

COMPARISON OF LIFE CYCLE IMPACT ASSESSEMENT METHODS IN A CASE OF CROP IN NORTHERN FRANCE

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Abstract

Life Cycle Assessment (LCA) applied to the agri-food sector has been rapidly developing in the last years, however initiatives like Agribalyse[®] have shown the lack of consensus making on the impact assessment phase (choice of characterization methods). A review of the proceedings of the 8th International Conference on Life Cycle Assessment in the Agri-Food Sector (LCA Food 2012) [1] revealed the absence of prevalence of a life cycle impact assessment (LCIA) method, where several calculation methods and variations of them are used.

The Agribalyse[®] project has not conducted specific research on a LCIA method, it is limited to the selection of various impact categories [2], resulting in a very large conglomerate impact categories which makes more hard the control and interpretation of the results, which leads to use traditional LCIA methods. But a review of the LCA papers in the agri-food sector is not clarified that LCIA method is the most appropriate to the features of the agricultural sector.

For impact assessment of flow resulting from the life cycle inventory (LCI) phase on the culture of chicory in northern France, we have used four evaluation methods: the three LCIA methods used for most authors of LCA Food 2012, which are the CML2001, IMPACT2002+ and ReCiPe and the method recommended by the European Commission ILCD2011, which show similar results in impact categories considered reliable, but also they show differences in the assessment of various impact categories less consensual.

The differences between the results of those four methods show we must be attention during the interpreting of the results of LCIA phase, regardless of the method chosen, the issue is not to identify the process stage that produces higher environmental impact (e.g. for photochemical oxidation with CML2001 is the process stage of fertilization that stand out, while with ILCD2011 is the process stage of grubbing-up that is outlined).

Keywords

LCI databases, LCIA methods, Agribalyse[®].

1. INTRODUCTION

The program Agribalyse[®] is an initiative launched by the French authorities in order to develop a public LCI database of agricultural products in France by the end of 2012 [3]. Although the Agribalyse[®] project has resolved partially issues resulted from data gaps in LCI databases for agricultural products in France, however it does not explain sufficiently which is the better LCIA method adjusted to the France's agri-food products. Agribalyse[®] project

was limited to the selection of usual characterization methods, including especially those recommended by the ILCD [2], providing forty impact indicators which make more hard the control and interpretation of the results. Furthermore some of impact indicators give the same results in the distribution of the burden for a specific impact category between process stages. This problem leads to use usual LCIA methods.

When we have to do the LCIA phase of an LCA in the agri-food sector, what LCIA method we should to use? A review of the LCA papers in the agri-food sector is not clarified that LCIA method is the most appropriate to the features of the agricultural sector.

2. METHODS

2.1 Application case study

An LCI was carry out on chicory root, based on real agricultural practices documented for chicory root harvested from 2010 to 2012. The studied areas corresponded to the specific supply areas of two chicory root drying plant in the northern France.

The functional unit studied is "1 tonne of chicory root arriving in drying plant".

The agricultural practices considered in this study are stubble ploughing, loosening, grinding, ploughing, hoeing, sowing, crop protection agent (pesticide application), fertiliser (fertilising), grubbing-up and transport to drying site.

2.2 Choice of LCIA methods

A review of the proceedings of the 8th International Conference on Life Cycle Assessment in the Agri-Food Sector (LCA Food 2012) [1] was done to find an appropriate or agreed LCIA method to the agricultural sector in France, but this search revealed the absence of prevalence of a LCIA method.

Several calculation methods and variations of them were used: CML2001 was used 25 times, ReCiPe 14 times, IMPACT2002+ 6 times, Eco-Indicateur99 5 times, SALCA 3 times and variations of available calculation methods were utilized 18 times.

Four LCIA methodologies were chosen for assessment of the system to illustrate the differences that can arise on the selection of a LCIA method, the three LCIA methods used for most authors of LCA Food 2012, which are the CML-IA baseline v3.01 (Normalisation/Weighting set: EU25), IMPACT2002+ v2.11 and ReCiPe Midpoint (E) v1.09 (N/W set: Europe Recipe E) and the method recommended by the European Commission ILCD2011 Midpoint v1.03. In addition, various impact categories from CML2001 (all impact categories) v2.05 (N/W set: West Europe, 1995) were used to complete the environmental indicators in CML-IA baseline v3.01 (e.g. land competition and ionising radiation).

All impact calculations were performed with the LCA software SimaPro 8.0.2 [4] and the LCI database BDD Agribalyse[®] [5].

3. RESULTS AND DISCUSSION

Four different LCIA methods were used, which give reliable results for the climate change, ozone layer depletion, ionising radiation and acidification environmental indicators. Moreover, for photochemical oxidation and eutrophication indicators results showed slight differences; on the other hand for aquatic ecotoxicity, land competition and human toxicity indicators showed different results between impact assessment methods.

As environmental indicators of each LCIA method are quantified in different units and with the goal to show how each indicator gives a different burden to each relative contribution from process stage, the results are shown as a percentage.

3.1 Aquatic ecotoxicity

Although for aquatic ecotoxicity category the characterisation results are expressed in the same unit for CML-IA and ReCiPe methods (kg 1,4-dichlorobenzene equivalents), there are little differences of distribution of environmental impact among two methods (figure 1), but the most notable difference is carried through IMPACT2002+, which distributes the burden more evenly among the different process stage than the other three methods.

Analyse only the results from IMPACT2002+ method without comparison with results obtained from other methods, could lead to underestimate the importance of the stage of fertilization. If the four methods are compared, it can be concluded that aquatic ecotoxicity is largely impacted by the ecotoxicity profile of the fertiliser products applied.

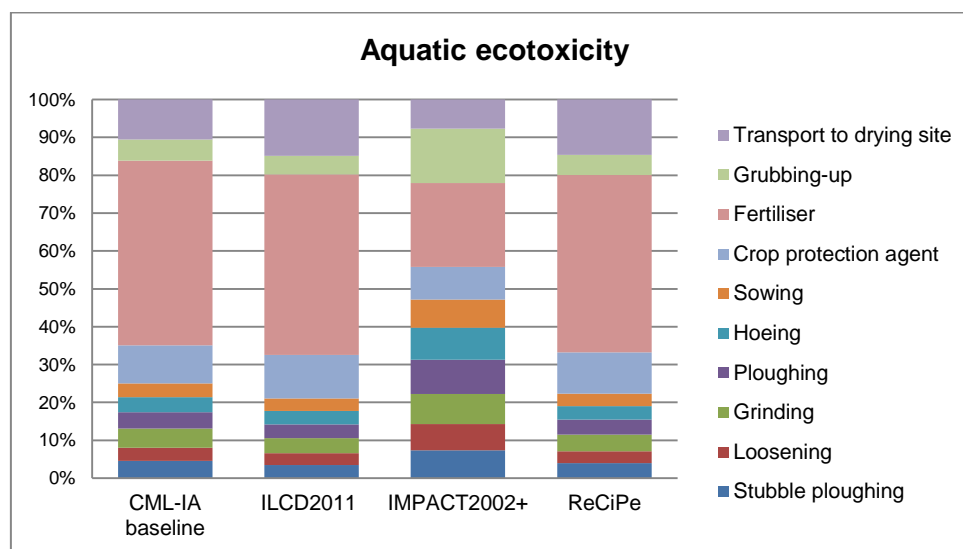


Figure 1: Contribution of several stages process of the chicory root life cycle to the aquatic ecotoxicity indicator results of each LCIA method

3.2 Land competition

For land competition category (figure 2), with the addition of two environmental indicators ReCiPe (agricultural and urban land occupation) the same results were obtained in the distribution of the burden that obtained for the CML2001 method (both methods use the same unit, m²a).

In this case, it is the ILCD2001 method which distributes the burden evenly between the process stages, while the other three methods show the stage of transport to drying site and fertilization as the most important. For example, when land competition is analysed using IMPACT2002+, the environmental impact of transport to drying site is 5,7 times bigger than using ILCD2011.

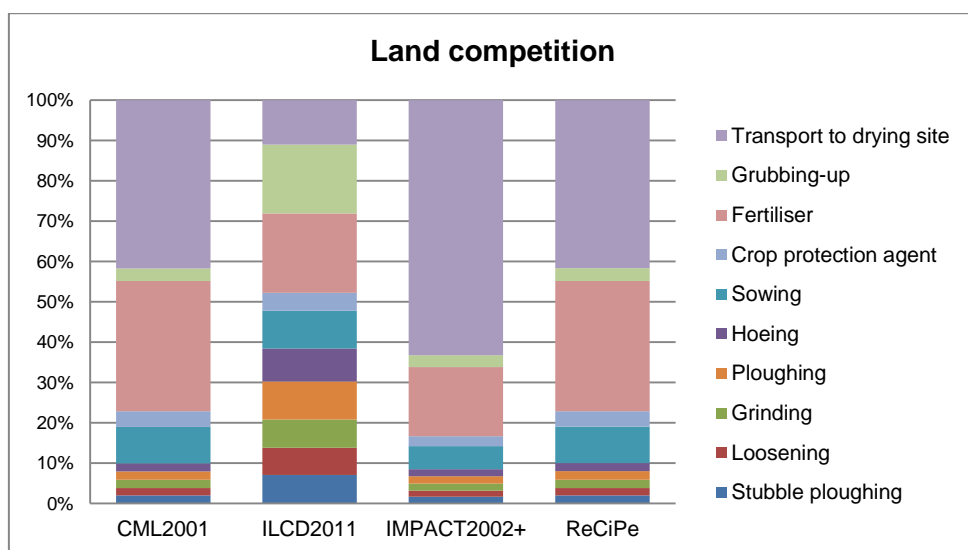


Figure 2: Contribution of several stages process of the chicory root life cycle to the land competition indicator results of each LCIA method

4. CONCLUSIONS

Agribalyse[®] defines a scope of study and a LCI database specific to the French agricultural systems, but it does not provide a simple and operational LCIA method, leading to choose other usual methods, which causes the results from different studies are not comparable to each other for all categories of impact, and that most of the environmental indicators are only partially comparable, because the results can change depending on the calculation method used.

Although environmental indicators generally agree in identifying the process stage that produces higher environmental impact, they don't always coincide in giving equal charge to each process stage, which limits when making comparisons and deeper assessment.

Thus, using different LCIA methods may lead to different conclusions [6], which requires use various LCIA methods when doing the LCA study of a specific system.

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