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# Quantifying Water Use, Conservation and Footprint in the Winery Industry

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## Extended Abstract

The two stages of wine-making, viticulture (grape growing) and vinification (turning grapes into wine), each exert complex and variable water demands that can have significant impacts on local water resources. At the same time, consumers have begun to demand environmentally mindful production practices, while wine makers recognize the need to protect local freshwater resources to ensure sustainability and reduce costs. This study focuses on identifying water use demands, common wastewater treatment methodologies, opportunities for water conservation and reuse, and potential application of the water footprint (WF) concept to the winery industry.

The viticultural stage requires abundant irrigation to support grape growing, often using a combination of rain water and local surface and/or ground water resources. Pest control chemicals can cause pollution of local waterways, while the physical configuration of the vineyard and use of cover crops can affect irrigation needs and potential for runoff. Like grape-growing, winery operations are seasonal in nature. Water use is generally limited to cleaning activities, as the grapes provide the water necessary for the final product. The winery wastewater (WWW) generated is typically high strength and low pH during the vintage season, and low strength and high pH during bottling [1]. This results in complex treatment needs that cannot always be accommodated by on-site wastewater treatment systems [2], however the potential for effluent reuse for irrigation of the vineyard is an attractive method to reduce extractive water use for vineyard operations [3]. Effluent reuse for irrigation can impact soil quality, and must be taken into consideration to avoid negatively impacting vineyard grape yield.

The water footprint (WF) concept has been used to quantify the impact of producing of a wide-range of consumer products on rainwater (green WF), groundwater and surface water resources (blue WF) [4]. The impact of pollution on freshwater (grey WF) is evaluated using dilution ratios, and apply to contaminants released from both vineyard and winery operations. Applying the WF framework to wine-making is complex due to the combination of agricultural and chemical processes that need to be considered and, as such, its use for benchmarking has so far been limited. Recent advances include modifications of the WF process specific to wine-making, and identification of site-specific factors that need to be considered when using the WF as a performance benchmark [5]. Two approaches are used for green and blue WF assessments, namely: the consumptive approach, and the hydrological water-balance approach. The consumptive approach yields a more direct assessment of volume of water needed to produce a bottle of wine, while the water-balance approach is better suited to understanding the longer-term and regional impacts and sustainability of wine-making on freshwater resources. Finally, treating WWW to levels that exceed regulatory limits for discharge does not eliminate the grey WF associated with these discharges. As such, a comprehensive WF assessment would include all three WF components (green, blue and grey).

## References

[1] M. B. Johnson, M. Mehrvar, "Characterising winery wastewater composition to optimise treatment and reuse," *Aust J Grape Wine R*, vol. 26, no. 4, pp. 410-416, 2020.
[2] M. B. Johnson, M. Mehrvar, "Winery wastewater management and treatment in Niagara Region, Ontario, Canada: A review and analysis of current practices and treatment performance," *Can J Chem Eng*, vol. 98, pp. 5-24, 2020.
[3] D. Storm, *Winery Utilities: Planning, Design and Operation*. Dordrecht, Netherlands : The Chapman & Hall enology library, 1997.
[4] A. Y. Hoekstra, A. K. Chapagain, M. M. Aldaya, M. M. Mekonnen, *The Water Footprint Manual – Setting the Global Standard*. Washington, DC : Earthscan LLC, 2011.
[5] M. B. Johnson, M. Mehrvar, "From field to bottle: water footprint estimation in the winery industry" in *Water footprint*. S. Muthu, Ed., Singapore : Environmental Footprints and Eco-design of Products and Processes, Springer Nature, 2021.