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Extending the capacity of infrared spectroscopy to predict carbon and nitrogen pools in vineyard agroecosystems globally: innovative techniques to measure the impacts of differential groundcover management



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FINAL PROJECT REPORT

At the time of travel (November 2019), I was a 3rd year PhD researcher from the University of Western Sydney/University of Aberdeen seeking to extend my research through international collaboration on sustainable vineyard management. In late 2019 I submitted my manuscript entitled "Soil carbon and nitrogen pools are increased by cover cropping in South Australian vineyards: detecting short-term management effects using infrared spectroscopy" for peer review. The paper covered my 2016-18 work at the WA/University of Adelaide under-vine cover cropping trials in SA, and clearly demonstrated the benefit of grass and legume cover crops in increasing plant available nitrogen (N) and increasing soil organic carbon (SOC). Additionally, I successfully employed a low-cost, efficient and easily accessible infrared spectroscopy (IRS) technique to measure and predict these outcomes related to cover crop management. The purpose of the travel was to visit Pennsylvania (PA), NY state and Virginia (VA) to collect soils from comparable cover cropping trials and perform infrared spectral analyses (IRS) in order to extend the capacity of IRS to be used in vineyards globally.

Vineyards are some of the most intensively managed agroecosystems and are particularly depleted in soil organic carbon (SOC) and vulnerable to soil nitrogen (N) loss. Typical vineyard management practices such as tillage reduce the protection of stable soil aggregates and removal of natural vegetation for crop conversion reduces soil organic matter (SOM) accumulation and protection. The direct effects of management practices on soil health will render vineyard soils especially vulnerable to degradation and reduce their climate adaptability. Therefore, implementing management practices that build and maintain SOC and N are of paramount importance to the wine industry. At present industry engagement in

sustainable vineyard management is largely ad-hoc, as many managers view the practices as laborious, and believe that quantifying the results of their efforts is largely inaccessible.

The aforementioned study in Australian vineyards demonstrated that herbaceous under-vine communities increase SOC input and improve N availability, and that these outcomes are quantifiable using a time and cost-effective infrared spectral (IRS) technique. Considering these results, the next step was is to extend our data into similar vineyard systems both nationally and internationally to validate and enhance the IRS technique, so that the process becomes well-adapted for a variety of vineyard agroecosystems. Additionally, I began to develop the technique with another researcher, Dr Charlie White (Penn State University) to better identify organic matter spectral bands via concurrent OM removal and addition; these data are still in preparation. International data collaboration is essential to identify global similarities and differences in the magnitude of SOC and N responses where they exist; and to improve the efficacy and accessibility of IRS techniques to quantify those outcomes in diverse systems.

This research collaboration will make quantifying sustainable management outcomes simpler and more cost effective for vineyard managers. By positioning it at the forefront of a niche international research initiative, I aim to enhance Australia's competitive advantage through its contribution to building viticultural research technologies that contribute to environmental sustainability in the vineyard. International collaboration is an important component of career development for early career researchers such as myself, and I anticipate that this work will strengthen my ability to make an impact as a researcher in the field of sustainable agriculture and soil health management.

Data from this project remains under preparation/analysis between the laboratory in Pennsylvania State and me (now located at the University of Arizona). The travel inspired new questions around refining the predictive capacity of IRS in diverse soil types, particularly regarding the separation of the most important spectral components. Information from this project will be disseminated *via* peer reviewed publication in approximately 12 months' time and will contribute significantly to enhancing IRS methodology, and improve understanding of how cover crops can increase soil organic matter accumulation in vineyards agroecosystems.