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Australian Grape and Wine Authority



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R&D at work

The benefits and costs of alternative viticulture

Organic and biodynamic viticulture is good for soil, grapes and ultimately the quality of wine – but in the current environment it comes with a potential financial penalty for growers.

That is the key finding of a recently completed six-year project carried out in McLaren Vale by researchers from the University of Adelaide. It was funded by AGWA, with in-kind support from Gemtree Wines, the McLaren Vale Grape Wine & Tourism Association, Peats Soil and others.

With organic and biodynamic practices forecast to grow at more than 11% per annum, the project set out to determine its relative sustainability compared with both low-input and high-input conventional viticulture.

The trial was carried out within a 10 hectare planting of 20-year-old Cabernet Sauvignon vines. Initially, it was intended to run for just three years to assess the effects of converting from conventional management to organic and biodynamic management as part of a PhD project undertaken by Luke Johnston. It was extended after changes in soil and vine parameters did not become apparent until the third year.

The final report – prepared by chief investigators Chris Penfold and Dr Cassandra Collins and collaborators Prof Petra Marschner and Assoc Prof Sue Bastian – concludes that while winegrape production is one of the easiest forms of primary production to manage organically or biodynamically, the achievable yields

are frequently lower and production costs higher.

During the trial, yields for organic, biodynamic and low-input conventional viticulture were 79%, 70% and 91% respectively of the yields achieved with the high-input conventional viticulture treatment, due to weed competition for soil moisture in the undervine zone. This outcome was reflected in the gross margins analysis, which showed the organic, biodynamic and low-input conventional viticulture systems generated 74%, 65% and 91% of the financial return per hectare of the high-input conventional viticulture system.

Higher operating costs associated with the use of tillage for under-vine weed control also contributed to this result. In this calculation there was, however, no premium applied to the prices received for organic and biodynamic fruit. Depending on region these may be up to 100%, which helps compensate for the lower yields and increased production costs. The researchers note that for some growers, other aspects of winegrape production – such as improvements to soil and wine quality – are more important than financial returns.

In this project, sensory evaluation by a panel of local viticulturists and winemakers found significant benefits for wine quality once organic and biodynamic practices have had time to have an impact. Panellists noted little difference between wines made in 2010 (the first year wines were made from the trial) but for the following four years organic and, in



One of the trials at Gemtree Wines.

particular, biodynamic wines were consistently described as being more rich, textural, complex and vibrant than low- or high-input conventional viticulture wines.

'These findings support anecdotal evidence from winemakers who have used this language as a reason for why they have chosen to make wine from organically and/or biodynamically managed fruit,' the report says.

'How wine compositional changes relate to the textural changes perceived by winemakers in the wines made from these systems is yet to be determined.'

Important in the assessment of an agricultural system's sustainability is its impact on soil properties. In the trial, the maintenance of plant growth undervine and use of tillage rather than herbicides for weed control generated more microbial carbon and larger earthworm populations. While not impacting on vine growth, the application of compost also had desirable impacts on soil quality.

The final report is available at research.agwa.net.au.



LAICanopy app to help optimise vine balance

The old saying about 'the value of the whole being greater than the sum of the parts' comes to mind when talking with Cassandra Collins and Roberta De Bei about their current AGWA research project.

With a team of colleagues from the University of Adelaide, Treasury Wine Estates and DJs Growers they are working to identify which vineyard canopy measures most accurately indicate optimal vine performance – while at the same time developing a smartphone app that will make recording those measurements commercially practical.

Both endeavours are important and valuable in their own right, but if the two come together as planned it could be a game changer in terms of the industry's ability to measure vine canopies and manipulate them to maximise grape quality.

Dr Collins is Chief Investigator and Dr De Bei a Postdoctoral Research Fellow for the four-year multi-faceted AGWA-funded project, which is being run at the University of Adelaide's Waite Campus and at six experimental sites in two states.

As the first of several tools being developed, a smartphone app suitable for estimating leaf area index is due for release in the middle of the year.

'It is the first part of the toolkit we want to develop,' Dr De Bei said. 'It looks at the structure and vigour of the canopy and allows you to calculate some measures that are used to decide if a vine is in balance or not.'

Dr De Bei and other collaborators Dr Sigfredo Fuentes and Prof Stephen Tyerman were involved with the app's early development, which received seed funding through two previous funding programs (Wine 2030 and Vineyard of the Future).

The key is algorithms originally developed in the forestry industry that analyse a photograph you have taken and provide an estimate of the leaf area index and canopy



LAICanopy. Upward looking image of a grapevine canopy obtained using an iPad; LAICanopy home page with function tabs; image uploaded to the app and automatically binarised; instant results containing leaf area index (LAI) and canopy porosity.

porosity. However, the code is too difficult and expensive for practical use.

'The challenge has been getting code that's been written for complex and expensive software programs and putting it into an iPhone or iPad that is easy to use and with us every day,' Dr De Bei said. The team hopes to be able to create an Android version of the app in the near future.

While this work has been going on, others have been looking at where such a tool can be used to best effect in assessing quality in terms of vine balance through canopy measurements.

The traditional way to measure vine balance is the Y/P ratio – the relationship between yield and pruning weight – but this is rarely done in commercial settings, because it is much too time consuming. An app would overcome that problem but the Y/P measure may, in fact, not be as important as previously assumed.

Dr Collins said many other vineyard trials have thrown up confusing results with vineyards renowned for consistently producing fruit for top-quality, high-value wines being technically out of balance according to the Y/P measure.

At the same time, an AGWA-funded project being carried out by Masters student James Hook in McLaren Vale is showing a strong relationship between harvest fruit grade and the ratio of leaf area index and yield.

'In this project, James is assessing a number of vineyards that produce fruit of varying quality and there is this lovely correlation – I didn't expect it to be so strong,' Dr Collins said. 'There is also a correlation between these measures and fruit colour.'

'The more we look at all of our trials, the traditional Y/P measure for vine balance doesn't hold up and this other measure may end up being more meaningful. We are about to analyse the second year's data and if it holds as strongly as that first year, then I think we are going to feel even more that this is the way of the future.'

Another facet of Mr Hook's research will be to attempt to manipulate a given vineyard's quality (for example from C grade up to B grade) by taking these measures and changing the canopy. Can it be done and, if so, at what part of the season?

'A number of the tools we are looking to develop are around trying to measure early enough in the growing season to make a management decision to get to where you are trying to be in terms of quality or yield,' Dr Collins said.

'The other side of this project is knowing how to use these tools. We hope we can get to the point where we can say "hey, these are all the different ways that we have been able to use them and what they mean and how you might be able to use them in your business", rather than just saying "here's a tool, you work it out". I hope we're on track to do this.'



Researcher in focus: Dr Cristian Varela

Even in a country that reveres Vegemite, yeast is something of an unsung hero. We know you can't make beer, most types of bread and wine without it – but hardly see it as central to why we enjoy the taste and diversity of all three.

Those in the know however, know the full story. Yeasts are major players that can be used to create everything from biofuels to biodegradable plastic and in the winery they can make very different wines from the same grapes. They also have a lot in common with humans at the genetic level.

'There are things you can extrapolate from the way yeast works and use that information to study the genetics of humans and more complex organisms. There are research groups working on yeast and using that information to study humans or other organisms,' said AWRI senior research scientist Dr Cristian Varela.

Dr Varela will explore his own wine-based research in a broader context when he spends four months in Canada this (northern) summer, courtesy of an Australian Government Endeavour Research Fellowship.

The University of Toronto is world-renowned for its research into yeast genes and the interactions between those genes, in particular yeast strains. It can offer Dr Varela some serious equipment to play with and in turn they are interested in what he knows about wine yeasts.

'They are interested in studying a real-world yeast strain, and exploring what wine yeast can do is a perfect opportunity,' he said.

'At the University of Toronto they focus mainly on yeast strains that are used only in the lab. These yeasts can provide lots of information, but they don't survive and don't work very well in real-world environments.

'Although these strains are very similar at a genetic level, there are fundamental

differences between them. If you get a laboratory yeast strain and drop it into grape juice, it probably won't ferment – and if it does it won't make a nice wine. We are going to provide a yeast strain that makes good wine and compare it to the lab strains.

'Hopefully we can find differences between the strains and perhaps explain why one is better at making wine and coping with the stressful conditions that winemaking involves.'

Dr Varela's interest in yeast began as a student in his native Chile. After completing an undergraduate degree and Masters in biochemistry (the latter focusing on microbiology), he started his PhD looking at industrial bacteria before switching to wine yeast, a move that saw him spend time in both South Africa and France.

He was contemplating postdoctoral work in Denmark in 2004, until an AWRI advertisement caught his attention.

'It was in wine yeast, an area I knew and enjoyed, and there was little doubt the weather would be better,' he said.

In Adelaide his work has focused on both good yeasts and bad (think Brett). In a current major project he is working with colleagues in Australia, Chile and Spain to study the ability of non-conventional yeasts to naturally produce lower-alcohol wines that are still full in flavour.

The AWRI team recently used a non-Saccharomyces strain to reduce the alcohol level of Shiraz by 1.6% – a breakthrough that made news in such publications as Scientific American. They've now improved that to 1.8% in both Shiraz and Chardonnay, while also dealing with an issue to do with off-flavours. Now they are working to replicate that outside the laboratory.

Much of Cristian's other work focuses on understanding exactly how individual yeast



Dr Cristian Varela

strains behave and how they might be used. This work will continue in his absence.

'Some winemakers choose not to add yeast when making wine (relying instead on indigenous microorganisms on grape skins to initiate fermentation), but adding yeast is a common practice that can help to shape wine flavour and style,' he said.

'It would be really good if, depending on the composition of the grapes or grape juice coming into the winery, we could say "with these grapes if you want to get that wine style then you should choose that yeast strain". That would be a great tool for winemakers. But you need to link a lot of things to get to that point.

'At the moment we are characterising lots of yeast strains – some commercially available, some isolated here in Australia, and some from overseas – to come up with a comprehensive list of what these yeasts can do in terms of flavour.'



Climate change focus in clonal trials

Dr Michael McCarthy's latest research is testing his logistical skills as much as his scientific knowledge.

As lead investigator for a major AGWA-funded project assessing clonal variability in Chardonnay and Shiraz, he has to ensure that seven trial sites across three states are picked at similar maturities and that all small lot wines are prepared using similar protocols.

That means getting fruit from the Riverland and Barossa regions, as well as Armstrong, Drumborg and Mt Langi Ghiran in Victoria, to Adelaide's Waite Campus for processing – often at short notice. WA fruit from Margaret River and Great Southern is sent to Bunbury, where after primary fermentation it also finds its way to Waite for finishing and bottling.

The Australian Wine Research Institute (AWRI) will then undertake sensory assessment of all wines of both varieties for three vintages (2014–16), as well as sequencing selected Shiraz clones to

establish clonal relationships and evaluate genetic diversity across clones.

The project has two aims. The first is to improve our understanding of how clones can contribute to wine style and which clones are best suited to which regions. Dr McCarthy, Principal Scientist Viticulture with the South Australian Research and Development Institute (SARDI), believes a lack of such knowledge is a major reason why industry uptake of different clones has been slow.

'With the Australian wine industry seeking more complexity and regional differences in wines, there is the opportunity to demonstrate that clones may bring another level of interest in wines,' he said.

Even more importantly, the research is investigating how knowledge of clonal variability can help the industry prepare for future climate change.

'The Australian industry is fortunate in that, due to a number of factors, vineyards have greater longevity than in a number of other

countries,' Dr McCarthy said. 'However, if climate change projections prove correct, vineyards planted now will experience warmer and probably drier conditions throughout their lifetime.'

'The challenge, therefore, is to know which clones should be planted now for this future. Can we use existing differences in the present climate between geographically separated sites as a surrogate for climate change and gain some insights about how clones may perform in this future climate?'

The four-year project, which began in June 2013, is evaluating clones from mature field plantings. A standard set of viticultural observations is made for all clones at each site and data loggers record canopy temperatures during the growing season. Nearby automatic weather station data is used to describe the regional climate.

Dr McCarthy says progress to date has been 'incredibly smooth' due in no small part to the enthusiasm of everyone involved.

Drumborg suffered an unexpected cold snap in 2014, but all other sites were harvested and the wine processed. Sensory analysis of the Chardonnay was conducted late last year and the Shiraz early this year. The researchers are currently working through the AWRI's reports.

All sites were harvested this year and the 2015 wine is now being made by Michael Coode, of WIC Winemaking, at the Waite Campus and Richard Fennessy, from the WA Department of Agriculture and Food, in Bunbury.

The project's other main collaborators are viticultural consultants Libby Tassie (SA), John Whiting (Victoria), and Dr Simon Schmidt from the AWRI.

In May, two wine tastings were held in Victoria in collaboration with the AWRI. Regional tastings are planned for later in the year.



Project team members at Voyager Estate in Margaret River last October.

Left to right: John Whiting (VIC), Richard Fennessy (WA), Liz Waters (AGWA), Mike McCarthy (SARDI) and Glynn Ward (WA). Absent: Libby Tassie (SA).