E-LCA FED BY REGION-SPECIFIC DATA SUPPORTING THE CEREAL SECTOR IN WALLONIA (BELGIUM)

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Abstract

Based on a comprehensive description of the Walloon cereal sector, the project “Alternatives for Cereals” – in short “ALT-4-CER” – considers current and future opportunities for food, feed, fuel and fibre uses of Walloon cereal resources (so-called “4F” scenarios) through an exhaustive comparison of sustainable performances of existing and potential conversion chains. Scenarios are evaluated through Environmental and Social Life Cycle Analyses fed by region-specific data. Multifunctional systems such as 4F cereal chains involve specific methodological choices regarding e.g. functional unit selection, system boundary definition, impact categories or stakeholders groups. As so, consequential LCA appears to be the relevant option for assessing the consequences of possible evolutions in the Walloon cereal sector by evaluating potential environmental and socio-economic impacts of studied scenarios. Beside the socio-economic work package, Environmental Life Cycle Analyses are conducted in order to identify territorial differences regarding the cultivation step in comparison with generic data found in commonly used databases. Cultivation pathways and agricultural work processes are modelled on the basis of current research in the Region. New cropping practices such as no tillage or direct sowing are being explored. Machines and tractor consumptions are adapted according to common practices in Wallonia. Methods assessing direct field emissions relating to agricultural inputs application during and after plant production are also closely surveyed, especially since local climate, practices and soil characteristics can have a huge impact on environmental performances. Other aspects such as inputs manufacture and management, and animal feeding and husbandry are scrutinized too. Downstream of the cultivation step, different conversion processes will be studied, with a focus on existing facilities. In a later step, environmental and socio-economic assessment results will be integrated thanks to multi-criteria analysis involving stakeholders.

Keywords: Cereals, life cycle assessment (LCA), ELCA, SLCA, decision making.

1. INTRODUCTION

In the present sustainable development framework, agriculture raises major concerns in terms of productions and farmers’ income diversification, competition for arable land between food and non-food uses, employment preservation or creation in rural areas, climate change mitigation and natural resources protection.

Current environmental policies and regulations aim at moving towards more sustainable production and consumption pathways. This transition requires the improvement of the energy, environmental and social balances of considered processes and reference systems. This shift also involves the search for new and alternative uses of agricultural resources, products and co-products.

Comparing current and potential cereal uses in Wallonia, the overall goal of the 3-year project “Alternatives for Cereals – ALT-4-CER”, started in March 2011, is to define and to evaluate alternative scenarios for food and non-food uses of cereal resources in Wallonia with the support of involved stakeholders.
On the basis of the scenarios developed during the first phase (see paper from Delcour et al. in these conference proceedings), the project is evaluating environmental impacts of food and non-food cereal uses through the development of Environmental Life Cycle Assessments (E-LCA) adapted to the local context, fed with specific data collected for Wallonia. Simultaneously, a Social Life Cycle Analysis methodology (S-LCA) is being developed in order to grasp socio-economic impacts of defined scenarios (see paper from Delcour et al. in these conference proceedings).

In a later stage of the project, relevance of the selected scenarios will be evaluated through multi-criteria analysis supported by the sector. Stakeholders will again be convened in order to help weighting sustainable indicators identified in the E-LCA and S-LCA processes.

2. SCENARIOS EVALUATION WITH LCA

Scenarios of food and non-food cereal uses are being evaluated regarding environmental and socio-economic aspects through Life Cycle Analyses (LCA) fed by region-specific data adapted to the local context.

The bottleneck to estimate production chain sustainability is the lack of knowledge regarding material and energy flows, and environmental and socio-economic impacts, from raw material extraction to waste disposal. Among available evaluation tools, LCA is nowadays the most commonly used method [1]. Using LCA can have two complementary goals: either to compare products, processes or services according to their impacts, or to identify, within a production and use chain, key points to be improved in order to minimize any given impact. The ISO 14044:2006 standard [2] defines three impact category groups called “Areas of Protection”: (i) natural and abiotic resources use, (ii) human health consequences and (iii) ecological consequences. Beside E-LCA, recent developments in LCA tend to integrate socio-economic aspects in S-LCA, in order to grasp all three pillars of sustainable development. With respect to S-LCA, a fourth Area of Protection is usually added: human dignity and well-being [3].

The use of local and specific data is crucial when conducting LCA. Data uncertainty is closely related to data reliability and completeness, but also to geographical, temporal and technological correlation [4]. Supported by long-term expertise and wide-spread contact network of the research team, the ALT-4-CER project has committed itself to collect and use specific data, adapted to the Wallon context.

3. SCOPE AND GOAL DEFINITION

3.1 Consequential versus attributional LCA

Two types of LCA methodologies are used according to the objective(s) of the study: attributional LCA (A-LCA) and consequential LCA (C-LCA). A-LCA describes the relevant physical flows entering and exiting a product system. C-LCA expresses how these flows will evolve in response to decisions or changes. When C-LCA is useful to assess the consequences of individual decisions, A-LCA enables distinguishing between systems having important impacts. These complementary objectives allow both A-LCA and C-LCA methodologies to be valid for decision-making [5].

Regarding these definitions, the goal of the ALT-4-CER project can be formulated as follows: to assess the consequences, in terms of environmental and socio-economic impacts, of potential changes in Walloon cereal uses by 2030, in comparison with the current situation (2010). Consequential LCA is therefore the appropriate choice with respect to this objective.

3.2 System boundaries and functional unit definition

The first step of any LCA is to define the goal and scope of the study [6]. This essential stage lays the basis of the study by answering key questions such as “What do we study? In what purpose? Who is the targeted audience?”. System boundaries need to be cut between impacts considered as relevant and others.

Besides a functional unit (FU) needs to be chosen. The FU aims at providing a reference to which all input and output flows in the assessment are normalized [7]. In a comparative study, the FU shall be the same for all compared product systems. This is a prerequisite for ensuring equivalence among the product systems [6].

Food and non-food uses considered in ALT-4-CER are classified in “4F” categories:

1. Human (Food) uses (i.e. flour mills, beer products, starch products used in agro-food industries, etc.);
2. Animal (Feed) uses (i.e. feed ingredients for animal rations, agro-food and biofuel industry co-products, grain and/or straw self-consumption on farm, etc.);
3. Energy (Fuel) uses (i.e. ethanol production from starch, second generation ethanol production
from straw, biogas production from maize, straw direct combustion, etc.);

4. Material (Fibre) uses (i.e. straw for animal litter, non-food uses of starch, straw use as isolation material, biorefineries, etc.).

These four categories imply various end-uses and very different functions of the initial cereal resources.

With respect to agricultural LCA, [8] considers that the kilogram is a convenient FU in order to take into account both production efficiency and impacts. Normalizing impacts according to land occupation on the contrary does not account for production efficiency. On the other hand, both the mass and surface can be used as FU for assessing global impacts, whether the hectare is preferred for regional impact assessment [9].

Considering the multiple functions of the various systems studied here the proposed FU is “any useful output per hectare in an average year” [10]. This option uses a FU which is the same for all 4F scenarios and illustrates the competition for land between food and non-food. On the other hand, the function of agriculture is not to occupy land. Nor is this solution convenient to compare different production systems, such as organic farming versus conventional farming, or different land use intensities, because it does not account for the lesser productivity of organic farming or less intensive production systems. A sensitivity analysis will thus test conclusions strength according to another FU defined as “any useful output per kilogram of a given cereal in an average year”. Besides, regarding S-LCA, a FU considering working hours can be a useful unit for specific socio-economic concerns.

4. ENVIRONMENTAL LIFE CYCLE ASSESSMENT

Environmental Life Cycle Analysis (E-LCA) aims at identifying territorial differences regarding the cultivation step in comparison with generic data found in commonly used databases.

Cultivation pathways and agricultural work processes are modelled on the basis of current research in the Region. New cropping practices such as no tillage or direct sowing are being explored. Machines and tractor consumptions are adapted according to common practices in Wallonia. Methods assessing direct field emissions relating to agricultural inputs application during and after plant production are also closely surveyed, especially since local climate, practices and soil characteristics can have a huge impact on environmental performances. Other aspects such as inputs manufacture and management, and animal feeding and husbandry are scrutinized too. Downstream of the cultivation step, different conversion processes will be studied, with a focus on existing facilities.

First results will be presented and discussed at the LCA Conference in Lille in November 2012.

5. ELCA AND SLCA INTEGRATION THROUGH MULTI-CRITERIA ANALYSES

Scheduled as the ultimate phase of the ALT-4-CER project, multi-criteria analyses are envisaged in order to weigh and integrate environmental and socio-economic performances evaluated thanks to ELCA and SLCA. These LCAs intend to express their results using midpoint evaluation methodologies and not endpoint evaluation where results are weighted and aggregated into a few final impacts, more meaningful for a non-scientific audience but less certain [11].

Multi-criteria analyses will subsequently aim at integrating the opinion of stakeholders and actors of the cereal chain (producers, converters, consumers, decision-makers, NGOs, etc.) in order to weigh environmental and socio-economic performances according to the sector priorities.

6. REFERENCES


