint (PEF), the World Food LCA Database or Agri-footprint, which tend to promote less data-intensive emission models.

We propose a solution to this dilemma. Just as a variety of characterization methods can be used to produce different sets of impact indicators for a given LCI data set (Fig. 2a), several sets of emission models (corresponding to different objectives) can be used to produce different LCI data from a given data set of farmer practices and soil and climate data (Fig. 2b).

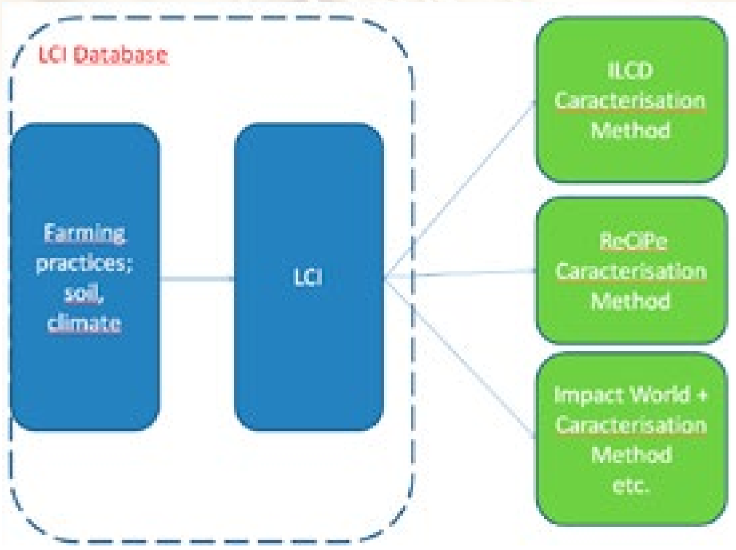

Figure 2a. A variety of characterisation methods can be used to produce different sets of impact indicators for a given LCI data set.

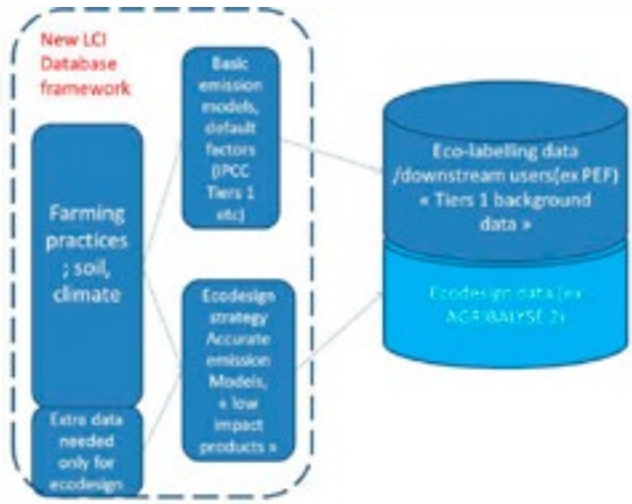

Figure 2b. Several sets of emission models can be used to produce different LCI data from a given data set of farmer practices and soil and climate data.

From a practical point of view, this solution can be implemented in the MEANS-InOut software platform (INRA 2016), where users will be able to choose which set of emission models they wish to implement. Such software solutions can help users in implementing the more complex models through a user-friendly data capture interface, also limiting risks of errors.

While some flexibility due to different goals from database developers and users seems justified, criteria not related to scale or data accuracy should be harmonised. Database harmonization should not lead to lower overall quality of LCIs. In general, heterogeneity is acceptable only when it allows important time saving or avoids data gaps, and when those data are not required for all kinds of users (Table 1). Table 2 summarises our view on harmonisation requirements for food LCI databases.

Table 2. Proposed harmonisation requirements for characteristics of LCI databases.

Characteristic	Harmonisation required	Comments
Scope	Yes	Scope should be similar, even if for minor inputs basic assumptions can be enough (ex : infrastructure)
Time-related coverage	Yes	Some 3 to 5 years average should always be considered to avoid atypical results due to climatic variability
Allocation to co-products	Yes	Provide a standard default option, but give the possibility to modify
End of life	Yes	No reason for heterogeneity, not a hotspot for food products
Background LCI database	Yes	Choice of background LCI database (ILCD or different versions of ecoinvent) will affect results. Unit processes should be used to allow switching background databases
Direct emission modelling	Not necessarily	From Tier 1 to Tier 3 approach, depending on database strategy
Accounting for crop sequences and their consequences	Not necessarily	Irrelevant for downstream users, useful for ecodesign
Fertilization practices	Not necessarily	For downstream users, N input is sufficient, more detail is necessary for eco-design strategies
Manure management and feed practices	Not necessarily	For downstream users a simplified representation is sufficient, full detail is required for eco-design
Data for key parameters	Not necessarily	For key parameters (such as yield, N input etc.), data sources should be based on best data available (national statistics for some countries, FAO for others etc.).
Data quality rating	Yes	ILCD rating system seems a good starting point
Naming	Yes	Consistent naming of LCIs is necessary.
Formats	Yes	All informatics barriers should be removed as soon as possible

5. Link between characterization methods and LCI databases

Life Cycle Impact Assessment (LCIA) is not directly within the scope of LCI databases. LCI databases provide flows which can theoretically be connected to any characterization method in LCA software, as long as the substance names are developed correctly. So far, most LCI databases try to provide all relevant flows for the main characterization methods (ILCD, ReCiPe, etc.). However, as characterization methods become more comprehensive (ex : water scarcity indicators, more biodiversity indicators in the future ?), including new flows at the LCI database level can become a real challenge, considering that the new flows must also be completed in all background processes for the new indicator to be fully operational. Cooperation between databases developers can be really useful on this topic. Also, it is inevitable that a significant delay will remain between LCIA developments, and their full implementation in LCI databases. One strong side of LCA is that it can assess all kind of processes and economic sectors. To keep this flexibility, we think that LCI databases should try to remain as complete as possible regarding flows, leaving the possibility and responsibility to users to choose the most relevant characterization method for each situation.

6. Conclusion: who can do more can do less?

Until recently, food LCI data were relatively rare. As more food LCI data sets are being released, we enter a new phase where simultaneously, data coverage should be improved, and data consistency and database harmonization will become real challenges. Considering the difficulty of defining a clear "goal and scope" for databases, we propose to accept that full harmonization of databases is not necessarily a target. The focus should rather be on transparency and repeatability. Database developers should be encouraged to clearly state their priority, and whether their methodology is more appropriate for eco-design (including the farm stage) or environmental labelling. In our view, heterogeneity between databases is only acceptable for parameters related to data accuracy and spatial scale (ex: direct emission modelling). On the contrary, heterogeneity is not acceptable on parameters not linked to spatial scale or quality of emissions, i.e. methodological choices such as scope, allocation or data quality rating. This approach would enable users to (a) benefit from high quality data when available, those being required mainly for ecodesign and by upstream users, (b) and at the same time to have a broad range of data to cover the diversity of food and origin for downstream users. Since AGRIBALYSE aims to support eco-design strategies, it will probably implement more complex methodologies and emission models compared to other databases that are more focused on eco-labelling, and looking for broader coverage and easier repeatability. While extra efforts required for the development of databases to support eco-design strategies may seems costly, they are essential to guide changes in farming practices. User-friendly software and database tools will allow flexibility in database development based on the principle that who can do more can do less.

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