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Vineyard carbon balance: assessing the perspective for carbon farming through long-term eddy covariance measurements

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Vegetation plays an important role in the global carbon budget, absorbing from the atmosphere about 29% of CO_2 anthropogenic emissions. Today, forest ecosystems are recognized as carbon sink, while agricultural lands are not taken into account. This is due to the rapid turnover of the carbon assimilated by crops. Indeed, their biomass is removed for food production and the residues and soil organic matter are rapidly degraded due to deep and frequent soil cultivation. However, woody crops like vineyards present biological, structural, and management peculiarities, such as perennial structure, abundant pruning debris, limited soil disturbance, and vegetation cover of the alleys, which could potentially lead to the sequestration of a significant amount of CO_2. Recently, several initiatives started to exploit the sequestration potential of agriculture, to reach the targets of Paris agreement ("4 per mille", Carbon Farming...), but means, rules, and realistic assessment of sequestration potential are still lacking, exposing these proposals to substantial criticism. Eddy covariance technique, as implemented in coordinate networks, can be a powerful tool to proof this important environmental role of agriculture.

In order to asses the carbon balance of woody crops on a multi-annual scale, in 2015 we deployed an eddy covariance station in a vineyard located in the Franciacorta area (Northern Italy). The analysis of five years of measurements (2017-2021) shows a consistent pattern over this period with the vineyard acting as carbon sink on annual basis. The net CO_2 uptake varied among the years, due to different environmental conditions, but on average it was around 200 $g_C\ m^{-2}\ y^{-1}$. This amount, considerable for an agricultural ecosystem, can represents an important base to quantify the role of viticulture in the perspective of carbon farming initiatives. Even if it can be objected that this sink may be only temporary and the built-up can be substantially disrupted at the end of the vineyard life cycle, these results show that there is a concrete possibility of storing carbon in agricultural soils. Thus, vineyards seem to be good candidates for carbon farming. Proper practices can be defined to preserve this storage at best, greatly contributing to the global carbon budget and boost the role of agriculture in climate change mitigation initiatives.