Optimizing water use efficiency for improved wine quality in Coonawarra vineyards using remote sensing technologies - Season 2

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Executive Summary

The agricultural sector is the largest user of freshwater in Australia accounting for nearly 70% of total consumption. Given the increasing demand for freshwater simultaneously with its scarcity, and the need to continually improve wine quality for a competitive export market, a second season of data collection was undertaken in the vintage of 2017 to assess remote sensing aerial imagery as a tool to quantify vine water and nitrogen (N) status across the Coonawarra region. In addition to the dataset collected last year, prototypes of plant-based non-contact infrared sensors for water stress monitoring, known as thermography towers (TT), were tested over the growing season in several vineyards across the region. Remote sensing was done using a manned fixed wing aircraft equipped with thermal, multispectral and RGB (visible) cameras in two flights across ~1500 ha of vineyards on 21st February and 25th March, 2017. Concurrent to each flight, an intensive ground truthing survey that examined plant physiological indicators of vine water status (stomatal conductance (g_s) and midday stem water potential (Ψ_s or Ψ_{md})) and vine N status (tissue N concentration) were performed across ~100 ha of vineyards for the two predominant varieties, Cabernet Sauvignon and Shiraz.

Airborne remote sensing of vine water status across the region revealed moderately positive correlations with gs, particularly during Flight 1 when the VPD was higher, suggesting that the technique could be promising for measurement of water status for irrigation scheduling, particularly under high VPD conditions above 2KPa which is quite typical during the irrigation season in Coonawarra. The relationship between gs and these thermal water stress indices was stronger for Shiraz than for Cabernet, possibly due to Shiraz being a relatively anisohydric cultivar.

The TT derived thermal index (CWI) was moderately correlated with gs in both flights and was more consistent for Cabernet than Shiraz. Positive CWI values generally indicate well water vines; these values could be used with cultivar specific thresholds to schedule irrigation in the future—however, more research on defining these thresholds for each cultivar is required. The initial prototypes have revealed areas of improvement and optimisation of the sensors for increased robustness and ability to access data from multiple platforms. The current systems only allows manual data access but future designs could incorporate wireless data access through the Cloud. Automated and continuous sensing of crop water status has the potential to increase yield, crop water use efficiency, refine quality and decrease water and energy costs thereby increasing on-farm profitability.

Vine N status was predicted quite well by several remote sensing indices tested in this trial obtained from the multispectral camera. In particular, the index MCARI correlated well with tissue N in both cultivars, while OSAVI correlated strongly with the proximally sensed chlorophyll

index as well as yield in Shiraz. In Shiraz, NDVI was a strong predictor of WUE; higher NDVI values corresponded to lower WUE. These relationships may in the future allow growers to manage vine productivity and vineyard WUE by tracking vegetation indices such as NDVI, MCARI, and OSAVI.

The aim of this funding was to evaluate the potential of aerial remote sensing and the new TT technology for potential long term commercial applications for use within the grape growing region of Coonawarra. However, the scope of this trial potentially extends into many other grape growing regions within Australia, and indeed across other agricultural sectors. This project will present for the Coonawarra community a timely, broad scale, and new innovative examination of vine water use efficiencies, and novel irrigation system technologies. The aim is to demonstrate to the community economically viable improved irrigation strategies based on real time actual vine needs that lead to enhanced wine quality and lower irrigation volumes. Furthermore, this project aligns with the vignerons vision to improving water use efficiency and adapting to climate change.