



Editorial

Towards eco-efficient agriculture and food systems: theory, praxis and future challenges



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A B S T R A C T

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This paper introduces the Special Volume (SV) dedicated to the 2012 Life Cycle Assessment (LCA) Food Conference. During recent years, these conferences have seen a rapid increase in the number of participants, reflecting the development of an interdisciplinary research and development community at the intersection between the agronomic, food/nutrition science and environmental system analysis disciplines. This introductory paper summarises the key issues addressed in the individual papers of this SV, which present a balance between methodological and applied studies. The application of LCA to agro-food systems exemplifies a dynamic and productive interaction between scientific disciplines that previously led separate lives. As a result, LCA in the agro-food sector leads LCA methodological developments on topics such as the attributional versus consequential debate, land use changes, impacts on biodiversity, biotic resource depletion, water use, soil quality, and modelling of direct emissions of crop and animal production systems. Future challenges for the LCA Food research and development domain concern the following issues: functional unit and multi-functionality, emission models, land occupation and transformation, LCA for low-income countries, resilience of agro-food systems and presentation and transparency of results.

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1. Introduction

The production, transformation, distribution and consumption of food contribute to human health and prosperity. However, the agriculture and food sectors also cause major environmental impacts. As the human population grows in number and wealth, demand for food will increase, putting more pressure on land and other inputs for food production, while climate change will pose increasing challenges to agricultural production (Foresight, 2011). Therefore a shift towards sustainable food systems is essential and urgent. During the last two decades, Life Cycle Assessment (LCA) in the agro-food sector has developed rapidly as a major tool to guide this evolution.

This Special Volume (SV) of the Journal of Cleaner Production (JCLP) is based mainly on papers presented at the eighth edition of

the 'International Conference on LCA in the Agri-Food Sector', in short: the LCA Food 2012 conference. Two years ago this journal produced a Special Issue dedicated to the seventh edition of the LCA Food conference (Notarnicola et al., 2012). The LCA Food conferences have become the world's premier scientific forum on LCA in the agro-food sector. Previous editions of the conference took place in Belgium (1996, 1998), Sweden (2001, 2007), Denmark (2003), Switzerland (2008) and Italy (2010). During recent years, the LCA Food conferences have seen a rapid increase in the number of participants: 61 in 2007, 160 in 2008, 272 in 2010 and 436 in 2012.

This vigorous growth reflects the rapid development of an interdisciplinary research and development community at the intersection between the agronomic, food/nutrition science and environmental system analysis (ESA) disciplines. Research in the disciplines of agronomy and food science goes back several hundred years, whereas LCA, as one of the key methods in ESA (Finnveden and Moberg, 2005), has been developed since the 1970s. It has its roots in energy analysis studies and was initially developed for and applied to industrial production systems

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(Boustead, 1996). The question of whether LCA can be applied to agricultural production systems was raised in the 1990s and was at the origin of the LCA Food conference series (van der Werf et al., 2013), which was initiated in 1996 in Brussels.

The LCA Food community has thus developed an interdisciplinary research field in which two mature disciplines (agronomy and food/nutrition science) interact with the much younger discipline of LCA. Although some conference participants are involved almost exclusively in one of these disciplines, most are interdisciplinary, having one foot in agronomy and/or food/nutrition science and the other in LCA. Interdisciplinary environments and viewpoints foster innovation (De Moor et al., 2010; Robinson, 2011), and this may be one of the factors contributing to the success and the vigorous growth of the LCA Food conferences.

Another interesting characteristic of the LCA Food community is the diversity of the sectors involved: at the 2012 conference 33% of the participants were from research institutes, 32% from academia, 30% from private companies and the remaining 5% from government, NGOs and international organisations. As the papers in this SV document, the contents of the LCA Food conferences present a mix of contributions spanning the continuum from pure methodological research to applied case studies.

The objectives of this introductory paper to the SV are to outline the development of the LCA Food conference series, summarise the key issues that the articles in this SV address and reflect on how this field might evolve as well as on issues for future research.

2. The LCA Food 2012 conference

LCA Food 2012 took place in Saint Malo, France from 1 to 4 October. It was organised by the French National Institute for Agricultural Research (INRA), with the support of the French Environment and Energy Management Agency (ADEME).

2.1. Objectives

The goal of the LCA Food conferences is to serve as a global forum for sharing recent developments in LCA methodology, databases and tools, as well as applications of LCA to food- and non-food production systems and consumption patterns. In the 2012 call for papers, particular focus was placed on the following topics:

Methods

- Impact assessment: biodiversity, water and land use, soil quality, toxicity, spatial differentiation
- System definition, allocation, functional unit, attributional and consequential LCA
- Quantification and reduction of uncertainty
- Life cycle sustainability assessment
- Ecodesign of agricultural and food systems

Applications

- Annual and perennial crops, terrestrial and aquatic animal production
- Eco-labelling, communication, consumer behaviour
- Food consumption patterns and diets
- Trade-offs between food quality and impacts
- Assessing farming systems at the territory/regional scale

2.2. Attendance

Despite the global recession, the number of participants was higher than ever before: 436 participants from 36 countries (up from 30 in 2010). Non-OECD countries represented 28% of countries but only 5% of participants. Eighty-six per cent of the participants

came from Europe, 6% from North America, and 2% each from Asia, Oceania, Africa and South America. It should be noted however, that a significant proportion of those 'coming from' OECD countries and Europe are in fact nationals of non-OECD countries outside Europe. Forty-seven per cent of participants were female, and 17% of participants were students.

2.3. Contents

A total of 362 abstracts were submitted. Review by the 23-member International Scientific Committee resulted in the selection of 121 oral presentations and 183 posters. Compared to the 2010 conference, there were more presentations on land use and land-use change, emission modelling, uncertainty, animal production and consumers & food labelling. The topic of tools & databases saw fewer presentations, while life cycle sustainability assessment, crop production and food & diet were major subjects at both conferences.

The book of abstracts of the conference (Corson and van der Werf, 2012a; containing abstracts of oral presentations and posters) was available for participants, as was as an electronic version of the conference proceedings (Corson and van der Werf, 2012b; containing 6-page papers of oral presentations and abstracts of posters).

3. This special volume of the Journal of Cleaner Production

This SV of the JCLP was developed to highlight papers resulting from the 2012 LCA Food conference. From the 121 abstracts accepted as oral presentations, 26 papers were chosen for inclusion in this SV. To these papers, eight additional manuscripts submitted as part of the normal flow to the JCLP on agro-food-related subjects were added. Selection and processing of the papers in this volume was performed by Christel Cederberg, Michael Corson, Kiyotada Hayashi, Tara Garnett and Hayo van der Werf.

The 34 papers selected for the SV have been grouped according to the following topics:

- **General perspectives on LCA and food system sustainability.** Papers by keynote speakers that question the role of LCA as a tool to contribute to food system sustainability.
- **LCA methodology.** New methods regarding land use, land-use change, soil carbon dynamics, water footprint, biotic resource depletion, system modelling, co-product handling, uncertainty, nutritional quality, food waste.
- **Tools to guide producers and consumers in food-system decision-making.** Carbon footprint calculators, tools that summarise food impacts to support consumer decisions.
- **Agricultural production case studies.** Controlled traffic farming, tomato, cucumber, lettuce, escarole, rice, broiler, milk, beef cattle, sheep, crop and livestock production systems.
- **Food production and consumption case studies.** Raspberry, tomato puree, consumer perception, meals, coffee, food waste.

3.1. General perspectives on LCA and food system sustainability

Before entering into the wonderful world of agro-food LCA methodology and applications, it is useful to take a few steps back and learn from those outside of LCA about how they perceive the field, to understand their views, expectations, propositions and criticism.

Garnett's (2014) article addressed LCA from 'outside the frame' by analysing three emerging perspectives on achieving sustainable food security: efficiency, demand restraint and food-system

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