Precision management technologies prove their value in selective harvesting in Australia's major production regions

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Mark Krstic summaries a recently-published paper, which reports on the findings of a study that examined the feasibility of using precision management/selective harvesting technologies when grape and wine production is geared towards large fermentation volumes.

Dr Rob Bramley, from CSIRO Ecosystem Sciences, in Adelaide, along with co-authors Jackie Ouzman (CSIRO Ecosystem Sciences) and Craig Thornton (Wingara Wine Group – Deakin Estate) recently published a paper in the *Australian Journal of Grape and Wine Research* (Bramley *et al.* 2011) titled 'Selective harvesting is a feasible and profitable strategy even when grape and wine production is geared towards large fermentation volumes'. The paper presents a solid case to industry to consider the value of selective harvesting using precision management technologies, even in the major production regions (Murray Valley, Riverland and Riverina), where prices paid for grapes are often lower than those paid in other premium production regions.

The research follows other research conducted by Rob Bramley and his team over several years, which has looked at both the temporal and spatial variation in yield and grape composition across a number of vineyard sites. In his previous work, the potential for enhancing the profitability of both grapegrowing and winemaking through the use of selective harvesting has been demonstrated conclusively. However, there has been a perception that such selective management strategies may not be well-suited to Australia's major production regions (Murray Valley, Riverland and Riverina) where winery infrastructure is geared to large production volumes, and where independent grapegrowers are generally supplying grapes to wineries. The paper by Bramley *et al.* aimed to examine the merits of selective harvesting using precision management technologies in these types of growing regions.

The study was undertaken on the Deakin Estate (Wingara Wine Group) property near Nangiloc, Victoria, in the Murray Valley grapegrowing region. Since 2004, Bramley and his team have been collecting data from two 1994-planted Cabernet Sauvignon vineyards at Deakin Estate (row and vine spacing is 3.0m and 2.44m, respectively, trained on a quadrilateral cordon and the vineyard is mechanically hedged) using remotely sensed digital multi-spectral video imagery, collected at veraison, to estimate plant cell density (PCD), a surrogate measure of vine vigour, as well as yield maps. Using this data, Bramley was able to perform a sophisticated multi-variate *k*-means clustering of the PCD data and yield maps to identify similar zones within each vineyard, which were characteristically of either lower (LVY) or higher (HVY) vigour and yield (Figure 1). It is important to note that two Cabernet Sauvignon vineyards were required for this study to provide enough selectively harvested fruit from areas characterised as LVY to fill a commercial 75-tonne fermenter at Deakin Estate. The study tracked maturity in a range of randomly allocated vines across each of the LVY and HVY zones leading up to harvest, with the aim of harvesting fruit in each of these zones at 24°Brix (13.3°Baumé). Commercial harvest in the LVY sections occurred on 6 March 2009, while in the high vigour/high yield sections (HVY) commercial harvest took place over two dates, on 27 March 2009 (in HVY B section) and 3 April 2009 in the HVY A section. Therefore, three commercial wines were made in this study - one LVY wine and two HVY wines - all made in 75t fermenters at Deakin Estate. Small-lot wines were also made from each of these LVY and HVY zones as part of this study.

Looking at the fruit composition at harvest, the variation in sugar ripeness was not significant, with all fruit being picked between 23.0-23.5°Brix, which was the original aim. The earlier harvest date in the LVY zones (6 March 2009), compared with the HVY zones (27 March and 3 April 2009) was most probably a function of the

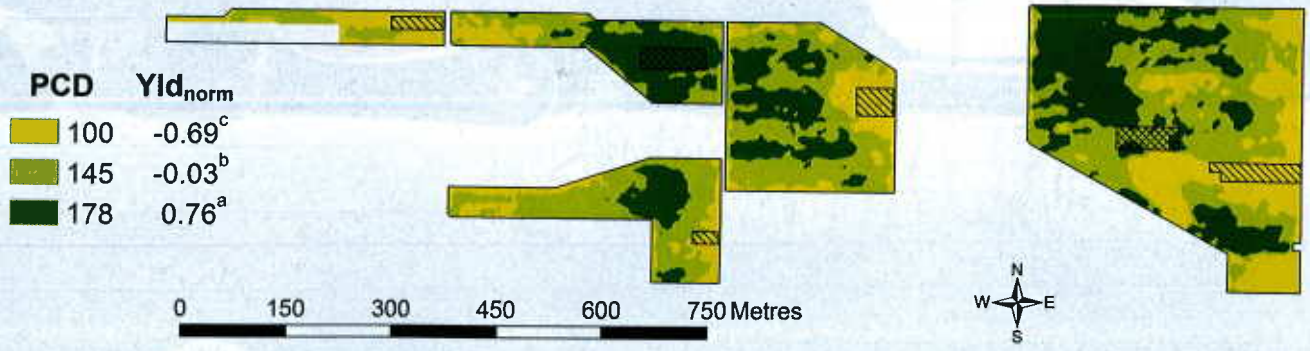

Figure 1. Variation in yield and PCD (veraison) in two blocks of Cabernet Sauvignon, vintage 2009. The map shows the results of clustering the yield maps with the remotely sensed imagery (PCD) using *k*-means clustering; three cluster solutions are shown. The values in the legend are the cluster means; yield values labelled with different letters are significantly different (a = 0.05). Source: *Australian Journal of Grape and Wine Research* (2011) 17:298-305.

lower yield-to-pruning-weight ratios observed in these zones (the average yield in the HVY A zone was 21.2 tonnes per hectare, while in the HVY B zone it was 27.3t/ha, making the overall average for the HVY zone 24.3t/ha). Following on from this, the LVY zones had fruit with lower berry and bunch weights (the average yield in the low vigour zone was 15.9t/ha), higher average colour (1.18 compared with 0.93mg anthocyanin/gram fruit) and higher average phenolic content (1.42 compared with 1.14 absorbance units/gram fruit), compared with fruit from the HVY zones. Pruning weights for all zones are provided in Table 1 (see page 36). All of these fruit compositional measures indicate that fruit from the LVY zones should make some better quality wines, but whether this would be enough to jump from the 'premium' to 'super premium' wine price points is another matter.

When the commercial-scale wines were assessed by a team of 25 trained sensory panellists, no differences were observed between the two commercial HVY wines. In comparing both the HVY wines with the LVY commercial wine, generally the LVY wine was preferred and considered to have a fruitier aroma, with a fuller body but with less astringency than the HVY A wine. The panellists also identified differences with respect to 'spicy' aroma, 'bitterness', 'stalky flavours' and 'warmth'. Again, whether this represents enough of a difference in wine quality to justify the jump from a so-called 'premium' to 'super premium' classification is the key question to justifying the additional harvesting costs and precision viticulture data acquisition and interpretation. The study also looked at a so-called 'partial gross margin analysis' from both the perspective of a winery and a grapegrower. In the winery case, considering the additional costs for harvest, including the opportunity cost for not filling

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a fermenter in the LVY case, there was a $1211/tonne (or approximately $1.21 per 750mL bottle wine) benefit in using the selective/differential harvesting approach, assuming that the differentially harvested fruit was able to achieve a $5/bottle premium over and above the conventional approach. Even if this differential is $1/bottle, there is still a benefit in selective harvesting the LVY zone relative to the HVY zone. This benefit is $220/t, or approximately $0.22 per 750mL bottle of wine.

While much of the benefit for an increase in wine value is captured by the winery, growers in the major production regions of Australia are typically selling fruit to larger wineries, and there is a perception that they would not receive the benefit from adopting this sort of selective harvesting technology. However, even with factoring in additional harvest costs, and assuming growers would be rewarded in terms of price per tonne paid (in this case, it was assumed that 'premium' grade would receive $423/t – the district weighted average for Cabernet Sauvignon in 2009), and that fruit that achieved a 'super premium' grade would receive $520/t (conservative estimate), then the benefits of selective harvesting over the conventional approach to harvesting is around $7/t (or $1428 in total) across the 25.3ha Cabernet Sauvignon example presented here in the Murray Valley. This does indicate that most of the value in selective harvesting is

Table 1. Differences in pruning weights among the sample vineyard zones#.

	Vigour		Block		Parcel (i.e., block by vigour)			
	High (HVY)	Low (LVY)	Main	Back	Main HVY	Main LVY	Back HVY	Back LVY
Pruning weight (kg)	0.37a	0.23b	0.22b	0.33a	0.21b	0.23b	0.50a	0.24b

#Each set of comparison (vigour, block, parcel) values not connected by the same letter are significantly different (P<0.05)
Source: *Australian Journal of Grape and Wine Research* (2011) 17:298-305.

realised by the wineries (figures based on a corrected Table 3 from Bramley *et al.* paper).

While this research has demonstrated the potential value of a selective harvesting approach in a region such as the Murray Valley, potential users need to be aware that these 'partial gross margin analysis' costings have not incorporated the costs and time inputs to collect the PCD imagery and yield maps data since 2004 in order to be able to produce the normalised PCD, yield maps and *k*-means clustering analysis of the Cabernet Sauvignon vineyards (which the authors clearly point out in their paper). Also, specialist help from someone like Bramley with expert skills to undertake this type of spatial data analysis and interpretation is needed to assist in differentiating the LVY and HVY zones within a vineyard. Even armed with this information, and depending on your machine harvester technology, there may be some additional complexity required to geo-reference and mark out the different zones in the vineyard, and to collect different fruit maturity samples leading up to actual harvest. This will add costs over and above the normal conventional machine harvesting process. However, most importantly, before undertaking this selective harvesting process, grape producers would want to be confident that the required differential would be paid at the weighbridge for all these efforts. In the example highlighted in the Murray Valley, the price differential needs to be at least $69/t ($492/t versus $423/t) to justify the additional harvesting costs associated with using this selective harvesting strategy and to break even. However, in airing these cautionary notes, I think that the work clearly demonstrates that selective harvesting can be profitable, even when applied to situations where production is geared to large fermentation volumes. It does provide a counter to the view that precision viticulture only offers opportunities to small (boutique) producers or to large, well-resourced companies with a flexible winery infrastructure.

REFERENCE

Bramley, R.G.V; Ouzman, J. and Thornton, C. (2011) Selective harvesting is a feasible and profitable strategy even when grape and wine production is geared towards large fermentation volumes. Australian Journal of Grape and Wine Research 17(3):298-305.