

# CRCV TALKING TECHNOLOGY

## Objective measurement of grape and wine quality

The Cooperative Research Centre for Viticulture held a one-day seminar on Tuesday 19<sup>th</sup> July at the Stamford Plaza in Adelaide to assess issues related to the objective measurement of grape and wine quality. Summaries of each presentation are provided in this document. Some of the full presentation are available from the 'Resources' section of the CRCV website.

### Matching Variety To Climate Is Fundamental To Quality

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*Peter Dry, The University of Adelaide, on behalf of Richard Smart*

Australia has conceded to New Zealand a market niche for premium cool climate wine. Australian production is driven by the large amount of fruit produced in the warmer parts of Australia where the availability of low cost water is greater.

Another factor may be that good viticultural land is simply not available in many cool parts of Australia, but consultant Dr Richard Smart questions the validity of this argument.

Dr Smart of Smart Viticulture and his colleague John Gwalter have developed sophisticated climate data matching procedures to identify potential new vineyard regions, which is being used by Dr Smart's clients in many countries of the world.

Dr Smart presented this approach to the Melbourne Wine industry Technical Conference workshop on quality, and so was invited to contribute to the recent CRCV Talking Technology seminar.

His long standing colleague Dr Peter Dry, Associate Professor at the University of Adelaide made the presentation on behalf of Dr Smart who was in Spain at the time.

The presentation began with the statement that Australia's major cool climate region was Tasmania, and the wine industry there was substantially behind the development over the Tasman in New Zealand.

"The spectacular growth of New Zealand in recent times has been fuelled by international demand for Sauvignon Blanc, particularly from Marlborough. In 1990 there were fewer than 2,000 ha in Marlborough. Today, there are more than 5,000 ha, which is about the same size as the McLaren Vale region," Peter Dry said.

"Sauvignon Blanc from Marlborough is extremely easy to sell internationally and it's very profitable. For example, Sauvignon Blanc from Cloudy Bay yields to about 12 tonnes per hectare and 700 litres of wine per tonne and sells at \$24 per bottle. It's sold in six months, you don't have to worry about wood and, obviously, this equates to a very nice income."

But how can Australian wine producers utilise this information? Peter said it was imperative for producers to examine variety and temperature interactions – or variety by climate interactions.

"This is important because temperature is the most important of the climatic variables that determine wine quality. It certainly determines vine phenology and in turn determines the conditions under which the grapes will ripen," Peter said.

"There are other climatic elements to consider such as humidity, rainfall, wind, evaporation, sunshine and so on, and then there is the soil."

Peter said the impact of all these things – the terroir effects – on wine style and quality were real.

Technology has greatly assisted the assessment of climates for viticultural suitability and Smart Viticulture has developed statistical techniques to identify homoclimes for vineyard regions around the world. Homoclimes are regions with similar climates that can be expected to have similar viticultural outcomes.

Climate data is now available in gridded form, with climate estimated down to a small grid size, typically about two km by two km. This provides a powerful tool for homoclimate searches.

This information can be used to compare climate conditions in grape growing regions around the world. Dr Smart says that homoclimate searches can be a most useful first step in identifying new vineyard regions. His approach is firstly to use temperature homoclimes to identify regions of interest, then to study climate risks to production like frost and harvest-time rainfall.

Following steps are then done in the field, bearing in mind aspect and topography for mesoclimate variation, and studies of soil suitability. These procedures have been used to identify vineyard sites in Tasmania which are homoclimes of distinguished New Zealand regions.

Using the technology of climate data and GIS, maps can be produced to provide specific climatic information, for example a map of north eastern Tasmania showing growing season heat degree days (HDD) can be produced. Coloured zones on the map will represent a different zone of growing season HDD.

Using this data, a homoclimate search can be conducted to identify similar macroclimates as a first step in site selection. These can be followed by assessments of soil, water and so on.

“And very often, if you get the climate right, you can find suitable soils within a particular region,” Peter said.

Focusing on Tasmania, homoclimate analysis shows parts of the state are closely matched with parts of New Zealand. But can Tasmanian makers produce a wine in the style of Marlborough Sauvignon Blanc?

“Tasmania does have good temperature homoclimes for Blenheim in Marlborough, as do a few zones on the mainland including parts of the New England Tablelands in NSW. For these new regions, frost avoidance is an important issue, and site selection must be done carefully” Peter said.

“In Tasmania what homoclimate searching did find was a very close match with the Martinborough region which has a reputation for Pinot Noir. Gunns Tamar Ridge has established a new vineyard at White Hills in this homoclimate.”

Peter said homoclimate technology could also help Australian producers find a wider range of varieties for the most suitable locations.

“In 2004, 65% of our crush was from the top four varieties and the top 15 varieties make up 90% of the crush. We’re becoming a bit of a monoculture in this country as far as our varieties are concerned,” he said.

“And there is very little regional specialisation with varieties in Australia. For example, in the Riverland, McLaren Vale, Langhorne Creek and Coonawarra, each very different from a climatic perspective, the major four varieties are all the same – Shiraz, Cabernet Sauvignon, Chardonnay and Merlot.

“If we want to expand our portfolio of varieties, without causing disaster, we can use homoclimate matching to fast track the process of finding interesting varieties for the right locations in Australia.”

Any questions on this approach should be directed to Richard Smart at 0418 656 480, or at [vinedoctor@compuserve.com](mailto:vinedoctor@compuserve.com)

## The Link Between Grape Quality And Climate

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***Leanne Webb, CSIRO and University of Melbourne***

There is a very real relationship between prices paid for grapes and temperatures in regions, according to research conducted by CSIRO and University of Melbourne PhD student Leanne Webb.

At the CRCV Talking Technology seminar, Leanne spoke about the link between climate and grape quality. Leanne is completing PhD studies about the impact of climate change on viticulture over the next 25 to 50 years, with a focus on quality, crop value and phenology.

Leanne has found there is a positive and significant correlation between colour levels in grapes and average prices paid for those grapes per tonne when looking at varieties including Cabernet Sauvignon, Merlot and Shiraz.

Leanne decided that for her PhD studies average prices paid per tonne of grapes is adequate as a crude surrogate measure of 'quality'. She then studied climate data in regions around Australia, looking at factors such as heat degree days (HDD), mean January temperature (MJT), mean February temperature (MFT), minimum temperature, continentality, diurnal ranges and rainfall.

Climate data for the variables was averaged in regions throughout Australia. Leanne then compared the data and looked for relationships between climate and quality.

"When I plotted the regional average MJT with the dollars paid per tonne for Cabernet Sauvignon in Coonawarra in 2003 I saw that in places where it was too cool to grow Cabernet there were price depressions, moving to a peak, then prices become lower as it became warmer and warmer," Leanne said.

In regions throughout Australia Leanne also looked at biophysical attributes of temperature and found that the warmer temperatures became, the lower the colour measured. That cool climates produce higher quality wines (on average) comes as no surprise (given a variety will ripen in a 'climate'). This relationship is well understood in the wine industry and is supported by the body of viticultural literature.

The warmer climate is linked with lower values for the quality surrogates. After the 'heat' data is removed from the analysis, the next component (accounting for 24% of the variation in the data) shows that diurnal range is related to increased colour/G-G. This second component price is inversely related to the other quality surrogates. Quality factors related to diurnal range are not picked up in pricing.

Leanne has now been able to make predictions of the impact of various global warming scenarios on grape quality in the major viticultural regions.

# Towards An Objective Measurement Of Wine Quality – An Econometric Perspective

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**Professor Guenter Schamel, Humboldt University, Berlin**

New World wine brands are struggling to achieve the prices received by their Old World competitors in the United States, according to research conducted Professor Guenter Schamel of Humboldt University, Berlin, and his international colleagues.

Speaking at the CRCV Talking Technology seminar, Guenter revealed the results of one Hedonic analysis of *new* and *old* world wine sold in United States. The sample used was of 5,420 premium wines ( $P > \$5$ ) from 24 wine regions in 11 countries reviewed by *Wine Spectator* magazine.

We know that price is influenced by; regional origin (geography), relative peer performance (brands), and various control variables (e.g. quality scores, variety, etc.) The study was trying to determine a more objective measure of regional brand value.

Hedonic models estimate the contributions of product attributes to prices in the market. Regional quality performance is tied to *strength of producer brands*. Adjusting regional price premiums for producer brand strength yields a more objective measure of *regional brands*.

In the results top, average and low quality producers or brands within a region were identified based on relative peer performance. High-quality producers receive much higher premium (+21%) compared to the discount for low-quality producers (−9.6%). The premium for high-end producers is larger for reds (+3.9%) - but so is the discount for low-end producers of reds (−1.6%). This means red wine producers will gain more from high-quality consistency, but will also loose more if they fail.

On average, Guenter found that top New World wine brands never exceed prices paid for Napa Valley brands, which were chosen as the reference. In stark contrast, prices for top brands from Old World countries such as France and Italy were able to exceed even the top Napa Valley brands.

Results showed that, when compared to the Napa reference, Australian wines received prices that were 33% lower on average, New Zealand wines were 38% lower and Chilean wines were 53% lower in price on average.

When looking at the Old World, Burgundy achieved a positive price position. However, white wine from Germany also suffered at a 40% discount on average. Top quality German whites measured at a 22% discount in price.

When looking at varieties relative to prices paid for US wines, only Pinot Noir achieved a significant premium and all other varieties were sold at a discount. To catch up, regional promotion in the U.S. market is sensible for new world wine and for old world laggards including Germany! “New World producers still have to catch up with the Old World in terms of regional premiums. However, top quality New World brands are able to pick up most of the price difference,” Guenter said.

## Delivering A Grape Quality Index In The Vineyard

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**Garth Swinburn, Scholefield Robinson Horticultural Services**

Wine grape growers rely on signals from their wineries in the form of price and/or quality grades to manage their vineyard to maximise profitability. There is no universal, consistent and transparent method of grading wine grapes in the warm irrigated regions of Australia, Scholefield Robinson developed a simple method of grading wine grapes in the field just before harvest to help growers benchmark vineyard performance.

Berry composition parameters are combined together in an algorithm to calculate a grade index called QIN score (Quality Indicator Number). This system was developed in 1999 and the major aim was to help growers improve their quality and manage their vineyard inputs more effectively.

Since 1999 the project has assessed 450 blocks of Shiraz, Cabernet and Merlot. The measurements that are taken into consideration include:

- Yield & yield components (Bunch number and berry and bunch weight)
- Canopy (Leaf area, canopy density and bunch exposure)
- Crop Load
- Berry composition (Colour, Brix (baumé), Titratable acidity (TA), pH and (more recently) phenolics, tannins and juice yield)

According to Garth, the aim of the Quality Index was to develop a meaningful measure that was independent of winery evaluation and was consistent from year to year.

“One of the most useful elements of this system is that it allows growers to benchmark their performance across the region. For example, a grower can see how well their Merlot performed against the other Merlot producers in the region.”

“Growers get a QIN for their vineyard blocks which they can track over time, but they also get ranked within the region to be able to see how they are performing against others. This is helpful because weather and climate can bring about quality differences across seasons, but the ranking system gives another indication of how they are performing.”

Growers are provided with the information at the end of the season and can use the system to determine their grape quality in comparison to profitability.

“The system is useful for growers because they can establish whether the quality gains, often associated with yield reduction, are providing financial benefits, and make a sensible business decision about what they are aiming for.”

The system has also been used to identify and implement improved vineyard management practices. For example, in an 8-year-old Shiraz block, vigour was an issue and the QIN was low as was the ranking. Severe pruning in the top wire was used to improve vine balance, with an improved QIN and a sharp rise in the rankings. The harvested grapes also had better colour, acidity and Baume.

Garth said although the system had limitations and could be more powerful, it has become a useful system for growers as well as a tool for them to communicate with their winery buyer.

“On the whole we have seen quality improve significantly in this region over the past seven years. This is partly due to incentives from wineries to improve colour in red wines. This system has allowed growers to benchmark their performance and have a greater awareness of their quality.”

## Vineyard Grape Measures And Wine Grading With Small Lot Wine Making

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**Patrick Iland, Consultant (speaking for Luke Rolley, Victoria)**

A GWRDC RITA grant provided funding for a project investigating the relationships between vine characteristics, berry composition and sensory attributes for Shiraz vineyards. The project assessed 42 Shiraz blocks in warm climate regions in Victoria and New South Wales including Gundagai, Swan Hill and Bendigo.

According to Patrick, the aim of the project was to benchmark vineyard performance and look for key indicators of quality and then bring it all together in one 'quality' equation.

"All of the growers involved supplied to Southcorp and the measure of quality for the project related to the product range where the grapes would be used."

A range of vineyard characteristics, berry composition/quality and wine composition/quality data were collected using Southcorp's assessment sheets. Three replicate 50kg ferments from each vineyard were used for small-lot winemaking trials. 126 small-lot wines were produced with sensory analysis used to provide a wine score out of 20 related to fruit concentration and complexity.

Patrick said small-lot winemaking was one of the challenges of the project.

"It is important that each of the wines are treated in the same manner and the wines were made to a protocol. The problem is this doesn't allow for the winemakers skill in enhancing the flavour and improving the wine.

The results also reflected this challenge, with wine grades ranging from 13.62 to 16.25.

"The process of small-lot winemaking compacted the results so that they fell in a small range, but interestingly, the results were scattered with a range of qualities across each region and vineyards.

The research team looked at the data to determine if there were any reasonable wine quality indicators that could then be used to predict quality.

"We hoped to find some of our berry analysis correlating with the wine score numbers. We found some reasonable correlation between berry colour (measured as colour per gram berry weight) and wine score, berry weight and colour score and Baume."

However, the results were not consistent across the two seasons of data collected in 2002 and 2003. Patrick said at the end of the project, it was impossible to use any one parameter in isolation to predict wine quality.

"There are obvious advantages to being able to use one parameter, not least of which is time and cost savings of having to test for many quality attributes. However, we found that no one parameter provided a good indication of wine score and that a number of parameters need to be considered."

Patrick said the factors that most affected quality included climate, irrigation management, canopy and trellis design.

"It is also worth remembering that winemaking is important and can really improve on the fruit. Make sure you impress your winemaker with your vineyard management to ensure your fruit gets the treatment you think it deserves."

## Commercial Wine Quality Grading – Correlations With Spectral Properties

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**Bob Dambergs, The Australian Wine Research Institute**

Some early work by Chris Somers at AWRI highlighted the importance of the visible wavelength spectral properties of red wine and he developed a suite of tests to take advantage of this observation.

Although there are many factors that influence quality, including the grapes, yeast and winemaking process, there is a good correlation between berry colour and final wine quality.

“While colour does not equal quality, because anthocyanins in grapes are not the final colour in red wine, there is a correlation which makes colour an effective vineyard measurement of quality.”

Using Vis-NIR, the research team examined near infrared as well as visible wavelengths and correlated them with commercial wine quality grading scores.

Wine grade correlated to some degree with absorbance in the near infrared regions, but the strongest correlations were with visible wavelengths. While subtle sensory differences may be beyond the scope of such calibrations, this work highlights the importance of the spectral properties of red wine.

“Vis-NIR predicts quality colour density and hue and is fast becoming a useful tool in industry.”

The CRCV/AWRI team are now working with Sydney-based Integrated Spectronics to develop a portable instrument that will measure colour (total anthocyanins) as well as pH and total soluble solids in red wine grapes.

Specialists in the development and manufacture of spectronic equipment in a range of different fields, Integrated Spectronics has become a supporting participant of the CRCV and are working with the CRCV's Vis-NIR project team to develop commercial products for use in the field.

Since the original project commenced, the team has used Vis-NIR to scan more than 3,000 red wine grape samples from six vintages and many regions. Together with reference analyses (wet chemistry) for the samples, the team have a powerful dataset for use in calibration of the Vis-NIR equipment and the data will be used in the development of the prototype. Integrated Spectronics has the necessary skills to develop electro-optical instrumentation, hardware and systems design that will complement the data collected by the CRCV project team.

## Berry Colour Index As A Commercial Grape Quality Factor – The Brown Brothers' Experience

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***Bernadine Long, Brown Brothers***

Brown Brothers have used a Berry Colour Index for more than 13 years, with the major outcomes of improved colour and a fair payment system to reward the efforts of growers.

According to Bernadine, the system was developed in the early 1990s when a lot of new growers had moved to the King Valley and many were struggling to control excess vigour and producing fruit that did not meet the company's expectations.

“The majority of the growers were on 10-year contracts so we had to look at how we could work with them to improve their quality. The starting point was really to define quality indicators.”

Bernadine said the winemakers wanted reduced crops and growers wanted to increase their yield and they needed to come up with a payment system that would reward reduced yield and improved quality.

“The Berry Colour Index evolved as something of a middle ground between the winemakers and growers and because there is an established relationship between berry colour and wine quality.”

She said the other advantage of the system was that growers related to colour as a parameter and that feedback could be provided to growers each vintage.

“We needed a system that was transparent and that related to grape quality, not wine quality.”

Representative samples are collected from the vineyard, with 100 berry sub-samples weighed and frozen. Skin disks are removed and pigment is extracted. The red pigment amount is converted to an index of predictive wine colour density.

Although the system is labour intensive and price is not determined until harvest, Bernadine said the advantages had outweighed the disadvantages.

“We know colour is not everything, but it generally works well. The correlation with Cabernet is excellent. It's not as strong with Shiraz, but across all varieties and regions, it holds up well.”

Brown Brothers have created a pricing structure that mirrors their Berry Colour Index system, with growers paid a base rate, a Baume bonus or deduction, a Botrytis (and other disease) bonus or deduction and a colour bonus.

Bernadine says the pricing structure has also changed over the past 13 years in line with new standards and improvements.

“When we started this system, many of our growers were struggling to achieve the desired Baume of 13.5 and we provided incentives. This has not been a problem for a few years, so we now charge a deduction if it is not in our range and have focused more of the bonuses on colour.”

Growers can earn an additional \$100 a tonne up to \$1100 extra per tonne for reaching specified colour density unit measurements.

“We've made the incentives a large part of the payment because we want our growers to be committed to this and we need to reward them for getting it right.”

Bernadine said the scheme had seen a steady incremental increase in colour measurements and believed the major factors were related to vineyard management.

“In 1992 when we started the colour index was 11. For the last 2 seasons it has been 16 and hit 17 in 2002 which was a great season.

“This improvement is because we have worked with our growers to improve their vine balance, canopy management and irrigation scheduling.”

Bernadine said measuring colour had allowed the company to renew contracts with growers based on evidence of their ability to meet specifications and had allowed them to target growers with the required colour levels.

“We have been happy with the scheme but are always looking at ways to improve it. We’re hoping the next move will be to NIR to predict colour to save us time and money.”

## Practical Large Scale Grape Compositional Testing At Hardy Wines

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**Chris Bevin, Hardy Wine Company**

Vintage at the Hardy Wine Company is a serious undertaking, with a vintage intake of 308,419 tonnes from Riverland and Sunraysia, representing 85% of the Hardy Wine Company total intake.

The winery in Berri Estates is one of the largest in Australia and the testing of grape quality represents a challenge on a significant scale.

Chris said although winemakers seem to know what they're looking for when it comes to quality, the company needed an objective definition of quality in order to be able to measure it objectively.

"In the absence of a rapid, quantitative measure of quality, colour seemed to provide an objective indication of quality in some regions, particularly warm regions."

"We chose to measure colour as an indicator of quality in Riverland and Sunraysia. This approach is not taken in McLaren Vale and Coonawarra where conditions for colour formation are ideal and colour does not always relate well to quality."

Chris said once the decision had been made, the biggest challenge was to develop a sampling system.

Two systems of colour measurement are used – a vineyard streaming system using a Zeiss Corona VIS-NIR and a weighbridge measurement using a FOSS VIS-NIR.

In terms of the sampling process, the vineyard streaming samples are collected by growers and 500g of berries are collected across a patch with samples collected at 9.5, 10.5 and 11.5 Baume. At the weighbridge a YUBA sampler is used to take a core sample, with the contents spread on a tray and 500g of berries manually selected.

In 2005, about 4,500 grower samples were processed, with the majority of the samples being Riverland Shiraz. The results are linked to grower payments.

"We processed about 500-700 samples per day which is an incredible effort. But obviously the sampling and testing is still a labour intensive process and we are looking at ways we can improve our process efficiency."

Options such as whole berry scanning would be ideal as the need to blend the berries would be eliminated.

"Blending mightn't seem like a problem, but when you have thousands of samples to be done, it adds up to a lot of time."

"We have started working on whole berry samples but still have more work to do before we can use this system."

Chris said there had been a general upwards trend for colour in the Riverland and Sunraysia.

"We've seen an improvement in colour in these regions consistently over a number of seasons. 2002 was an outstanding year and has not yet been surpassed but the results have been positive."

## Determining Wine Aroma From Compositional Data

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*Leigh Francis, The Australian Wine Research Institute*

The ability to predict wine aroma properties from measurement of volatile compounds has been a long-standing goal of wine research. Although sensory descriptive analysis using a trained panel can be used to objectively assess wine aroma qualities, measurement using instrumental chemical methods is highly desirable.

According to Leigh this is partly due to the time and cost of using trained panels.

“Sensory research is effective but time consuming, costly and requires large amounts of wine. A chemical analysis of the wines using stable isotope discrimination analysis (SIDA) is fast, accurate and needs only small volumes of wine, so there are good reasons for us to look to this method.”

A major impediment to the achievement of this aim has been the fact that hundreds of volatile compounds exist in wine, that complex interactions occur among the compounds, and that compounds of the wine matrix influence aroma perceptions. Nevertheless, it now appears that a relatively small number of key compounds can direct wine flavour.

“There are about 800 volatile compounds in wine. Some of these are from grape berries while others are from yeast, bacteria, oak wood and chemical reactions in storage. Our aim has been to work out which ones are most important to flavour and aroma.”

For aroma studies, CRCV researchers have used gas chromatography methods to get an indication of the most potent compounds for aroma. These have then been identified and researchers have determined the thresholds needed for the compound to have an effect.

According to Leigh, it is the balance of compounds which is of importance and it seems that no one dominating compound provides key aroma properties.

“We’ve identified a number of important compounds including those derived through fermentation and those derived from the grape, and we’re now working to determine the kind of mix of each that is needed to create various aromas.”

This has proven to be the case with a PhD project conducted at the AWRI by CRCV researcher Heather Smyth. She looked at the aroma compounds of importance in Unwooded Chardonnay and Riesling. She found a reasonably small number of key aroma compounds were of importance to wine flavour.

With analytical methods now developed to readily measure the compounds of importance, the next step for this research will be to develop an assay for the prediction of wine aroma and to link wine aroma with consumer preference data.

## Consumer Preference – The Ultimate Quality Test

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**Kate Lattey, The Australian Wine Research Institute**

Wine quality has traditionally been established by wine industry personnel, with little use of the consumer testing methods that are regularly applied to other beverages and food. Consumer preference data provides a direct indication of the degree of acceptability of a wine and allows the sensory attributes that most influence liking to be determined.

Knowledge and application of these techniques would be of great advantage in the wine industry.

According to Kate, consumer testing is different to market research which generally focuses on branding, marketing and pricing.

“Focus group research is often used for development of new products and can be a useful qualitative form of data collection. Consumer preference data is quantitative and involves statistical analysis.”

One of the most common forms of consumer preference tests involves rating the degree of liking, where a panel of consumers are provided with wines to taste in a controlled environment and asked to rate the wines on a 9-point scale, with 1 being ‘dislike extremely’ through to 9 being ‘like extremely’.

According to Kate the recruitment of consumers is an important part of the process.

“We select consumers who use and like the wine style being studied and we aim to have between 70 and 200 people on the panel. The tasting conditions, in special booths, are also important for getting good results.”

One of the projects that has been conducted by Kate and the CRCV/AWRI team was to determine sensory preferences of Riesling and Unwooded Chardonnay. Ten wines of each variety, representing different price points, regions and styles were selected. These were presented to a panel of 72 consumers who were recruited on the basis that they drink white wine at least once a fortnight. Each of the wines was also quality scored by a team of AWRI ‘expert’ tasters.

The consumers’ preferences were then mapped to determine the types of sensory qualities most preferred.

“We found that the most liked Riesling wines overall were high in floral, lemon and pineapple aromas, and while younger wines were generally preferred, some of the older wines were also highly liked.”

“As expected we found a divergence of opinions within the group, which in many ways is good news for winemakers who of course wish to create different styles of wines.

Kate said the findings indicated that there were four distinct groups of consumers that liked particular kinds of wines, which could then be matched to demographic data. However, the quality scores from the ‘expert’ tasters did not concur with the consumer data.

“Consumer testing is a really valuable tool for the wine industry and our study has shown that the experts and consumer don’t always agree, so we need to utilise these methods to understand what consumers like.”