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# Life Cycle Assessment of multiyear peach production

Elisabet Vinyes [a, *], Carles M. Gasol [a, b], Luis Asin [c], Simó Alegre [c], Pere Muñoz [a, d]

[a] Sostenipra Research Group, Universitat Autònoma de Barcelona, 08193 Bellaterra, Barcelona, Spain
[b] Inèdit Innovació s.l. Research Park of UAB, UAB Campus, 08193 Bellaterra, Spain
[c] Institute for Research and Technology in Food and Agriculture (IRTA), 25198 Lleida, Spain
[d] Institute for Research and Technology in Food and Agriculture (IRTA), 08348 Cabrils, Barcelona, Spain

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ABSTRACT

Considering that peach is a significant fruit in the Mediterranean countries, and most publications on environmental impacts of fruit productions are based on one single productive year, this study attempts to perform an environmental analysis of peach production using Life Cycle Assessment, in order to provide new information on peaches, and also introduce a multiyear perspective analysis to identify the variability of the environmental impacts related to annual orchard yield and weather variations. The system studied is a peach orchard (*Prunus persica* L.) with integrated agricultural practices. The study analyses the cultivation period, as well as the impact of the initial orchard establishment tasks (soil preparation and planting). Data used have been collected directly from an orchard located in the North East of Spain, and covers 15 years of real production. The functional unit adopted was the cultivation of 1 kg of peach. Four scenarios have been considered according to the different yield periods of the peach fruit tree: *Growth*, *Low*, *High and Multiyear*. The results of the study reveals that, depending on production scenario considered, the results per kg of peach can vary between 7% and 69% depending on the environmental indicator. If the impact of initial orchard establishment tasks (soil preparation and planting) is not included in the quantification, then 5% of total emissions may be overlooked, but sometimes a lack of data makes it difficult to include these stages. Caution should be taken when the functional unit is related to mass and only when a single year of production is studied, because unproductive years increase impacts on value per functional unit, whereas over-productive years decrease them. According to variability of the results obtained, multiyear approach should be considered in crops with an average life time of twenty years or higher. The present study can be considered a useful methodological framework for providing a deeper understanding of the key environmental impact issues related to fruit production based on peach case study, and how to avoid multiple interpretation of results associated to reporting annual environmental impact variations.



## 1. Introduction

The agricultural sector has changed in Europe over the last ten years, from traditional practices to more intensive methods, in order to increase the productivity of the plantations, and as a response to the growing demand of an increasing population. As a consequence of the increase of intensive methods, food production has become an important contribution to the depletion of natural resources and climate change (Martínez-Blanco et al., 2011a). The IPCC Climate Change Synthesis Report 2007 estimates that the direct impacts of agriculture contribute about 13.5% of global anthropogenic GHG emissions. Europe is currently encouraging farmers to practice more sustainable agriculture in order to meet all the needs of society: environmental, social and economic (European Commission, 2012). Even so, to promote environmental friendly agricultural production it is essential for farmers to identify the causes of environmental impacts of their production systems.

A few years ago, the main concern in the food industry was safety, but recently it is becoming conscious of the environmental repercussions of their products, and is attempting to open new horizons towards sustainable production. Consumers are also increasingly aware of the environmental performance of the food products they buy, and this is reflected in their purchasing decisions. To develop a proper environmental management for

* Corresponding author.
*E-mail address:* elisabet.vinyes@gmail.com (E. Vinyes).

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industries and farmers, it is essential to know the main environmental indicators of their products: emissions, energy and water consumption, waste generation, efficiency, etc. It can also give an environmental added value to their product, at the same time that it provides valuable information for consumers (Environdec, 2012).

Table 1 shows a review of some publications about environmental impacts of fruit production. The literature review was carried out from papers in international journals and conference proceedings. The review covered all main aspects for conducting environmental analyses of fruit production systems, giving preference to the agricultural stage. The information was collected from two main approaches: LCA and agricultural aspects. For LCA approach the following items were considered: functional unit (FU), system boundaries, environmental impact assessment method, initial stages consideration, and cultivation period considered. For the agricultural approach, the country of the study, and fruit variety were taken into account.

Most of reviewed studies only consider one productive year, and initial stages of orchard establishment (soil preparation and planting) are not included. The application of environmental assessment methods in the fruit sector is conventionally divided into a field phase and a retail phase (considering a spatial time of one productive year). Although there are important differences in the environmental impacts in the field phase, a major part of the impacts is related to the distribution chain in the retail phase, mainly due to the cooling (Cerutti et al., 2014). Another important aspect to be considered is that some resources are used annually, whilst others are present during the whole lifetime of the orchard (Mila i Canals and Clemente Polo, 2003).

According Table 1, Life Cycle Assessment (LCA) is one of the most used standardized methodologies (ISO14040) for estimating the environmental burdens linked to fruit production, and it has shown to be an effective mechanism to report environmental performance in the food and beverage sector in general (Vazquez-Row et al., 2012). However there are a limited number of fruit crop LCA studies, and they still do not present enough environmental information, the impacts are partially analysed, and the existing studies mainly focus on one productive year, when the life span of fruit crop plantations range from 20 to 60 years. Quantitative environmental assessment methodologies such as LCA require significant time and resource inputs during the data acquisition and life cycle inventory (LCI) phase. Approaches to streamlining the LCI data collection process without degrading data quality are therefore required, and is especially true for agricultural products (Bellon-Maurel et al., 2014). The main reason that may explain this is due to environmental and energy aspects for the development of fruit crops were not taken in account by farmers during the last decades, so there is no available data and the existing information that can be found are not reliable data. In recent times, after the emergence of new private sustainability standards such as: Global Gap, SAGP Guidelines, SAI initiative, etc. and the growing competitiveness in the private markets, all the actors involved in fruit production showed much interest in environmental impacts that their products generate, and became aware of the need to collect much more reliable data to improve the quality, the availability and the temporality of these, in order to develop environmental studies with a high quality and rigorousness. Nonetheless, in the European context, the EU Framework Programme for Research and Innovation has been developed: Horizon 2020, which encourages companies to develop more sustainable strategies in order to reduce the environmental impact of their companies and the use of resources. For the fruit sector in Mediterranean countries, the peach is an important product. The main producers of peaches in Europe are: Italy, Spain, Greece and France, all together produce 42% of the world production. According to FAO statistics (2011) the largest peach and nectarine producer is Italy with 1,474,337 tonnes, followed by Spain 1,129,300 tonnes, Greece 810,000 and France 313,300. While Italy stands out as the largest producer, Spain is the major exporter, due to its early season harvest, lower production costs, and varietal renewal using higher quality varieties. Greece is the major EU peach processor. Spain is the second peach and nectarine producer in the European Union, and ranks third in the world after China and Italy (European Commission, 2012). This study will analyse the region of Catalonia, located in the North East

**Table 1**
Environmental fruit studies published in last 10 years.

| Fruit | Country | Tool | Method | Boundaries | FU | Cultivation period | Initial stages | References |
|---|---|---|---|---|---|---|---|---|
| ***Europe*** | | | | | | | | |
| Apple | Switzerland | LCA | SALCA v.31 | Production | ha, $ | 4 years | No | Mouron et al., 2006 |
| Apple | France | LCA | CML<br>EDIP97<br>IPCC 2007 | Production | ha | 1 year | No | Alaphilipe et al., 2012 |
| Apple | Italy | LCA | EDIP | Production | kg | 1 year | yes | Cerutti et al. 2013 |
| Apple | Italy | LCA | CML01 | Production & supply chain | kg | 1 year | yes | Assomela, 2012 |
| Kiwi | Greece | LCA | CML01 | Production & supply chain | kg | 1 year | yes | Zeus, 2012 |
| Citrus (products) | Italy | LCA | IPCC GWP100<br>CML01 | Production & processing | kg | 1 year | No | Beccali et al., 2010 |
| Orange | Spain | LCA | CML | Production | t | 1 year | No | Sanjuán et al., 2005 |
| Orange | Italy | LCA | Impact 2002+ | Production & processing | kg | 1 year | No | Clasadonte et al. 2010b |
| Peach | Italy | LCA | Impact 2002+ | Production & processing | kg | 1 year | No | Clasadonte et al. 2010a |
| Nectarine | Italy | EF | Eco indicator 99 | Production | gha $t^{-1}$ | 1 year | No | Cerutti et al., 2010 |
| Strawberry | Uk, Spain | Literature | IPCC 2007 | Production & processing | kg | 1 year | No | Williams et al., 2008 |
| ***Other countries*** | | | | | | | | |
| Apple | New Zeeland | LCA | EDIP97 | Production & processing | t | 2 years | yes | Milà i Canals et al., 2006 |
| Apple | Brazil, Uk | LCA | CML01<br>Baseline 2000 | supply chain | t | 1 year | yes | Sim et al., 2007 |
| Cacao | Ghana | LCA | CML01 | Production & processing | kg | 1 year | No | Ntiamoah et al., 2008 |
| Pear | China | LCA | IPCC 2007 | Production & processing | t | 1 year | No | Liu et al., 2010 |
| Orange | Brazil | LCA | EMS4<br>PIRA | Production & processing | kg | 1 year | No | Coltro et al., 2009 |
| Pineapple | Costa-Rica | LCA | PAS,2050<br>USEtox<br>TRACI | Production & processing | kg | 1 year | No | Ingwersen, 2012 |
| Kiwi | New Zeland | CF | PAS 2050 | Production & supply chain | kg | 6 years | yes | Mc. Laren et al. 2010 |