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Eco-innovation and benchmarking of carbon footprint data for vineyards and wineries in Spain and France

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ABSTRACT

Environmental sustainability in the wine sector has become a priority, as a result of both the growing interest in environmental issues and the consumer's demand for more information regarding the environmental impact of the products they purchase. In this context, the use of carbon footprint as an indicator to assess and report the environmental burdens associated with wine production has gained a role of primary interest. The present study has the aim of improving the wine sector's sustainability by providing inventory data on wine production systems from a total of 18 wineries located in major wine-producing regions in Spain and the South of France. The main novelty of this paper is: the corporate carbon footprint approach, the greater number of wineries studied, the diversity of location of those wineries, the detail of data presented and the identification of the best reference flow for vineyards. Data was statistically analysed. Vineyard consumptions are usually related to the area of cultivation. However, although 1 ha of vineyard or 1 kg of harvested grape could both be considered good reference flows for vineyard processes, this study shows a greater standard deviation of average data calculated per ha rather than per kg. Impact results show a major contribution of the winery phase to the corporate carbon footprint (73%), mainly due to glass production for bottling (45.6% contribution) and electricity consumption (9.2%). In the vineyard phase, contribution comes mainly from diesel production and combustion due to field works (11.3%) and the use of phytosanitary products (6.0%). The results revealed that with the establishment of best practices and with optimized resource consumption, the corporate carbon footprint values can be reduced by almost 25%. The comparative results presented can be used as a reference that will enable wineries to compare their impacts to the average, to identify in which aspects they are within the average and which aspects they are outside the average and whether these aspects are significant to their carbon footprint. This may encourage wineries to adopt measures for Eco-innovation through carbon emission reduction.

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1. Introduction

Wine production constitutes one of the most ancient economic sectors and is still at present a very important agri-food activity in Europe. Among the main worldwide producers, Southern European countries, Spain and France, currently have the highest surface area of territory dedicated to wine production (Salvat and Boqué, 2009). Grape growing accounts for a large majority of agricultural activities in regions where wine production is concentrated and, similarly to other agricultural activities, it has a significant impact on the environment due to the use of fertilizers, pesticides, water and energy, soil erosion and land use, and to the production of substantial amounts of organic waste (BREF of food, drink and milk industry, 2006).

In the past decade, pressure from environmental authorities and an increasing interest from consumers and foreign importers in environmental issues leading to a higher demand for information

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regarding the environmental impact of the products they purchase, have led to new appellations and quality standards resulting in a steady decline of wine production in Europe (OIV, 2012). In order to keep up with the current demand trends and to improve market quota, competitiveness and consumer satisfaction, a growing number of stakeholders in the wine sector has started to analyze and disseminate environmentally relevant results (Szolnoki, 2013). Consequently, environmental sustainability has become a priority for those involved in the wine supply chain (Forbes et al., 2009).

In this context, the application of life cycle assessment (LCA) as a standardized environmental management tool (ISO 14040, 2006; ISO 14044, 2006) has gained a role of primary interest within the extensive literature, regarding assessment of the different environmental burdens associated with wine production for moving toward sustainable grape growing and wine production practices (Rugani et al., 2013). Wine LCA studies vary on the type of wine (Fusi et al., 2014; Pattara et al., 2012; Amienyo et al., 2014) the country where wine is produced, such as Spain (Vázquez-Rowe et al., 2012a, 2012b), France (Bellon-Maurel et al., 2015), Italy (Benedetto, 2013; Benedetto et al., 2014; Iannone et al., 2016; Marras et al., 2015), Portugal (Neto et al., 2013), Australia (Thomas, 2011), Canada (Point et al., 2012; Steenwerth et al., 2015) and the life cycle stages included in the study, cradle to grave (Gazulla et al., 2010) or cradle to gate (Pattara et al., 2012). Although LCA has proven to be useful to quantify the environmental burdens associated within life cycle stages of wine, it has disadvantages due to its wide scope in terms of system boundaries or multiple impact categories.

Certainly, in Europe, there is a huge ongoing effort to improve and promote the use of LCA in different sectors, including the wine sector, through the PEF[1] and OEF[2] methodologies of the Single Market of Green Products Initiative.[3] However, there is an even higher worldwide trend of simplification (Baitz et al., 2013; Bala et al., 2010) focussing on a single indicator, carbon footprint, relevant to global warming, which is internationally considered as critical environmental concern (Pattara et al., 2012; Weidema et al., 2008). Being a one-indicator methodology doesn't mean that there are no methodological pending issues in carbon footprint calculation; for instance, the accounting of organic carbon is of great importance (Arzoumanidis et al., 2014). Carbon footprint may be assessed at product level, following the LCA methodology for only this one impact category and following standards such as: PAS 2050 (2011), ISO 14067 (2013) or GHG Protocol for products (2011). It can also be assessed at corporate level, following standards such as: ISO 14064 (2006) or GHG corporate protocol, (2004).

Corporate carbon footprint can be calculated at three scopes (GHG corporate protocols, 2004 and 2011): 1) direct emissions, 2) emissions from electricity production and 3) indirect emissions upstream or downstream on the production chain. There are a number of industrial sectors which have high greenhouse gas (GHG) emissions at their facilities (mainly due to combustion) or because of their intensity in electricity use. Those which are affected by EU Directives and the dominant scopes are scope 1 and 2 (DIRECTIVE 2003/87/EC). The rest of the economic sectors have diffuse emissions and are normally found within the scope 3. In order to calculate any contribution (emission factor) from a process within scope 3, such as the emissions produced due to the production of fuel or a certain raw material, or the management of a certain waste, there is a need to use the LCA methodology (GHG corporate protocol, 2011). Therefore, whether a complete LCA is needed or only a product carbon footprint or a scope 3 corporate carbon footprint, there is somehow a need for LCA methodology.

The wine sector has started to follow the trend for simplification. Some carbon footprint studies of wine production systems have been published, either product (Vazquez-Rowe et al., 2013; Cholette and Venkat, 2009; Pattara et al., 2012) or corporate (Marras et al., 2015; Penela et al., 2009), and carbon calculators have also been developed for the wine sector (IWCC; WFA, 2011; Colman and Päster, 2009). . The corporate studies refer to one vineyard in Italy (Marras et al., 2015) and a winery in Spain (Penela et al., 2009). This last study does not present the inventory data.

Most of the wine literature refers to product LCA studies (not really carbon footprint), thus providing a picture of the environmental profile of the wine sector and identifying the main hotspots throughout the wine production chain. Nevertheless, a review of those studies revealed that they have been focussing on either only one type of wine from only one winery (Neto et al., 2013; Fusi et al., 2014; Benedetto, 2013; Vázquez-Rowe et al., 2012b) or a higher number of wineries but within a specific region or production phase: vineyards in Galicia (Vázquez-Rowe et al., 2012a) and wineries in La Rioja (Gazulla et al., 2010). And, where multiple types of wine and different regions were studied, most of the inventory data was gathered from previously published studies, with different years of production and system boundaries (Vázquez-Rowe et al., 2013).

The value of the present paper, compared with the previous literature, is in the corporate carbon footprint approach used, the statistical treatment of inventory data from a greater number of wineries than previously published, the location of these wineries (different regions in Spain and France) and different types of wine (red and white).

Hence, the main objective of the article is to provide inventory data on wine production systems from 18 wineries (3 cooperatives) located in 2 countries, 7 regions, 14 denominations of origin (see Table 2) in order:

(i) to be used as background data for corporate carbon footprint of wineries or product carbon footprint of wine and derived products;
(ii) to highlight the main hot spots contributing to the carbon footprint of this sector;
(iii) to show opportunities for improvement of sustainability and competitiveness within the wine production system;
(iv) to help wineries benchmark and monitor their environmental performance against the mean values obtained.

An internal critical review of the collected inventory data and a comparative statistical study of chemical and energy consumptions per hectare of vineyards and per kg of grapes have also been performed.

2. Materials and methods

2.1. Methodology

Corporate carbon footprint following the ISO 14064 standard methodology was used to analyze the GHG emissions from 18 wineries. This method is a bottom-up process analysis, which begins with collecting and analysing a great deal of specific information from all the processes involved in the production of 1 bottle of wine. Thus, quantities of material and energy consumptions/inputs and emissions/outputs per one year was gathered from all involved companies and processes.

The bottom-up process analysis is limited, and truncates life-cycle stages further upstream. This phenomenon is well known as

[1] Product Environmental Footprint.
[2] Organisation Environmental Footprint.
[3] http://ec.europa.eu/environment/eussd/smgp/.

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