Environmental assessment of the wine sector in the territory of Langhe and Roero

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Introduction

The wine industry is increasingly adopting sustainable practices, with the European Union implementing the Common Agricultural Policy to support farmers and encourage sustainable management of natural resources. Italy is the 1st wine producer in the world (OIV, 2022), and 66% of production in Northern Italy is dedicated to high quality wines. In 2023, Piedmont earned 41 D.O.C. and 19 D.O.C.G. certifications, accounting 25% of national D.O.C.G. labels. In recent years, a shift towards prioritizing quality over quantity happened in the wine industry, allowing small wine producers to enter the global market. This study aims to investigate the excellence of wineries in Piedmont, their environmental impacts, and the added value that producing highest quality wine can offer to the global market (Iannone et al., 2016).

Methodology

The study began by surveying the recent literature (2013-2023) on Scopus database with the keywords: “wine”, “environmental assessment”, “carbon”, “water”, “ecological”, “footprint” in various combinations. Then, we assessed the environmental impacts of Italian high-quality wine production in Piedmont through the simultaneous application of Carbon, Water, and Ecological Footprint methodologies in 12 case studies located in the Langhe and Roero area (South Piedmont). The data collection has been built through a questionnaire, collecting data about vineyard area, wine bottles produced, applied agricultural practices (conventional or biological), water, energy, and material consumption (fuel, fertilizers). The system boundaries included viticulture, vinification, bottling, and packaging, to obtain a complete assessment of the whole wine-making process. A single bottle of wine (0.75 L) was defined as functional unit, based on literature (Zambelli et al., 2023).

Results and discussions

The literature review provided 40 references. In details, most studies analyzed the Carbon Footprint (CF) of wine production, fewer the Water Footprint (WF) and no one the Ecological Footprint (EF). Apart of this significant knowledge gap, the key finding of literature is that 55% of CO_2 eq. emissions are associated to packaging phase (Vinci et al., 2022) and 68% of Water Footprint is due to the Green WF (Borsato et al., 2020).

12 case studies have been identified to analyze the production of high-quality wine in Piedmont (Figure 1). These included wine producers ranging from 12,000 to 300,000 bottles per year and cultivated areas from 2 to 50 hectares, with grapes production from 13 to 192 tons per year. The average CF was 0.88 Kg $CO_{2\,eq}$/FU, ranging between 0.62 and 1.65 Kg $CO_{2\,eq}$/FU. Almost 40% of CO_2 eq emissions are related to bottling phase, 32% to energy demand, and 20% to fuel used in agricultural machines. Using electrical tractors or decreasing the glass bottle thickness are two possible actions to reduce the CF; the use of a thinner glass bottle could avoid up to 0.43 $CO_{2\,eq}$/FU (Vinci et al., 2022).

Regarding the WF, over 95% was Green WF due to evapotranspiration, in agreement with literature (Aivazidou & Tsolakis, 2020; Bonamente et al., 2016; Borsato et al., 2019). This is due to strict irrigation regulations in force in Italy in high-quality, certified wine production. The irrigation in Piedmont is legalized only for emergency water scarcity conditions, and these influences particularly the Blue WF. The average total WF was around 881 L/FU, ranging between 593.1 and 1574.4 L/FU with contributions due to Green (96%) and Blue (3%) WF. Collecting rainwater can help to reduce the Blue and Grey Water components of the WF.

About the EF, over 70% is related to the area required for the vineyard; this factor is calculated through the "calculated area" approach, in which product flows are divided by local yields and finally correlated to the global vine yield (Kitzes et al., 2009). All the EF components are quantified in terms of global hectares (gha) to provide an understanding of the amount of land required to produce certain resources or the absorption of emissions. The average EF was 81.3 gha, ranging between 9.46 and 231.2 gha, accounting for around 70% for land used for cultivating vineyard and the remaining 30% for the area required for the assimilation of carbon dioxide emissions. Approximately half of the case studies implemented biological agriculture to avoid pesticides and fertilizers, and to restore natural balance conditions. However, according to our results, it should be noticed that avoiding the use of chemical additives in agriculture does not necessarily lead to a lower environmental impact. This is because the production yield may be slightly lower without these additives, and certain resources, such as water consumption, are mainly used during the production phase of wine rather than during the growth of grapes in the vineyard.

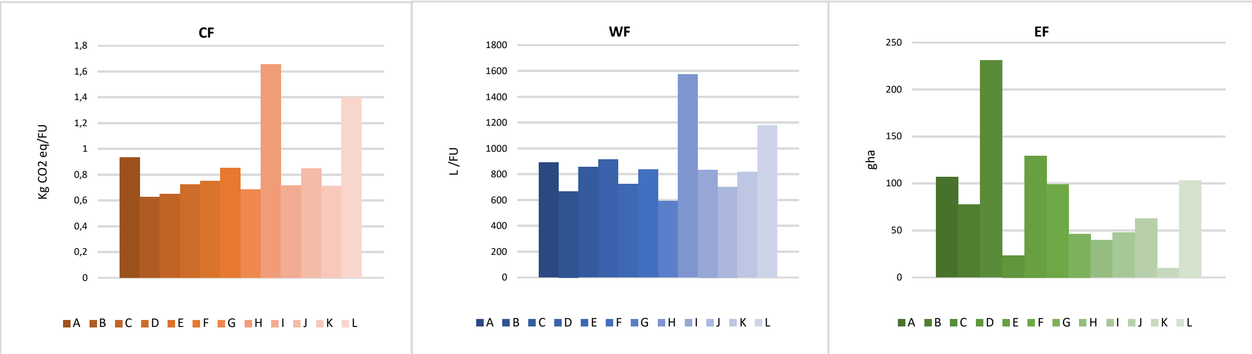

Figure1. Environmental Footprints (CF: Carbon Footprint, WF: Water Footprint, EF: Ecological Footprint) of the 12 wineries involved in this study

Conclusions

The Italian wine industry is renowned for its production and quality, and wine is becoming one of the most environmentally analyzed agricultural products. Within this study, a single bottle of wine accounted in average 0.88 Kg $CO_{2\,eq}$ as Carbon Footprint (40% related to glass bottles), 881 L as Water Footprint (95 % related to Green WF), and 81.3 gha as Ecological Footprint (70 % related to vineyard area). While CF and WF values agree with literature, the EF data are novel. Approximately half of the case studies implemented biological agriculture, but the associated environmental footprints weren't necessarily lower. In overall, there are certain practices that can minimize the impact of wine production, as thinner glass bottles and electric tractors. However, high-quality wine production is deeply connected to the history of Piedmont, involving mostly small producers. In this context, the adoption of different practices and operations may be not immediate.

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