

Agriculture 4.0 Technologies in Vineyards. Potential Environmental Benefits?

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Abstract

Pesticide distribution in vineyard presents environmental and economic issues, related both to the high susceptibility of the crop to various pathogens and to the low efficiencies of pesticide application. As a result, both environmental risks related to contamination of air, water and soil and economic risks, as pesticides being one of the major cost, have been determined. The integration of Agriculture 4.0 technologies (A4.0T) in vineyard management offers opportunities to improve production efficiency, quality, and environmental sustainability. However, widespread adoption faces challenges rooted in economic and cultural factors, particularly in small-scale farms where financial constraints and the advanced age of farmers impede the uptake of digital solutions. It is imperative to develop tools that identify farms suitable for A4.0T adoption in viticulture and quantify associated sustainability benefits. This study reports the preliminary results of two projects (WineryFarming4.0 - Smart solutions for an effective implementation of Agriculture 4.0 in winery production and smartDEFENSE - Tecnologie digitali innovative per aumentare l'efficienza e la sostenibilità dei sistemi di difesa in vigneto) regarding the quantification of the environmental benefits related to the use of smart applications as Agriculture 4.0 technology capable to provide to the winegrower relevant information on when, how much, and where to apply plant protection products. The environmental benefits were evaluated using the Life Cycle Assessment approach. Two functional units (i.e., one area based - 1 ha - and one mass based - 1 t) and a "from cradle to farm gate" approach were considered. Primary data were collected about cultivation operations, working times, machine characteristics, inputs used, while secondary data were used regarding to the emissions of active ingredients, fertilizers and pollutants related to diesel combustion. The adoption of smart application technology resulted in a reduction in pesticides distribution, as well as dilution water. Consequently, for both functional units, the conventional cultivation (without smart application support) shows a higher impact for all the evaluated impact categories with an impact reduction that is higher for the environmental effect more related to the emission of the active ingredient. Using mass functional unit, the difference between the two treatments is even more pronounced as a consequence of a higher grape production in grape cultivation supported by the info provided by the smart application. In conclusion, the digital technology for pesticide

distribution in vineyards, determine a reduction of the environmental impact, especially when associated with an increased yield per hectare. The preliminary results should be confirmed considering more than a growing seasons and a bigger sample of farms.

Keywords: Keywords: Life Cycle Assessment, vineyard, pesticide, environmental impact, precision agriculture

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