

Volume 3, Number 1 2019

Special issue on “LCA of tropical agricultural products”

Table of content

Using the LANCA® model to account for soil quality within LCA: first application and approach comparison in two contrasted tropical case studies

Alexis Thoumazeau^{a,b}, Cécile Bustany^{a,c}, Jérémy Rodrigues^d, Cécile Bessou^a

^aSystemes de pérennes, Univ Montpellier, CIRAD, Pôle ELSA, F-34398 Montpellier, France

^bEco&Sols, Univ Montpellier, CIRAD, INRA, IRD, Montpellier SupAgro, F-34398 Montpellier, France

^cBioWooEB, Univ Montpellier, CIRAD, Pôle ELSA, F-34398 Montpellier, France

^dBRGM, BP 6009, 3 av. C. Guillemin, F-45060 Orléans, France

An LCA of French beans from Kenya for decision-makers

Claudine Basset-Mens

CIRAD, France

Food chain sustainability assessment, Part I: a transdisciplinary and operational framework

Alexandre Thévenot, Jonathan Vayssières

CIRAD, France

Food chain sustainability assessment, Part II: the case of poultry production in a tropical island

Alexandre Thévenot, Jonathan Vayssières

CIRAD, France

LCA of lime and mango fruit systems in Guinea-Bissau

Helena R Farrall, Emanuel Emanuel Ramos, António G. Brito*

University of Lisbon, Portugal

Using the LANCA® model to account for soil quality within LCA: first application and approach comparison in two contrasted tropical case studies

Alexis Thoumazeau^{a,b}, Cécile Bustany^{a,c}, Jérémy Rodrigues^d, Cécile Bessou^a

^aSystèmes de pérennes, Univ Montpellier, CIRAD, Pôle ELSA, F-34398 Montpellier, France

^bEco&Sols, Univ Montpellier, CIRAD, INRA, IRD, Montpellier SupAgro, F-34398 Montpellier, France

^cBioWooEB, Univ Montpellier, CIRAD, Pôle ELSA, F-34398 Montpellier, France

^dBRGM, BP 6009, 3 av. C. Guillemin, F-45060 Orléans, France

Abstract

Assessing the effect of land management on soil quality is nowadays a key environmental concern, as the soil system is linked to major ecosystem services. There is a strong methodological shortage to integrate the impact of anthropogenic pressure on the soil system within large scale environmental frameworks, such as the Life Cycle Assessment. The LANCA® method was proposed to meet this need, integrating five impact categories of soil functions and directly applicable within the Life Cycle Assessment framework. Although the most recent 2016-LANCA® version shows readiness to be integrated in this large scale environmental framework to meet the demand, it has not yet been applied and validated on case studies. This study proposes a first application of the LANCA® model on two contrasted agricultural-based case studies to share experience in implementing the model through both background and foreground approaches, to analyze the first model outputs and to provide tracks for further model improvements. The results proved that both LANCA® approaches were poorly sensitive to the agricultural land managements tested. The foreground approach was difficult to implement due to the lack of transparency of the targeted characterization factors calculation procedure. Further global sensitivity and redundancy analysis should also be proposed in order to validate the consistency of the global model.

Key Words: LANCA®, Land Use, Land Management, Life Cycle Assessment, Soil Quality, Case studies.

An LCA of French beans from Kenya for decision-makers

Claudine Basset-Mens

CIRAD, France

Abstract

Although challenging, private and public decision-makers increasingly demand for quantitative assessments of the environmental performance of value chains in South contexts. This paper presents and critically analyzes a complete LCA study performed with Endpoint indicators for a public decision-maker for the fresh French bean (FB) value chain of Kenya. A cradle-to-gate LCA study was done including five main stages: agricultural production, transport by road before pack-house, pack-house, transport by road after pack-house, and intercontinental transport by air-freight; using 1 kg of raw French bean processed as functional unit. Supported by local experts, primary data were collected for all inputs and outputs for 33 farms over five counties and two pack-houses. An expert-based typology defined four farm types: large-farm, medium-farm, small-holder farm (SHF) contracted and small-holder farm scattered. Best available methods for field emissions were used and adapted when possible to local conditions (e.g. P losses). At market-gate, air-freight was identified as main hot-spot pleading for the design of stabilized FB products that could be seafreighted. At farm-gate, large differences were observed between farm types, with the medium-farm obtaining the least impacts per kg of French bean, and fertilizer, water and land use being the key-drivers of their eco-efficiency. Impacts due to pesticides applications were small at Endpoint level but were incomplete. These results should be validated with a greater sample of stakeholders and the scope of the LCA should be extended to the consumption stage. Further research is also needed to provide LCA practitioners with operational and reliable tools for a better inclusion of pesticides' impacts and uncertainty.

Keywords: LCA; decision-makers; French bean; Kenya; pesticides

Food chain sustainability assessment, Part I: a transdisciplinary and operational framework

Alexandre Thévenot, Jonathan Vayssières

CIRAD, France

Abstract

Food chains face huge pressure to progress toward sustainability. The two main sustainability assessment approaches used today, neo-classical economics and eco-efficiency, have weaknesses that make them either ethically unacceptable, or inadequate to address the complexity and dynamics of the food chain. Both aim to maximize shareholders' interests and generally ignore equity, the main principle of sustainable development. Inspired by recent advances in several business theories and in sustainability science, this paper proposes a framework to approach corporate sustainability from the stakeholders' point of view based on a transdisciplinary approach. The framework was elaborated with holism and feasibility in mind. It first highlights the need to define a spatial scale in order to set boundaries for evaluating equity and efficacy, two components of the notion of sustainable development. To achieve a holistic representation, the system under study is defined as a social ecological system. Recent developments in stakeholder theory propose considering both social and environmental concerns as stakeholders (human and non-human stakeholders) thus reintroducing the two concerns as equal constraints in management activities. To achieve feasibility, the system boundaries are more clearly defined by selecting only the salient stakeholders of the social ecological system. The salience of the identified stakeholders is measured by the depth of their interactions with the food chain. In the proposed framework, the type of interaction and the cut-off criterion depend on the type of stakeholder. The participation of human stakeholders is of particular importance when defining issues at the scale of the territory and the corresponding indicators and assessment methods to be used to assess sustainability. As illustrations, we describe two methodologies for socio-economic and environmental impact assessment which fit the requirements of the framework particularly well. This paper discusses how the effective incorporation of concepts and methods from different disciplines (environmental sciences, economics, engineering science, etc.) is achieved by using the proposed framework.

Keywords: Sustainability science, food chain, transdisciplinarity, coupled systems approach, systems analysis

Food chain sustainability assessment, Part II: the case of poultry production in a tropical island

Alexandre Thévenot, Jonathan Vayssières

CIRAD, France

Abstract

Food chains can be powerful driving forces for sustainable development. In this paper, a new framework for sustainable assessment is applied to analyse the contribution of the main poultry supply chain in Reunion Island to the sustainable development of this island territory. Sustainability was assessed over a three-year period using a transdisciplinary approach paying particular attention on the involvement of the main stakeholders of the supply chain. The stakeholders participated in framing the problem, selecting the appropriate indicators, and interpreting the results. The first system delimitation included all stakeholders whereas only the salient stakeholders were selected for the assessment. Two assessment methods were used depending on the indicators chosen: environmental life cycle assessment and input-output analysis. Indicators were spatialized and grouped in six categories to represent what parts of the social-ecological system needs to be in Reunion Island. Our results revealed a highly complex network of firms involved in the supply chain. We show how the proposed framework can simplify interpretation for decision makers by focusing only on the most salient firms. Among the 1,126 firms involved in the supply chain, efforts were thus concentrated on 139 firms which are salient for the social subsystem and 124 which are salient for the ecological subsystem. Spatial differentiation of effects is a useful way to underline the transfer of impacts between territories. For the ecological subsystem in Reunion Island, the effects linked to supply chain activities which threaten resources conservation and ecosystem health are mostly externalized due to the strong dependency on foreign resources: fossil energy and raw materials used for livestock feed (e.g. 97.5% of impacts on freshwater ecotoxicity occur outside the territory). On the island, most damage occurs is to the ecosystem and human health. Concerning the social subsystem, the supply chain provides employment on the island due to the use of local services (e.g. 89.7% of indirect jobs are provided on the territory). Several environmental mitigation measures were integrated and tested through scenarios. Improvement of on-farm eco-efficiency was shown to be a mitigation measure that significantly affects the food chain. Human and ecosystem health and resources conservation would be improved by this measure (+14%). But the community and the supply chain industrial network would also be negatively affected (-2.5%). Multi-criteria analysis is particularly useful for decision making. It makes it possible to evaluate the necessary trade-offs between resources conservation, ecosystem and human health on the one hand, and employment in the supply chain industrial network and the surrounding community on the other. This type of analysis involves a heavy burden of data collection and analysis. The firms' participation guaranteed complete high quality data. Data availability is probably the most important limitation for a broader implementation of the proposed framework to assess other food systems around the world.

Keywords: Sustainable development, life cycle assessment, input-output analysis, broiler supply chain, Reunion Island

LCA of lime and mango fruit systems in Guinea-Bissau

Helena R Farrall, Emanuel Emanuel Ramos, António G. Brito*

University of Lisbon, Portugal

Abstract

Tropical fruits are playing an increasing role in global commodity exchange with significant impacts on local social, economical and environmental frameworks. Value Chain Analysis is a conceptual approach for continuous improvement at the chain level as a whole and Life Cycle Assessment (LCA) is the appropriate methodology to evaluate value chain environmental sustainability. Therefore, this study presents the environmental LCA of three tropical fruit products value chains – fresh lime, lime vinegar and fresh mango - in Guinea-Bissau.

Over the entire three life cycles studied, fruit cultivation mainly contributed to water consumption and land use, and freshwater eutrophication in the case of mango. Fruit transport to market, either to national, export or to value chain compound, dominated the other impact categories. Overall, mango presented the highest impacts while lime showed the lowest. The results show that transportation is the main driver for environmental impacts and highlight the significance of low input characteristics in the sustainability assessment of food systems.

Keywords: tropical fruits; low input systems; value chain analysis; VCA4D programme