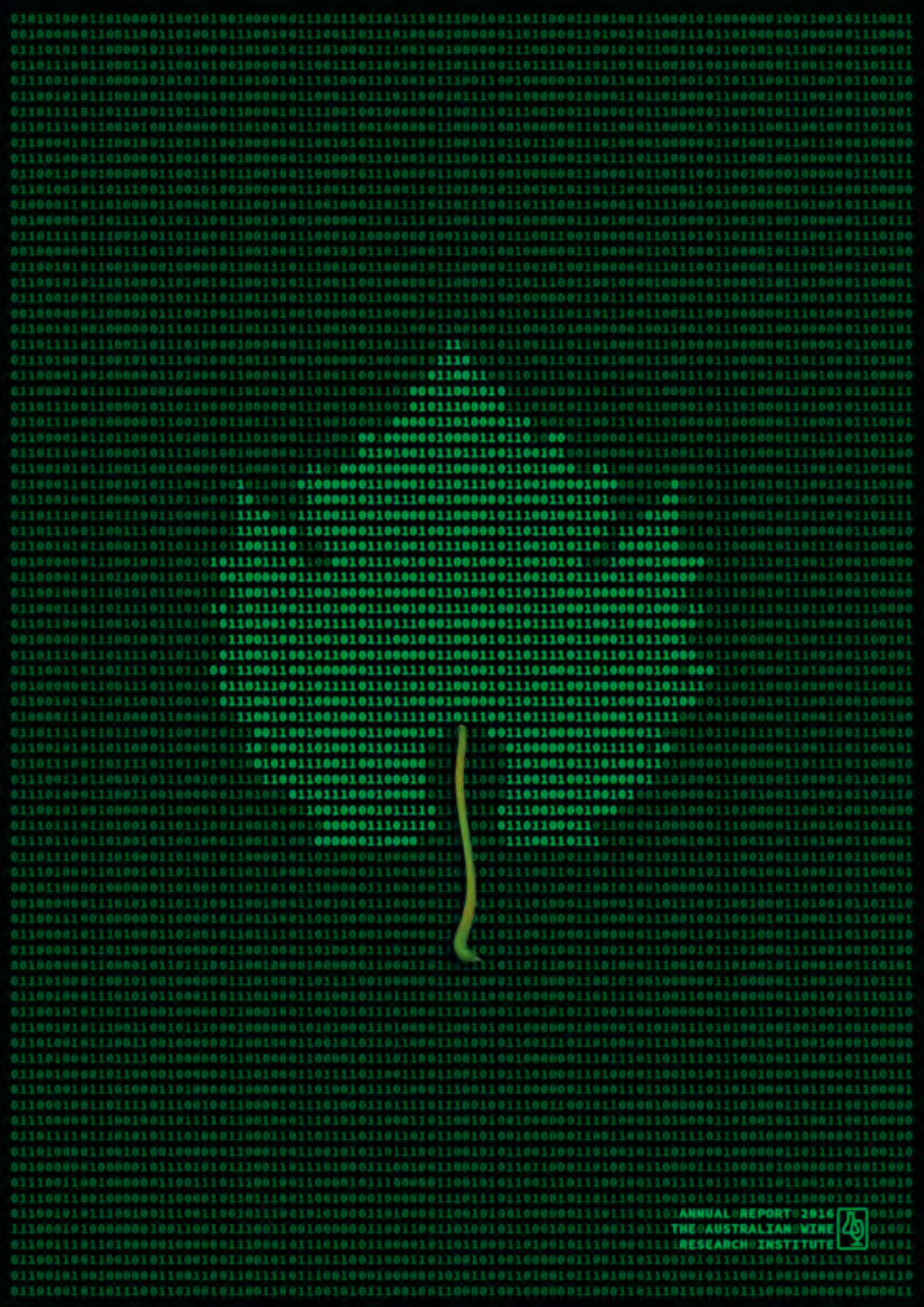

ANNUAL REPORT 2016
THE AUSTRALIAN WINE
RESEARCH INSTITUTE

Board members

Ms L.E. Rose, B AppSc, BSc, GAICD
Chair – Elected a member under Clause 25.2(c) of the Constitution

Mr T.J. Bekkers, BAppSc (Ag) (Hons), Grad. Cert. (Mgt)
Elected a member under Clause 25.2(c) of the Constitution

Dr J.S. Harvey, BSc (Hons), PhD, MBA, GAICD
Elected a member under Clause 27.1 of the Constitution (from 1 January 2016)

Mr K.R. Horton, BAppSc (Wine Science)
Elected a member under Clause 25.2 (c) of the Constitution

Dr D.L. Johnson, BSc (Hons), PhD, MBA, GAICD
Ex officio under Clause 25.2(a) of the Constitution as Managing Director of the AWRI

Mr B.M. McKinnon, BAgSc (Oenology) (Hons)
Elected a member under Clause 25.2(c) of the Constitution

Dr S.C. McNab, BAgSc (Hons), PhD
Elected a member under Clause 25.2 (c) of the Constitution

Ms M.J. Retallack, BAppSc (CPM), PGradDip (NRM), BEd, Grad Dip (Viti), PCert(Arb), CPAg, GAICD, ARLF
Elected a member under Clause 25.2 (c) of the Constitution (until 17 November 2015)

Ms E.A. Riley, BAppSc (Wine)
Elected a member under Clause 25.2 (b) of the Constitution

Prof. B.P. Schmidt, AC, FAA, FRS, BS (Astronomy), BS (Physics), AM (Astronomy), PhD
Elected a member under Clause 25.2(c) of the Constitution

Mr M.R. Watson, BEc, MBA, ACA, IPAA
Elected a member under Clause 25.2(b) of the Constitution

The company

The Australian Wine Research Institute Ltd was incorporated on 27 April 1955. It is a company limited by guarantee that does not have a share capital.

The Constitution of The Australian Wine Research Institute Ltd (AWRI) sets out in broad terms the aims of the AWRI. The AWRI's activities are guided by its business and research, development and extension plans, and its stated mission, values and behaviours:

Mission
Supporting the Australian grape and wine industry through world class research, practical solutions and knowledge transfer.

Values
The AWRI's values provide guidance in how it will deliver on its mission. These values are:

- Excellence
- Integrity
- Passion

Behaviours
The behaviours that support those values are:

Excellence
- Outcomes focused, delivering results
- Personal mastery – being the best one can be
- Asking and answering the right questions
- Relevant to industry
- Collaborating to achieve faster, better or cheaper outcomes

Integrity
- Accountability to stakeholders
- Dealing honestly, impartially and consistently
- Scientific and professional rigour

Passion
- Enthusiasm for our people, our industry, and our products
- Spirit of creativity
- Enjoying work and celebrating achievements
- Desire to do better
- Pursuing knowledge and understanding

The AWRI's laboratories and offices are housed in the Wine Innovation Central Building within an internationally renowned research cluster on the Waite Research Precinct at Urrbrae in the Adelaide foothills. Grape and wine scientists from other organisations are co-located with the AWRI in the Wine Innovation Central Building.

The Waite Research Precinct is also home to other research and teaching organisations including: Australian Centre for Plant Functional Genomics (ACPFG), Australian Genome Research Facility (AGRF), Australian Grain Technologies (AGT), Australian Plant Phenomics Facility, the Centre of Excellence in Plant Cell Walls, CSIRO, South Australian Research and Development Institute (SARDI), the University of Adelaide's *School of Agriculture, Food and Wine* and the Waite Research Institute.

Registered office
Cnr Hartley Grove and Paratoo Road, Urrbrae, SA 5064

Postal Address: PO Box 197, Glen Osmond, SA 5064
Telephone: (08) 8313 6600
Fax: (08) 8313 6601
Internet: www.awri.com.au
Facebook: www.facebook.com/The.AWRI
Twitter: www.twitter.com/The_AWRI
ABN: 83 007 558 296

Cover image
The 'digital Chardonnay leaf' cover image is inspired by this year's completion by AWRI scientists and collaborators of the world's first reference genome for the Chardonnay grapevine. The cover was designed by Reedcomm Creative Director Geoffrey Reed in collaboration with Art

CONTENTS

62ND ANNUAL REPORT – 30 JUNE 2016

PRESENTED TO THE AUSTRALIAN GRAPE AND WINE COMMUNITY

CHAIR'S REPORT

LOUISA ROSE

This has been a busy and productive year for the AWRI and its Board, with significant progress made in a number of key strategic areas and some important groundwork being laid for the future.

The most important strategic priority for the year has been the cooperation between the AWRI and Wine Australia that is starting to reform the Australian grape and wine research, development and extension (RDE) system to deliver greater value to the Australian grape and wine community. A number of reforms have already been agreed to and are being implemented, specifically:

- Wine Australia will continue its important role of determining the macro strategic direction for Australian grape and wine RDE.
- The AWRI will be entrusted to best determine how the AWRI's RDE activities are conducted to reach the agreed strategic goals.
- A new Wine Australia-AWRI strategic partnership will be finalised later in 2016.
- Extension activities are being centralised at the AWRI.
- Work is now underway to develop an updated RDE strategic plan for the AWRI, with new and continuing projects to commence prior to vintage 2017.

These are very positive outcomes for the Australian wine community and reflect an enormous amount of productive collaboration between the staff of the two organisations over a relatively short time. I would like to convey the thanks of the AWRI Board and staff to all those at Wine Australia for their contribution to this process and their continued support of the AWRI's activities. While much has already been achieved, Wine Australia and the AWRI remain committed to further collaborative reform in the year ahead.

An additional key focus for the Board during the year has been the AWRI's strategy for managing its reserve funds. Until this year, the AWRI has pursued a very conservative strategy based solely on term deposits. Recent growth in the AWRI's reserves, in part due to the payroll tax refund achieved last year, prompted the Board to adopt an investment policy that will generate better returns while maintaining a conservative strategy and better managing the risk inherent in the previous one-class investment strategy. All investment returns will continue to be invested in RDE for the benefit of the grape and wine community.

Significant strategic investments have been made in information technology platforms. Further co-investments have been made in capital equipment and RDE projects, in collaboration with other organisations.

The Board has also been delighted to invest in 'blue sky' projects generated through an internal competition – projects that have potential to add enormous value to industry but that had not been successful in attracting other funding. Examples include a revamp of the AWRI Ferment Simulator and a major survey of grape and wine production practices that will contribute information to RDE projects going forward.

Overall, these investments have resulted in a deficit for the year, one that is in line with expectations and part of a deliberate strategy to invest in areas with industry impact.

There were numerous research, development and extension achievements during the year of direct relevance to grapegrowing and winemaking across Australia. The project reports section provides a comprehensive update of these outcomes and I encourage you to read it in full and contact the AWRI if there are any areas you would like to know more about.

During the year the Board was sorry to farewell Mary Retallack, but will continue to work closely with her in her new role as a Wine Australia director. Dr John Harvey was welcomed back to the AWRI Board – his contribution and that of all the AWRI directors is gratefully acknowledged.

The year also saw significant change in the peak bodies of our industry, with Paul Evans moving on from the Winemakers' Federation of Australia (WFA) and Lawrie Stanford and Vic Patrick retiring from Wine Grape Growers Australia (now Australian Vignerons). The AWRI thanks them for their longstanding service to the grape and wine community and wishes their successors well.

Finally, I would like to thank the innovative and energetic AWRI staff, led by Dr Dan Johnson, for their ongoing commitment to supporting the Australian grape and wine community.

Louisa Rose
Chair

MANAGING DIRECTOR'S REPORT

Progress and impact

This year has been one of progress and impact across a number of fronts.

The third year of the 2013-2018 AWRI Research, Development and Extension plan has seen significant progress in achieving project outputs of benefit to the Australian grape and wine community. Important research findings are reported across a range of areas including wine provenance, yeast genetics, grape objective measures, wine flavour and texture. Similarly, there have been major advances in the services offered to industry, with Entwine Australia progressing well and new capabilities in areas such as biosecurity and luxury product design being developed.

In parallel, so many of the objectives in the AWRI's business and operational plan are complete or on target that a new plan will need to be developed in the coming year. Particular highlights achieved under that plan include the adoption of electronic voting for Board elections, development of a rigorous policy review framework, achieving payroll tax exemption, an overhaul of the AWRI reserves investment framework and significant investments in information technology upgrades. These and the other completed objectives ensure that the AWRI is delivering on its mission to support the Australian grape and wine industry as efficiently as possible.

Records were again equalled or broken for the sample volumes through each of AWRI Commercial Services, WIC Winemaking Services and the South Australian node of Metabolomics Australia.

RDE reform

The year has seen a key focus on working closely with Wine Australia to reform the grape and wine RDE system, ensuring that it delivers the greatest possible value for levy payers, and better integrating RDE with marketing.

I am extremely pleased with the progress that has been made so far, in particular in terms of the way in which the organisations are partnering day to day and in demonstrable examples of improved efficiency such as the integration of grape and wine extension platforms. The AWRI team has enjoyed playing a greater role in Wine Australia's events in export markets – bringing a technical wine education side to customer and consumer-facing events in Asia and North America.

More detail about the specific steps taken thus far towards RDE reform can be found in the Chair's report; however, a key priority for the next six months will be the development in conjunction with Wine Australia of an updated RDE plan setting out the AWRI's strategic priorities and activities well into the future.

60th birthday review articles

Celebrations of the AWRI's 60th birthday culminated in the publication of a special issue of the *Australian Journal of Grape and Wine Research* containing 18 review articles authored by AWRI staff and spanning the value chain from viticulture through to wine storage. This significant body of work has been very positively received and will stand the test of time as a key reference for researchers and industry alike.

AWITC

Preparation for the 16th AWITC has been a major area of activity during the year. AWRI staff contribute across the board to this industry event, including conference management, communications, the executive and planning committees, plenary presentations, the trade exhibition, the poster display and the workshop program. Several new partnerships that will bring additional value to the conference week have been developed: with WFA to combine the Outlook Conference with the AWITC, with McWilliam's Wines to hold the Maurice O'Shea Award Dinner in conjunction with the conference and with Fair Events to stage the Australian Wine Industry Trade Exhibition.

DAN JOHNSON

Entwine Australia

Since taking over the management of Entwine Australia in August 2015, significant progress has been made in improving and communicating the value proposition of membership. Members can now easily benchmark their sustainability metrics against aggregated data from other members in their region or size category, with metrics focusing on areas where growers and winemakers want to see improved efficiency and cost savings. Membership numbers have increased by 15% in the past 11 months, including new Entwine members and members who had previously withdrawn from the program. Importantly, in early 2016, Entwine received endorsement from Australian Vignerons, WFA and Wine Australia, to be the principal vehicle to convey the Australian wine industry's sustainability credentials. Opportunities to more closely integrate Entwine within Wine Australia's promotion of Australian wine will be explored over the coming year.

Workplace health and safety

Ensuring that the AWRI's workplace health and safety is of an exceptional standard has been a priority led by the AWRI Board. An external review of the AWRI's WHS procedures and culture was conducted and pleasingly the results of the review were extremely positive and highlighted the AWRI's strong commitment to workplace health and safety. Some opportunities for incremental improvement were identified, in areas such as driver training, contractor management and records management, and these have since been addressed.

Staff tenure continues at a high level, averaging 7.2 years per employee – a further reflection of a safe, rewarding organisational culture.

Technical trends

As with previous years the nature of the industry's technical support needs in the past year was reflected in the volume, timing and nature of enquiries answered by the AWRI helpdesk team. The 2016 growing season was characterised by a dry winter and spring, with warm October temperatures leading to early budburst and an early start to harvest. While some regions experienced long-term drought conditions throughout the season, others in coastal NSW and WA experienced intense late rains that put vines under high disease pressure. The shift towards early ripening and concurrent ripening of different varieties again saw a compressed vintage.

Throughout the year a total of 4,477 information requests, helpdesk enquiries and problem investigations were addressed, and the AWRI Commercial Services laboratories completed analyses on more than 23,000 samples. More than 2,000 enquiries and requests for assistance were addressed by the helpdesk, with greater than 80% answered within 24 hours.

The majority of the winemaking enquiries received were from wine companies and suppliers closely aligned with the wine industry, with the remaining queries made up from government organisations, students, legal personnel and journalists. A total of 247 queries turned into investigations where samples were requested and further analysis performed (on 1,291 samples) to identify the problem and how it could be remediated.

Viticultural enquiries

During the year, the viticulture team responded to 657 viticulture-related enquiries, an increase of about 35% on the previous year. Around one-third of viticulture queries related to sustainability matters. The next most common topics for queries were agrochemicals (16%), vineyard pests/diseases (9%), vineyard practices (8%) and viticulture in general (7%). Other common queries covered weather, grapevine varieties and smoke taint.

Agrochemical queries were dominated by questions about captan, a commonly used fungicide that was removed from the list of 'recommended' products for export wine due to a regulatory change proposed by the European Union. Fungal diseases made up about two-thirds of the pest/disease-related queries with most of the remainder being about insects. Issues with *Botrytis* were seen particularly from NSW following the wet weather experienced shortly before harvest.

Winemaking enquiries

The winemaking team responded to 1,336 enquiries in 2015/2016.

Vintage 2016 was another rapid and compressed vintage across many wine regions in Australia. Above average yields due to higher bunch numbers and the compressed vintage again placed stress on harvest and processing infrastructure. There was a delay in harvesting some blocks which resulted in high baumé fruit and higher alcohol wines. Ferment speeds tended to be fast, either to turn tanks over quickly to be prepared for the next batch of fruit or because of insufficient refrigeration capacity to cool both grapes and ferments. Some fermentation problems were also seen, with winemakers having little time or spare tank space to deal with stuck or sluggish ferments promptly.

During January and February, bushfires occurred in some states, with Western Australia affected early in the season, and Tasmania following later, with some vineyards experiencing lingering smoke haze in the lead up to harvest. Again this created significant concern among growers and winemakers about smoke taint. A number of factors can influence the likelihood of a smoke event causing smoke taint in wine. Analytical data from testing volatile phenols and their non-volatile glycoside precursors can give a good indication as to whether or not fruit has been exposed to smoke. Sensory and chemical analysis of small-scale ferments can also assist in assessing the likely impact on final wines; however, this does take additional time to complete. Many calls to the helpdesk were taken during this period requesting assistance with interpreting analytical results. In some cases, where the results indicated that the wine contained only slightly higher levels than might be expected for non-smoke exposed vineyards, some winemakers very sensitive to smoke taint still saw signs of smoke-related characteristics. For vintage 2016 the majority of analytical results were found to be similar to, or only slightly higher than, levels that might be expected for non-smoke exposed vineyards, making it difficult to use analytical data alone to determine the extent of any taint.

Regulatory enquiries

There were 99 regulatory-related enquiries during 2015/16. One area of interest during the year was questions about health and nutrition labelling for wine and wine products. Broadly these questions can be divided into the topics of alcohol, allergens, preservatives and health and nutrition statements for Australia, which all fall under the auspices of the Australia and New Zealand Food Standards Code. As the incidence of food allergies and intolerances is increasing worldwide, sensitive consumers are looking into all aspects of their daily diet and this includes wine consumption. Common misconceptions about allergens in wine relate to histamine and sulfur dioxide. Other regulatory queries covered: migration of phthalates from packaging materials; concentration and potential toxicity of elements such as arsenic, copper, fluoride, iron, lead and manganese in wine; accuracy and legality of different methods for sugar measurement in wine; organic wine standards and certification; and Australian and international status of water additions in winemaking.

Project highlights

Many of the AWRI's current research projects have been in progress for three years and have now produced results with considerable impact. A complete list of highlights is published elsewhere in this report but some worth particular mention are listed below.

- A reference genome for Chardonnay has now been completed for clone I10V1, with the use of new data from a long read PacBio sequencing platform (a platform that the AWRI has since committed to support at the Waite Campus). The next phase of the project is working towards a comprehensive cataloguing of genetic diversity between different Chardonnay clones. Genomic comparisons will initially focus on differences that have potential for use as markers for clonal material in the field. Understanding of the genetic differences among clones will also be combined with knowledge about their different behaviour in the vineyard and winery.

- AWRI scientists were involved in a collaborative project examining the contents of beer bottles from a >200-year-old shipwreck, which may have demonstrated that yeast cells can survive in beer for that length of time. This is an exciting prospect and a reflection of the world class technical capability at the AWRI.

- More than 100 samples of wild ferments were sourced from thirty wineries across Australia. Metagenomic analysis is determining both the identity and proportions of yeast and bacteria that were present throughout the fermentation in each of these wines. This represents the first stage of developing a highly detailed map of the microbial landscape of Australia's wine-producing regions.

- The volatile compound benzyl mercaptan was found to give a 'struck match', 'flint' or 'mineral' aroma to Chardonnay, with a study also showing that premium Chardonnay wines from cooler regions and with some bottle age tend to have a higher concentration of this compound.

- Oxygen concentration in Chardonnay must at the time of inoculation was found to have no impact on fermentation duration or the concentration of yeast-derived aroma compounds in wine. However, aeration of ferments later than typical practice still had a stimulatory effect on fermentation performance without negative consequences for wine sensory attributes. This suggests that, if required (e.g. for stimulation of a sluggish/stuck ferment), the use of oxygen outside the previously defined narrow window (24-72 hours post-inoculation) can be considered beneficial for ferment performance with limited risk to sensory outcomes.

- Strontium isotope ratios combined with trace metal concentrations were able to differentiate Australian wines from those produced overseas. This combination of analytes also had potential for identifying region of origin of Australian wines.

- Detectable monoterpenes were released *in vitro* through interaction of saliva with glycosides. Up to 80% release of monoterpenes was achieved during incubation of glycosides isolated from wine with saliva. When glycosides were tasted in-mouth, monoterpenes were also detected using an expired air trapping method. The ability of an individual's saliva to break down the glycosides appeared to be quite consistent but varied significantly across different individuals, in line with previous work on volatile phenol glycosides. This highlights that flavour released in-mouth from glycosides may contribute to differences in perception of wine between individual consumers.

- Several *Brettanomyces* strains that differ in their inherent tolerance to sulfite have been exposed over several months to increasing concentrations of sulfite. In each case, some cells have been able to grow at sulfite concentrations greater than the original parent strain could tolerate. This observation demonstrates the need to future-proof Australia's *Brettanomyces* control strategy, especially in view of market pressures seeking to minimise the concentration of sulfite in wine.

Financial and administrative performance

Following on from last year's achievement of payroll tax exemption in South Australia, an equivalent exemption was secured in Victoria and Queensland – the other two states where AWRI staff are currently based. In addition, the AWRI was registered with the Australian Charities and Not-for-profits Commission from 1 January 2016.

Investments have been made from the two new strategic reserves reported in last year's report. The Strategic IT reserve has supported upgrades in infrastructure across the AWRI that are boosting productivity and collaboration. The Co-investment reserve has allowed access to grants including the SA River Murray Sustainability Program waste into profit project this year and one of two Rural R&D for Profit projects commencing at the AWRI next year, and supported new capital equipment investments.

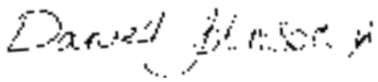
AWRI Commercial Services had another exceptional year, exceeding last year's record number of samples analysed. The ICP-MS instrument purchased late last year is now fully operational and able to offer analysis for 23 different metals of interest to the wine community. This capability will also be harnessed in a new research project extending a recently completed pilot study that demonstrated strontium isotope ratios and trace metal concentrations could be used to determine wine provenance.

Positive signs for the future

While profitability remains a big issue for much of the grape and wine community, and taxation is very much still on the agenda, current sentiment does seem to be increasingly positive. Export numbers are heading in the right direction and inbound visitors are finding the Australian wine story to be a compelling one.

At the AWRI, the coming year will see a refreshed RDE plan developed and launched, again focusing on projects with real impact on the issues important to Australia's grapegrowers and winemakers.

As always I am very grateful for the continuing efforts of the AWRI Board under the leadership of Louisa Rose and to the creative and dedicated AWRI staff.



Dan Johnson
Managing Director

BOARD NOTES

Chair
Ms L.E. Rose

Audit committee
Mr M.R. Watson (Chair), Mr T. J. Bekkers, Dr S.C. McNab

Personnel committee
Ms L.E. Rose (Chair), Mr B.M. McKinnon, Prof. B.P. Schmidt

Meetings
Ordinary General Meeting
The 61st Ordinary (Annual) General Meeting was held on 24 November 2015.

Extraordinary General Meeting
There were no Extraordinary General Meetings held.

Board
The Board of the AWRI met on the following dates: 15 September 2015, 24 November 2015, 23 February 2016, 31 March 2016 (via teleconference) and 7 June 2016.

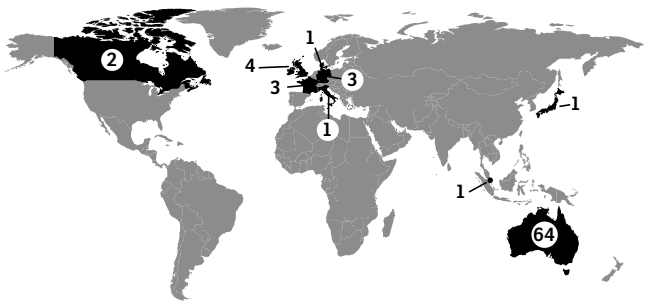
L TO R: BRETT MCKINNON, TOBY BEKKERS, JOHN HARVEY, DAN JOHNSON (FRONT), MARK WATSON, LOUISA ROSE (FRONT), KIM HORTON, BRIAN SCHMIDT, STUART MCNAB, LIZ RILEY

Investment

The Board of the AWRI acknowledges the continuing financial support of Wine Australia, the Government of South Australia, the Australian Government Department of Agriculture and Water Resources, Bioplatforms Australia and the Grains Research and Development Corporation along with a large number of confidential commercial clients.

Appreciation

Activities at the AWRI benefit from collaborations from individuals and organisations from the following different countries: Australia, Canada, France, Germany, Italy, Singapore, Japan and the UK. The assistance and cooperation from partners across the globe are gratefully acknowledged.



HIGHLIGHTS OF THE YEAR 2015/2016

GENERAL

Progress towards RDE reform

The AWRI and Wine Australia have been working closely together on reforming the Australian grape and wine research, development and extension (RDE) system to improve the productivity of the system for its investors and better integrate RDE outcomes with marketing. Significant progress has been made, in particular towards a new long-term strategic partnership with Wine Australia that reflects the AWRI's position as the sector's own RDE organisation and builds on previous successful multi-year investment agreements.

Further concessional status achieved

The AWRI was granted a charitable exemption under payroll tax legislation in Victoria and Queensland, following a similar exemption in South Australia in the prior year, and is now exempt from such taxes in all states in which AWRI staff are based. The AWRI was also registered with the Australian Charities and Not-for-profits Commission from 1 January 2016.

Implementation of IT Strategic Plan commenced

In late 2015 the AWRI Board approved an IT Strategic Plan that sets out a roadmap for step-changes in IT infrastructure, service delivery and knowledge management within the AWRI. Implementation of that plan, supported by the Strategic IT reserve created in the prior year, is substantially advanced, with many initiatives underway or complete in the areas of desktop and server infrastructure, wireless and wide area networking, software deployment and management solutions, remote access and audio visual technology.

New investment policy

A new investment policy was developed in order to address risks associated with concentration of investments within a single class of assets. This resulted in the appointment of an external investment manager, and the approval and implementation of a conservative investment strategy. The strategy has seen a significant component of the AWRI's reserves invested across a range of new investments, all of which are quoted and actively traded on the Australian Securities Exchange.

Success with Rural R&D for Profit grant applications

Support for two key projects under round two of the Rural R&D for Profit program was welcomed. The first project, *Digital technologies for dynamic management of disease, stress and yield*, is a collaboration between 15 organisations including Wine Australia, the AWRI, CSIRO, University of Queensland, University of Tasmania, the Fraunhofer Institute (Germany) and University of South Australia. The second project, *Mitigation of Climate Change Impacts on the National Wine Industry by Reduction in Losses from Controlled Burns and Wildfires and Improvement in Public Land Management,* is a collaboration between Wine Australia, the AWRI, Agriculture Victoria and LaTrobe University.

Major media coverage achieved through involvement in shipwreck yeast project

AWRI scientists were involved in a collaborative project attempting to isolate yeast from bottles of beer discovered in the shipwreck of the *Sydney Cove* off the coast of Tasmania. This ship was one of the first commercial trading ships to try and reach Sydney but was wrecked in 1797. When the wreck was excavated in 1990, beer bottles were among the artifacts collected. Surprisingly, live yeast were able to be isolated from two samples. Both samples yielded a mixture of *Saccharomyces* and *Brettanomyces* yeast. DNA analysis showed the *Saccharomyces* strain in both samples to be an unusual hybrid that is related to ale yeast. Brewing experiments have shown that it is able to brew beer. The story attracted the attention of ABC science show *Catalyst*, and the AWRI's expertise in yeast genomics was promoted to a mainstream audience when an episode about the project aired in June. The story took a measured approach, because it has never before been demonstrated that yeast cells can survive for hundreds of years, and the only way to definitively rule out sample contamination would be to obtain another bottle from the shipwreck.

60th birthday reviews published

To conclude the AWRI's 60th birthday celebrations, a commemorative issue of the *Australian Journal of Grape and Wine Research* was published in December 2015. It contains 18 review articles authored by AWRI staff on topics including greenhouse gas emissions in viticulture, smoke taint, consumer sensory science, effects of elevated storage temperature on wine and trends in Australian wine composition.

Support for Wine Australia's marketing program

The AWRI is now working closely with Wine Australia on its inbound visitor programs and in-market educational activities. This year, AWRI staff were invited by Wine Australia to participate in the Vinexpo event held in Hong Kong. The AWRI provided a booth with a wine education focus and a masterclass on pepper and spice characters in Australian Shiraz.

ENVIRONMENT AND SUSTAINABILITY

Entwine Australia

The management of Entwine Australia was transferred from WFA to the AWRI in August 2015. A significant body of work was completed to ensure that Entwine is relevant and valuable to members and the broader industry. In early 2016, Entwine received formal endorsement from the peak industry bodies Australian Vignerons, WFA and Wine Australia, and many other industry entities, to be the principal vehicle to convey the Australian wine industry's sustainability credentials.

Biosecurity

The AWRI was engaged by Australian Vignerons to deliver ongoing biosecurity management activities. As a signatory to the Emergency Plant Pest Response Deed, Australian Vignerons has a national responsibility for biosecurity arrangements in the wine sector and undertakes these responsibilities in close association with WFA, Wine Australia, Vine Health Australia and other agricultural industries.

Benchmarking spray practices

In May 2016 a project commenced that will benchmark agrochemical and fertiliser application practices on a regional or climatic basis. Spray diary information for more than 50% of Australia's vineyard area will be analysed, with the data used to raise awareness of issues such as spray efficiency, resistance management and best practice pest and disease control. Findings from the project will be disseminated through the AWRI's workshop program.

Mapping Australia's microbial landscape

More than 100 samples of wild ferments were sourced last vintage from thirty wineries across Australia. Metagenomic analysis will determine both the identity and proportions of yeast and bacteria that were present throughout the fermentation in each of these wines. This represents the first stage of developing a highly detailed map of the microbial landscape of Australia's wine-producing regions.

CONSUMERS, CUSTOMERS AND MARKETS

Understanding wine preferences in emerging markets

The 'discrete choice' method, which is well established for modelling consumer behaviour, was found to be less suitable for consumer research on wine in emerging markets such as China. This finding will help improve the design of future consumer research projects in emerging markets.

Award-winning wine and health paper

A paper authored by the AWRI and collaborators in Italy entitled 'The case for anthocyanin consumption to promote human health: a review' won a Tanner Award for being the most-cited paper published in *Comprehensive Reviews in Food Science and Food Safety* in 2013.

Improvements to the 'Dog book'

Now in its 24th year of production, the publication *Agrochemicals registered for use in Australian viticulture* ('Dog book') continues to underpin best practice in agrochemicals usage and to facilitate the export of Australian wine. This year the 'Dog book' was expanded to include guidelines on the minimum period of time that must elapse between the application of a chemical spray and re-entry of people into the treated area without protective clothing or equipment (known as the 're-entry period').

Regulatory databases expanded

The AWRI's databases *Analytical requirements for the export of Australian wine* and *Permitted additives and processing aids for winemaking and wine importing countries* have been regularly updated. In addition to information for regional trading blocs, the former database now contains information specific to 43 individual countries, and the latter for 22 individual countries.

IMPROVING PRODUCTS AND PROCESSES

Chardonnay reference genome complete

A reference genome for Chardonnay has now been completed for clone I10V1, with the use of new data from a long read PacBio sequencing platform. The next phase of the project is working towards a comprehensive cataloguing of genetic diversity between different Chardonnay clones. Genomic comparisons will initially focus on differences that have potential for use as markers for clonal material in the field. Understanding of the genetic differences among clones will also be combined with knowledge about their different behaviour in the vineyard and winery.

Yeast boosts rose aroma in wine

Novel *Saccharomyces cerevisiae* wine yeast mutants and *Saccharomyces* interspecies hybrids that produce elevated levels of 'rose' aroma compounds 2-phenylethanol and 2-phenylethyl acetate have been generated. A pilot-scale evaluation of the novel strains in Chardonnay was completed successfully, with the wines rated significantly higher in 'floral' aroma and perceived positively by the sensory panel.

'Apricot' flavour in white wine

Combinations of several lactone compounds have been highlighted as contributing to 'stone fruit' characteristics, notably 'apricot', in Viognier and Chardonnay wines. Further work will assess how these compounds are formed in wine.

'Struck flint' flavour in premium Chardonnay

The volatile compound benzyl mercaptan, also known as benzene methanethiol, was found to give a 'struck match', 'flint' or 'mineral' aroma to Chardonnay, with results also showing that premium Chardonnay wines from cooler regions and with some bottle age tend to have a higher concentration of this compound.

Rotundone across a vineyard is highly variable but spatially structured

The spatial pattern in berry concentration of the 'pepper' flavour compound rotundone across a premium Shiraz vineyard in the Grampians was found to be very similar across multiple seasons, strongly suggesting that topographic differences may influence rotundone formation together with seasonal climatic effects.

'Green' flavour in Shiraz wine can be caused by the inclusion of stalks in a ferment, but grape leaves have little effect

Trials suggest that grape leaves added to must have no effect on 'green' flavour of a cool climate Shiraz wine and can enhance fruit flavour, while the addition of stalks gives a substantial increase in 'vegetal' aroma and flavour and results in increased astringency and tannin.

'Smart surfaces' allow a novel approach to protein stabilisation

A novel magnetic separation technology for selective removal of pathogenesis-related proteins from wine was developed. The surface of magnetic nanoparticles was functionalised to selectively bind and remove pathogenesis-related proteins from wine, leading to protein stabilised wine. The particles and bound proteins were easily separated from wine by applying an external magnetic force, while leaving wine phenolic content unchanged.

Practical objective measures of grape grading models developed

By measuring a range of chemical compounds or spectral fingerprints in multiple grape batches of different grades of Cabernet Sauvignon, Shiraz and Chardonnay, relatively simple and practically adoptable analytical grape grading tools are achievable.

Impacts of oxygen in white wine production can be positive

In continuing work on the effects of oxygen during winemaking, oxygen concentration in Chardonnay must at the time of inoculation was found to have no impact on fermentation duration or the concentration of yeast-derived aroma compounds in wine. However, aeration of fermentation later than typical practice still had a stimulatory effect on fermentation performance without negative consequences for wine sensory attributes. This suggest that, if required (e.g. for stimulation of a sluggish/stuck ferment), the use of oxygen outside the previously defined narrow window (24-72 hours post-inoculation) can be considered beneficial for ferment performance with limited risk to sensory outcomes.

A sparkling performance by interspecific hybrid wine yeast

Following successful applications in production of red and white table wines, AWRI-generated interspecific hybrid wine yeasts are now also finding a place in sparkling wine production. Sparkling wines produced with hybrid yeast in ongoing collaborative trials with Yalumba and, over the past year, with Plumpton College (UK) were showcased at a workshop held at the International Cool Climate Symposium. An informal vote of the 125 attendees at the workshop indicated that hybrid-made sparkling wines were preferred over those made using an industry standard sparkling wine yeast.

Managing the impacts of copper on the formation of hydrogen sulfide in wine

As the risks of residual copper causing reductive characters in packaged wine are becoming increasingly apparent, trials have been completed to look at ways to manage residual copper once it has been added to wine. One practical solution is to bind copper to chelating compounds that either remove it from the wine matrix or chemically mask it, so that the copper can no longer participate in the formation of reductive characters. Addition of a commercial polyphenol extract suppressed H_2S formation after one year. EDTA, a common chelation agent used in food production, also proved effective, suggesting that various metal chelation environments within a wine can have a significant effect on limiting H_2S generation.

JENNIFER O'MAHONY AND DEBORAH THORNTON-WAKEFORD

Authenticity pilot study successful

Strontium isotope ratios combined with trace metal concentrations were able to differentiate Australian wines from those produced overseas. This combination of analytes also had potential for identifying region of origin of Australian wines. Next steps of this research will examine the isotope ratios of other metals, such as boron, lithium and lead as well as stable isotopes associated with water, for use as origin markers.

In-mouth flavour release

Experiments showed that detectable monoterpenes are released *in vitro* through interaction of saliva with glycosides. Up to 80% release of monoterpenes was achieved during incubation of glycosides isolated from wine with saliva. When glycosides were tasted in-mouth, monoterpenes were also detected using an expired air trapping method. The ability of an individual's saliva to break down the glycosides appeared to be quite consistent but varied significantly across different individuals, in line with previous work on volatile phenol glycosides. This highlights that flavour released in-mouth from glycosides may contribute to differences in perception of wine among individual consumers.

Biosynthesis of raspberry ketone

As part of the synthetic biology project, a *Saccharomyces cerevisiae* strain has been developed with new metabolic pathways to enable the biosynthesis of the aroma compound raspberry ketone. Raspberry ketone is the primary aroma compound found in raspberries and naturally derived raspberry ketone is a valuable flavouring agent.

Polysaccharides affect red wine mouth-feel

Whole polysaccharides were extracted from a red wine and fractionated into three molecular weight fractions using preparative size exclusion chromatography. Sensory assessment of the fractions in model wines showed that alcoholic hotness was reduced by medium molecular weight red wine polysaccharides. This result was consistent with earlier work on white wine polysaccharides.

Stress-tolerant MLF strains identified

One hundred and sixty-nine wine bacteria from the AWRI Wine Microorganism Culture Collection were characterised by genomic (DNA) sequencing and a sub-group of these was screened at laboratory-scale for tolerance to stresses encountered when grown in red, white and sparkling base wines. Thirteen genetically distinct stress-tolerant strains were identified. Novel Australian *O. oeni* isolates identified from this project are candidates for development as starter cultures, as these strains are predicted to perform well in Australian winemaking conditions and, because their provenance is known, they have the potential to contribute to regional identity of wines.

Sulfite tolerance of *Brettanomyces* can increase over time

Several *Brettanomyces* strains that differ in their inherent tolerance to sulfite have been exposed over several months to increasing concentrations of sulfite. In each case, some cells have been able to grow at sulfite concentrations greater than the original parent strain could tolerate. This observation demonstrates the need to future-proof Australia's *Brettanomyces* control strategy, especially in view of market pressures seeking to minimise the concentration of sulfite in wine.

EXTENSION AND ADOPTION

Helpdesk queries answered

Helpdesk team members responded to 2,092 technical queries on a range of winemaking, viticulture and regulatory topics, with more than 80% answered within 24 hours. A compressed vintage and above average yields were two of the main themes that wineries had to deal with in 2016.

Winemaking investigations

A total of 1,291 individual samples were submitted and analysed as part of 247 investigations carried out during the year. The number of investigations was more than 20% higher than the previous year, with the increase a result of a higher number of sensory and taint/contamination investigations.

Wide range of events delivered

AWRI staff were involved in organising 73 events during 2015/2016. These included roadshow seminars and workshops, greenhouse gas mitigation workshops, tailored sensory training events, a field day and the Advanced Wine Assessment Course. Of these, the Victorian node delivered 11 events across Victoria, featuring topics including trunk disease, future vineyard management practices, phylloxera, smoke taint and soil management, in partnership with Wine Victoria and the regional grape and wine industry associations across Victoria.

Adoption of climate change information

An independent report assessed the level of adoption of information provided through Extension and Outreach workshops. A key finding was that 85% of workshop participants were positively influenced and increased their knowledge about the impacts of climate change on the grape and wine sector. In addition, 80% of workshop participants discussed the workshop content with other attendees and shared it more widely within their networks, including using the information to provide advice and to support business decisions.

Electronic scoring at AWAC

Electronic scoring software was successfully integrated into the Advanced Wine Assessment Course, improving the efficiency of the course and the experience for participants. This software is being developed further so that it can be used by wine shows.

NSW weather station network expanded

In 2015/2016, 22 weather stations were added to the online network available via the AWRI website, bringing the total number of weather stations to 32. NSW grapegrowers and winemakers have around-the-clock access to a range of weather data including air temperature, soil temperature, rainfall, wind speed, wind direction and frost hours. More enhancements and weather stations are planned for 2016/2017.

John Fornachon Memorial Library

The library collection now includes more than 86,350 items. During 2015/2016, the library responded to over 1,500 reference enquiries and delivered 2,138 journal articles.

Preparations for the 16th AWITC

The AWRI was heavily involved in preparations and logistics for the 16th Australian Wine Industry Technical Conference, with staff contributing to conference management, communications, the executive and planning committees, the poster display and the workshop program.

Webinars continued

The AWRI's fifth webinar series was held during the year, featuring 23 webinars with more than 440 attendees. Approximately half of the webinars were delivered by AWRI staff and half by invited researchers and industry experts.

In-person interactions

Throughout the year AWRI staff gave 449 external presentations, coordinated 73 events, authored 8 posters, conducted 60 media interviews, presented 22 lectures to university students and supervised or co-supervised 12 students.

Peer-reviewed publications

AWRI staff authored 54 peer-reviewed papers for scientific journals, including the paper 'Effect of oxygen exposure during fermentation on volatile sulfur compounds in Shiraz wine and a comparison of strategies for remediation of reductive character' which won the ASVO prize for best oenology research paper published in the *Australian Journal of Grape and Wine Research*.

Industry publications

Six AWRI reports and six columns on alternative varieties were published in the *Wine and Viticulture Journal*. Twelve 'Ask the AWRI' columns covering topical issues from the AWRI helpdesk were published in the *Australian & New Zealand Grapegrower & Winemaker*. New technical literature published from around the world was abstracted in six issues of *Technical Review*. Grapegrowers and winemakers were alerted to topical issues in 18 *eBulletins* issued through the year. Updates of AWRI activities were provided in six issues of *eNews*, emailed directly to producers.

Social media engagement built

The AWRI's presence on Twitter grew by more than 270 to 3,093 during the year.

SERVICE CAPABILITIES AND FOUNDATIONAL DATASETS

Analysis record for AWRI Commercial Services

In 2015/2016 the Commercial Services laboratories processed more than 23,000 samples, an increase of 2% over the previous record year.

New metal analysis available

AWRI Commercial Services can now offer analysis for 23 different metals of interest to the wine community using the new ICP-MS instrument installed late last year.

Faster testing for *Brettanomyces*

Testing for the presence of *Brettanomyces* in wine has significantly improved, with Commercial Services now offering a 48-hour turnaround time using new molecular biology techniques, compared to 10 days using traditional plating.

Continued growth in Metabolomics capabilities

The SA Metabolomics Facility completed a record 37 projects during 2015/2016, with more than 50% conducted for new external clients. Seven new analytical methods were developed including an innovative HPLC-MS method to quantify carotenoids, xanthophylls and their metabolites in grapes. The efficiency for processing untargeted metabolomics data collected by GC-MS and LC-MS platforms was significantly improved through the development of an automated data analysis workflow which enables approximately five times faster turn-around times of metabolite data compared to manual annotation.

Share in new PacBio Sequel instrument

The AWRI has committed to invest in a next generation sequencer, PacBio Sequel. This innovative sequencing system will support the AWRI's projects requiring high-quality whole genome *de novo* assemblies (e.g. for grapevine, yeast and bacteria), and the detection of genomic variation in complex populations.

WIC Winemaking Services

WIC Winemaking has had a second vintage in a row exceeding 400 ferments. The service has purchased a range of new kegs and a small-scale crossflow filter that will enable process improvements for the coming vintage.

Smoke taint background study

The AWRI's 'smoke taint background levels database' will be expanded to include five additional grape varieties. This will assist helpdesk staff in interpreting analytical results from samples suspected of smoke exposure.

Readers are strongly encouraged to read the annual report in detail rather than relying on the brief details above for information.

Acknowledgements

Edited by Ella Robinson and Dan Johnson

Compilation assistance from Annette Freeman, Chris Day, Shiralee Dodd and Alfons Cuijvers

Design by Geoffrey Reed Communications

Photography by Jacqui Way Photography

MICHAEL ROACH

STATUS OF PROJECTS IN THE AWRI'S 5-YEAR RDE PLAN

	Project	Status at 30 June 2016
Theme 1: Environment and sustainability		
1.1 Reduce inputs and environmental footprint across the value chain	1.1.1 Improving winery energy efficiency	Active
	1.1.2 Capitalising on the carbon economy	Active
	1.1.3 Improving the environmental and economic performance of the Australian wine supply chain	Active
	1.1.4 Assisting industry to adopt renewable energy technologies	Inactive
1.2 Capture the full value of clonal resources for key Australian varieties	1.2.1 Assessing diversity and clonal variation of Australia's grapevine germplasm	Active
1.3 Reduce the economic and environmental impact of pests and diseases and the techniques used to manage them	1.3.1 Understanding genetic variation in grapevine diseases and the genetic basis for pesticide resistance	Active
	1.3.2 Improving the consistency of description and measurement of disease	Inactive
	1.3.3 Regional benchmarking of viticultural spraying practices	Active
Theme 2: Consumers, customers and markets		
2.1 Identify and secure new market opportunities through consumer insights	2.1.1 Identifying and securing new market opportunities through consumer insights	Active
	2.1.2 Genetics of odour perception and wine preferences	Inactive
2.2 Build and safeguard brand Australia	2.2.1 Collecting and disseminating information regarding agrochemicals registered for use and maximum residue limits in Australian viticulture	Active
	2.2.2 Origin verification and detection of counterfeit Australian wines	Active
	2.2.3 Informing wine consumers through understanding issues of wine consumption, health and nutrition	Active
	2.2.4 Increasing Australia's influence in market access, safety, regulatory and technical trade issues	Active
2.3 Improve market access through anticipation and removal of trade barriers and regulatory constraints	2.3.1 Emergency response capability	On hold
Theme 3: Improving products and processes		
3.1 Objective measurement and target setting of grape and wine style	3.1.1 Identification and origin of volatile compounds responsible for important sensory attributes	Active
	3.1.2 Assessment of relationships between grape chemical composition and grape allocation grade	Active
	3.1.3 Flavour precursors: contribution to wine aroma, in-mouth sensory properties and flavour release	Active
	3.1.4 Factors affecting wine texture, taste, clarity, stability and production efficiency	Active
3.2 Optimise primary and secondary fermentation for effective production of targeted wine style	3.2.1 Are there regional micro-organisms, and can they be harnessed to produce regionally distinct wine styles?	Active
	3.2.2 Enhanced winemaking outcomes and wine style diversification through provision of fit-for-purpose yeast starter cultures	Active
	3.2.3 Defining the nutritional drivers of yeast performance and matching yeast to must	Active
	3.2.4 Efficient and reliable malolactic fermentation to achieve specification wine style	Active
	3.2.5 Safeguarding and realising the potential of the Australian wine microbial germplasm collection	Active

	Project	Status at 30 June 2016
3.3 Novel products and effective processes	3.3.1 Technologies and strategies for the production of lower alcohol wine	Active
	3.3.2 Influencing wine style through management of oxygen during winemaking	Active
	3.3.3 Capturing and re-using aroma compounds entrained in fermentation gases	Inactive
	3.3.4 Developing simplified sparkling winemaking processes which reduce production costs while replicating the flavour and textural properties of wines produced using traditional methods	Inactive
	3.3.5 Development and application of process analytical technologies for effective winemaking process control	Inactive
	3.3.6 Producing less processed, allergen-label-free, wines	Inactive
3.4 Reduce cost of production	3.4.1 Novel products utilising existing winery capital equipment, surplus grapes and winery waste	Active
	3.4.2 Reducing wine movements during production	Active
	3.4.3 Evaluating alternatives to barrel maturation	Active
	3.4.4 Identifying cost reduction opportunities by mapping the grape and wine value stream	Active
3.5 Reduce the economic impact of taints and faults	3.5.1 Fault and taint remediation strategies and technologies	Active
	3.5.2 Ensuring the continued efficacy of *Brettanomyces* control strategies for avoidance of spoilage	Active
	3.5.3 Formation and fate of positive and negative sulfur compounds	Active
3.6 Deliver sound product to the marketplace	3.6.1 Maximising quality during bulk wine transport	Active
Theme 4: Extension and adoption		
4.1 Drive productivity, sustainability and profitability through facilitating rapid adoption of R&D outcomes	4.1.1 The staging and conduct of extension programs	Active
	4.1.2 Specialised technical troubleshooting and responsive helpdesk services for the Australian wine sector	Active
	4.1.3 Library service	Active
	4.1.4 Communication with stakeholders	Active
	4.1.5 Development of web and mobile-based extension tools	Active
4.2 Align supply chains with industry needs	4.2.1 Evaluating and enabling adoption of new technologies	Active
4.3 Enhance national outreach and promote regional engagement	4.3.1 Tailored regional research, development, adoption and extension through regional nodes	Active
4.4 Improve intellectual capital available to the Australian wine industry	4.4.1 Contributing to undergraduate and postgraduate education programs of relevance to the Australian wine industry	Active
Theme 5: Service capabilities and foundational datasets		
5.1 Service capabilities and foundational datasets	5.1.1 Enhancing data capture and integration for re-use and data mining	Active
	5.1.2 Chemistry, sensory, chemometrics and development capacity	Active
	5.1.3 Efficient management and administration	Active
	5.1.4 International scientific exchange program	Active

STAFF

The actual number of AWRI staff employed in a full-time, part-time and casual capacity as at 30 June 2016 was 123 (96.0 full-time equivalents). When the number of AWRI-based students (both from Australia and overseas) and visiting researchers is added, the total increases to 131. Of these, approximately 65% were funded by Wine Australia in 2015/2016.

Office of the Managing Director

Dan Johnson, BSc (Hons), PhD *Flinders*, MBA *UniAdel*, GAICD, Managing Director

Vince O'Brien, BE (Chem) (Hons) *UniAdel*, PhD *UniQld*, General Manager Business Development

Ella Robinson, BA, BSc (Hons) *UniAdel*, Communication Manager

Shiralee Dodd, BA, LLB (Hons) *UniAdel*, Executive Officer and Company Secretary

Gregoire Patacq, MEngAgron *Purpan Engineering School France,* Adv Master Strategic Mgt Int Bus *ESSEC Singapore,* Scientist (started 4 January 2016)

Annette Freeman, DipBusAdmin *Upskilled*, Executive Assistant to the Managing Director

Sarah Ballantine, BSc (Hons) (Chem) *UniAdel*, Wine Innovation Cluster Executive Officer (started 29 April 2016)

Corporate Services

Chris Day, BAgSc (Oen), MBA *UniAdel*, Grad Chartered Accounting Foundations *Deakin*, CA, Group Manager – Corporate Services

Mark Braybrook, Cert IV Eng/Mech Trade *TAFE*, Operations Manager

Kate Beames, AWITC Conference Manager

Andrea Francis, BSc *UniWA*, GradDip (EnvSci) *Murdoch,* AWITC Conference Secretariat

Adam Holland, Cert IV IT *NTUni*, IT Manager

Alfons Cuijvers, MLaw *UniAntwerp*, Human Resources Coordinator

Catherine Borneman, BBus (Acc) *RMIT*, CA, Accountant

Fang Tang, Undergrad (Foreign Econ) *RenminUniChina*, GradDip (FinMgt), MCom *UniNewEng*, Finance Officer

Pauline Jorgensen, Cert III (Bus Admin) *TAFE SA*, Finance Officer

Kylee Watson, Cert III (Fin Services) *TAFE SA*, Finance Officer (started 17 August 2015)

Deborah Thornton-Wakeford, Receptionist

Jennifer O'Mahony, Receptionist

Research

Markus Herderich, staatlich geprüfter Lebensmittelchemiker (CertFoodChem), PhD *UniWürzburg*, Group Manager – Research

Anthony Borneman, BSc (Hons), PhD *UniMelb*, Principal Research Scientist – Molecular Biology

Paul Chambers, BSc (Hons), PhD *UniHertfordshire*, Research Manager – Biosciences

Chris Curtin, BSc (Hons), PhD *Flinders*, Research Manager – Biosciences

Leigh Francis, BSc (Hons) *Monash*, PhD *UniAdel*, Research Manager – Sensory and Flavour

Yoji Hayasaka, DipEng (Ind Chem) *Tokyo IT*, MPharm *Victorian College of Pharmacy Monash*, PhD *Yamanashi*, Senior Research Scientist – Mass Spectrometry

Paul Henschke, BSc (Hons), PhD *UniAdel*, Emeritus Fellow

Paul Smith, BSc (Hons), PhD *Flinders*, Research Manager – Chemistry

Eveline Bartowsky, BSc (Hons), PhD (Microbiol) *UniAdel*, Senior Research Scientist – Microbiology

Keren Bindon, BSc (Hons) (Biol) *UniNatal*, MSc (Plant Biotechnol) *UniStellenbosch*, PhD (Vitic) *UniAdel*, Senior Research Scientist

Simon Schmidt, BSc (Hons), PhD *Flinders*, Senior Research Scientist

Cristian Varela, BSc (Biochem), MSc (Biochem), PhD (Chem Eng and Bioprocesses) *CatholicUniChile*, Senior Research Scientist

Marlize Bekker, BSc (Ind Chem), BSc (Hons), M (Chem), PhD *Stellenbosch*, Research Scientist

Cory Black, BSc (Hons), PhD (Chem) *UniOtago*, Research Scientist

Dimitra Capone, AssDip (Chem), BAppSc (Chem) *UniSA*, PhD *UniAdel,* Research Scientist

Peter Costello, BSc (Hons), MSc *UniNSW*, PhD *UniAdel*, Research Scientist

Wies Cynkar, BSc, PhD *Wroclaw*, Research Scientist

Toni Garcia Cordente, BSc (Chem), BSc (Biochem), PhD (Biochem and Mol Biol) *UniBarcelona*, Research Scientist

Martin Day, BSc (Hons) *UniSussex*, PhD *UniNantes*, M.Oen *UniAdel*, Research Scientist

Richard Gawel, BSc, Grad DipEd, *UniAdel,* GradDip (Oen) *Roseworthy*, Research Scientist

Josh Hixson, BTech, BSc (Hons) *Flinders*, PhD *UniAdel*, Research Scientist

Jacqui McRae, BSc (Env Mgt) *Victoria*, BSc (Hons) (Biotechnol), PhD (Nat Prod Chem) *Swinburne*, Research Scientist

Agnieszka Mierczynska-Vasilev, MSc, PhD, *UniLodz*, Research Scientist

Mark Smith, BSc (Hons), PhD *UniAdel*, Research Scientist

Darek Kutyna, MSc *AgUniPoland*, PhD *Victoria*, Post Doctoral Research Fellow

Michael Roach, BBiotech (Hons), PhD *Flinders*, Post Doctoral Research Fellow (started 29 February 2016)

Mango Parker, BSc (Chem) *Flinders*, Senior Scientist

Wes Pearson, BSc (Wine Biochem) *UniBritishColumbia*, Grad Cert Appl Sensory Sci and Consumer Testing *UC Davis*, Senior Scientist

Tracey Siebert, ScTechCert (Chem) *SAIT*, BSc *UniAdel*, Senior Scientist

Patricia Williamson, BSc (Food Eng) *StateUniCampinas*, MSc (Food Sci) *Unilllinois*, Grad Cert Appl Sensory Sci and Consumer Testing *UC Davis*, Senior Sensory Scientist

Sheridan Barter, BTech (Foren and Analyt Chem), BSc (Hons) *Flinders*, Scientist

Jenny Bellon, BSc (Biochem and Genetics) *UniAdel*, Scientist

Stella Kassara, BSc (Hons) *UniAdel*, Scientist

Alex Schulkin, BSc, *Bar-Ilan*, GradDip (Oen) *UniAdel*, Scientist

Mark Solomon, BSc (Med Chem) (Hons) *Flinders*, Scientist

Peter Sternes, BBiotech (Hons), PhD *UniQld*, Bioinformatician

Angus Forgan, BSc (Hons) *Flinders*, Research Laboratory Manager

Alice Barker, BAppSc (Hons), *UniOtago*, Technical Officer

Caroline Bartel, BSc (Biotech) (Hons) *UniAdel*, Technical Officer

Simon Dillon, BSc (Hons) *Flinders*, Technical Officer

Stephen Johnson, BSc (Hons) (Mol Cell Biol) *UniAdel*, Technical Officer (started 18 April 2016)

Charlotte Jordans, BAg, MSc (Agronomy) *UniCopenhagen*, Technical Officer (started 20 June 2016)

Radka Kolouchova, AssDip *TechCollFoodTech*, Technical Officer

Danna Lee, BSc (Mol Bio), BSc (Hons) *UniAdel*, Technical Officer (concluded 10 February 2016)

Jane McCarthy, Cert (Anim Hand), Cert (Vet Nurs) *TAFE SA*, AdvCert (Med Lab Sc) *UniSA*, Technical Officer

Joanna Verwey, Dip (Lab Tech) *TAFE*, Technical Officer

Jelena Jovanovic, Purchasing Officer

June Robinson, Laboratory Assistant

South Australian Metabolomics Facility

Natoiya Lloyd, BSc (Hons) *Flinders*, PhD *UniAdel*, Research Scientist

Jeremy Hack, Bioinformatician (concluded 8 December 2015)

Esther Kristianto, BSc (App Chem) *UniTechSydney*, Technical Officer

Vilma Hysenaj, BSc, Master (Pharm Chem), PhD (Food Chem) *UniGenova,* Post Doctoral Research Scientist

Casual Sensory Panel

Sara Davis, Penelope Elliot, Josephine Giorgio-Ion, Philippa Hall, Sonya Henderson, Caroline Holmstrom, Gurinder Khera, Mary Likos, Catherine Milne, Ralph Osborne, Luke Ramsden, Vivianne Rees, Sue Robinson, Loretta Royal, Kari Shorter, Heather Smith, Peter Tymukas, Sarah Young

Industry Development and Support

Con Simos, BAppSc (Oen) *UniAdel*, MBA *UniSA*, Group Manager – Industry Development and Support

Peter Dry, BAgSc, MAgSc, PhD *UniAdel*, Emeritus Fellow

Paul Petrie, BHortSc (Hons), PhD *Lincoln*, Viticulture Scientist (started 2 February 2015)

Linda Bevin, BBus (Info Mgt), GradDip (Lib and Info Stud) *QUT*, Information and Knowledge Manager

Adrian Coulter, BSc *Flinders*, GradDip (Oen) *UniAdel*, Senior Oenologist

Mark Krstic, BAgSc (Hons), PhD *UniTas*, MBA *MelbBusSchool*, Victorian Node Manager

Creina Stockley, BSc (Hons) *UniAdel*, MSc, PhD *Flinders*, MBA *UniSA*, Health and Regulatory Information Manager

Geoff Cowey, Dip *WSET*, BAppSc (Wine Sci) *CSU*, BSc (Hons) *UniAdel*, Senior Oenologist

Matt Holdstock, BSc *Flinders*, GradDip (Oen) *UniAdel*, Senior Oenologist

John Gledhill, BAppSc (Wine Sci and Vitic) *CSU*, Winemaker (started 27 July 2015)

Marcel Essling, BBus *Victoria*, BAgSc *UniAdel*, Senior Viticulturist

Mardi Longbottom, BAgSc, MVit, PhD, *UniAdel*, Senior Viticulturist

Gayle Baldock, BSc (Hons) *UniGuelph*, Scientist

Francesca Blefari, BBus *UniEdithCowan,* Events and Projects Manager

Anne Lord, GradDip (Info Stud) *UniSA*, Librarian

Michael Downie, BA (Hons) *UniAdel*, GradDip (Lib and Info Mgt) *UniSA*, Library and Information Services Coordinator

Virginia Phillips, Events and Projects Coordinator

Maria Calabrese, Events and Projects Administrator (started 6 July 2015)

Industry Engagement and Application

Peter Godden, BAppSc (Wine Sci) *UniAdel*, Manager – Industry Engagement and Application

Commercial Services

Eric Wilkes, BSc (Hons) (Chem), PhD *UniNewcastle*, Group Manager – Commercial Services

Neil Scrimgeour, BSc (Hons) (App Chem) *Wolverhampton*, Senior Project Scientist

Leanne Hoxey, BSc *UniAdel*, Quality Systems and Laboratory Manager

Randell Taylor, BSc (Hons) *UniAdel*, Manager Trace Laboratory

Karl Forsyth, BE (Hons) (Chem), BEc *UniAdel*, Senior Engineer (concluded 29 January 2016)

Simon Nordestgaard, BEc, BE (Hons) (Chem), PhD *UniAdel*, Senior Engineer

Amy Rinaldo, BSc (Hons) (Biotech) *Flinders*, PhD *UniAdel*, Project Scientist (started 16 November 2015)

Tina Tran, BSc (Microbiol and Biotech), BSc (App Biol) (Hons), PhD *Victoria*, Research Scientist (concluded 21 October 2015)

Tadro Abbott, BE (Hons) (Chem) *UniAdel*, Project Engineer

Kieran Hirlam, BE (Hons) (Chem), BFin *UniAdel*, Project Engineer

Pamela Solomon, BTech (Foren and Analyt Chem), BInnovationEnterprise (Sci and Tech) *Flinders*, Scientist

Heather Tosen, BSc *UniAdel*, Scientist

Bryan Newell, BAppSc (Chem and Physics) *UniSA*, Senior Laboratory Technician

Melissa Aitchison, BAgSc (Oen) *UniAdel*, Laboratory Technician

Elyce Batchelor, DipFoodTechnol, Cert II Food Processing *TAFE*, Laboratory Technician

Erin Kearsley, BTech *Flinders*, Laboratory Technician (concluded 8 April 2016)

Oliver Lovat, BTech (Foren and Analyt Chem) *Flinders,* Laboratory Technician (concluded 24 June 2016)

Candice Newton, Cert II Sampling and Measuring, Cert III Lab Operations, Cert IV OHS *TAFE SA*, Laboratory Technician (concluded 3 July 2015)

Kerry Pinchbeck, BSc (Medicinal Chem) *Flinders*, PhD (Wine Chem) *UniAdel*, Laboratory Technician

Tim Reilly, BSc (Hons) (Nanotechnol) *Flinders*, Laboratory Technician

Marco Schoeman, BSc (Biotechnol) *UniAdel*, Laboratory Technician

Matthew Wheal, BSc (Hons) (Biology), PhD *UniAdel*, Laboratory Technician (started 18 January 2016)

Brigitte Lynch, MBA *Australian Institute of Business*, Customer Relations Supervisor (started 6 June 2016)

Jillian Lee, Customer Service Officer (started 20 July 2015)

Robyn Gleeson, Customer Service Officer

Alana Spears, Cert II (Hosp Op) *TAFE SA*, Cert IV (Japanese Lang) *VLLC*, Customer Service Officer

Students

Yevgenia Grebneva, *TechUniDresden, Germany*, occupational trainee (20/4/2015-30/10/2015)

Neele Glameyer, *Rheinische Friedrich-Wilhelms-Universität Bonn, Germany*, occupational trainee (8/10/2015-6/4/2016)

Kathrin Vollmer, *UniHohenheim, Germany*, occupational trainee (3/8/2015-3/4/2016)

Pierre Boyer, *Ecole Superieure d'Ingenieurs Reunion Ocean Indien*, visiting student (27/4/16-27/8/16)

Lisa Hartmann, *UniAdel*, PhD student

Jing Wu, *UniBordeaux, France*, PhD student (3/1/2016-1/6/2016)

Ryan Zeppel, *UniAdel,* PhD student

Visiting Researchers

Federica Blando, *Institute of Sciences of Food Production (CNR), Lecce, Italy* (1/6/15-10/10/15)

Nadine Jaeckels, *Johannes Gutenberg Universität, Mainz, Germany* (7/9/15-7/12/15)

STAFF ACTIVITIES

Tadro Abbott is a member of the Entwine Reference Group and Entwine Technical Subcommittee.

Alice Barker is a committee member of the SA Branch of the Australian Institute of Food Science and Technology.

Eveline Bartowsky serves on the Joint Editorial Board of the *Journal of Applied Microbiology* and *Letters in Applied Microbiology.* She is an Associate Editor of the *American Journal of Enology and Viticulture* and the *Australian Journal of Grape Wine Research* and an editor of *Annals of Microbiology.* She also serves on the Editorial Review Board of the *Journal International des Sciences de la Vigne et du Vin* journal. Eveline is an Affiliate Lecturer, University of Adelaide and a member of the Australian Wine Industry Technical Conference Planning Committee.

Paul Chambers was coordinator of the Australasian Yeast Group (through its homepage at http://www.ayeastgroup.org/). He is a member of the Editorial Board of *Microbial Cell.* Paul was also Chair of the Organising Committee for the Yeast: Products and Discovery conference held in Adelaide in December 2015 and was a member of the organising committee for Bioflavour 2015, International Conference on Flavour and Fragrance Biotechnology held in Frankfurt, Germany in September 2015.

Chris Curtin is an Adjunct Senior Lecturer, University of Tasmania, and an Associate Editor of *Journal of the Science of Food and Agriculture.*

Chris Day is a Chartered Accountant and a Director, Treasurer and Public Officer of the Australian Wine Industry Technical Conference.

Martin Day is a Chartered Chemist and member of the Royal Society of Chemistry (UK), and is a member of the editorial board of the Atomic Spectrometry Updates, published in the *Journal of Analytical Atomic Spectrometry.*

Peter Dry is an Adjunct Associate Professor, University of Adelaide, and Associate Editor of the *Wine and Viticulture Journal.*

Angus Forgan is a member of the South Australian Institutional Biosafety Committee Network Forum.

Leigh Francis is an Associate Editor of the *Australian Journal of Grape Wine Research*; a member of the Editorial Board of the *Journal of the Science of Food and Agriculture*; an Affiliate Lecturer at the University of Adelaide; and an Adjunct Senior Research Fellow at the University of South Australia.

Peter Godden is an Ex-Officio Councillor of the Royal Agricultural and Horticultural Society of South Australia, and participated as a steward at the Royal Adelaide Wine Show. He also acted as a panel chair at the Barossa Wine Show.

Paul Henschke is an Associate Editor of the *Australian Journal of Grape and Wine Research,* and is a member of the Editorial Review Boards of *Food Microbiology* and *Mitteilungen Klosterneuburg.* He is an Affiliate Professor of the University of Adelaide and Fellow of the Australian Society for Viticulture and Oenology. He was member of the Organising Committee of the Yeast: Products and Discovery conference held in Adelaide in December 2015. He was an invited speaker and served as session co-organiser and poster judge at the 9th International Cool Climate Wine Symposium held in Brighton, England in May 2016.

Markus Herderich is a Director of the Australian Wine Industry Technical Conference; member of the Metabolomics Australia Executive Management Group; and member of the Wine Innovation Cluster Research Group. He is also an Affiliate Associate Professor, University of Adelaide; a member of the Policy Advisory Board of the *Journal of Agricultural and Food Chemistry;* a member of the Winemakers' Federation of Australia Wine Industry Technical Advisory Committee; a delegate and expert for the Organisation International de la Vigne et du Vin; and a co-organiser of the symposium *Advances in functional food and flavor chemistry* at Pacifichem 2015.

Leanne Hoxey is a member of the Interwinery Analysis Group committee.

Dan Johnson is Chair of the Australian Wine Industry Technical Conference; Honorary Adjunct Professor at Macquarie University; and a Director on the National Wine Foundation Board. He is a member of the International Scientific Board of L'Institut des Sciences de la Vigne et du Vin, Bordeaux; the Winemakers' Federation of Australia Innovation Policy Committee; the *Australian Journal of Grape and Wine Research* Advisory Committee; the *World of Fine Wine* Editorial Board; the Wine Innovation Cluster Leadership Group; the Waite Strategic Leadership Group; the Interim Governance Committee of the South Australian Food Innovation Centre; and the National Wine Sector Research, Development and Extension Implementation Committee. Dan is a graduate of the Harvard Business School Authentic Leadership Development program; the INSEAD Blue Ocean Strategy program; the IESE Creative Negotiation program; and the Australian Wine Industry Future Leaders Program.

Mark Krstic is a member of the Victorian Government's Wine Ministerial Advisory Committee; member of Horticulture Innovation Australia's Table Grape Strategic Investment Advisory Panel; member of the National Wine Extension and Innovation Network; member of the National Wine Research Network; Associate Editor of *Wine and Viticulture Journal*; Honorary Senior Fellow at the University of Melbourne; Coordinator of the Victorian Viticultural Association; and member of the Australian Wine Industry Technical Conference Planning Committee.

Natoiya Lloyd is a member of the Metabolomics Conference 2017 organising committee.

Matt Holdstock is a Director of the Australian Society of Viticulture and Oenology.

Mardi Longbottom is a Visiting Research Fellow of the University of Adelaide; President of the Australian Society of Viticulture and Oenology; member of the Executive Committee of Australian Vignerons; member of the Wine Grape Council of South Australia; member of the Limestone Coast Grape and Wine Council; member of the Limestone Coast Grape and Wine Council Technical Subcommittee; member of the Winemakers' Federation of Australia Innovation Policy Committee; member of the Environmental Technical Committee of Freshcare Australia; Fellow of the Governor's Leadership Foundation Program; and a member of the Australian Wine Industry Technical Conference Planning Committee.

Agnieszka Mierczynska-Vasilev is a member of the Australia-China NanoNetwork, an initiative of the Australian Technology Network of Universities and the International Strategic Technology Alliance.

Vince O'Brien is a member of the Winery Engineering Association Conference Planning Committee; the Winemakers' Federation of Australia Wine Industry Packaging Committee; CSIRO's Adaptive Value Chains Project Advisory Group; PIRSA's functional and luxury value chains advisory group; the SARMS Food Loss and Industry Waste Transformation Project Advisory Committee and participant on the South Australian Food Innovation Centre Interim Governance Committee.

Wes Pearson is a committee member of the McLaren Vale Wine Show and the McLaren Vale Districts Group and participated as a judge at the Australian Small Winemakers Show and as an associate judge at the Royal Adelaide Wine Show and Sydney Royal Wine Show.

Paul Petrie is a member of the *Australian Journal of Grape and Wine Research* Journal Advisory Subcommittee; a member of the Australian Wine Industry Technical Conference Planning Committee and Chair of the Charles Sturt University wine industry course advisory committee.

Ella Robinson is a member of the Australian Wine Industry Technical Conference Planning Committee, a member of the Communications Working Group for the South Australian Food Innovation Centre and a committee member for the SA Chapter of Wine Communicators of Australia.

Con Simos is Chair of the National Wine Extension and Innovation Network; board member of Wine Communicators of Australia; member of the Australian Wine Industry Technical Conference Planning Committee; member of the Wine Strategy Implementation Committee; member of the WA Wine Industry Association R&D Committee; and graduate of the Australian Wine Industry Future Leaders Program.

Creina Stockley is an Affiliate Senior Lecturer, University of Adelaide. She is a member of the Winemakers' Federation of Australia Wine Industry Technical Advisory Committee and Wine and Health Working Group. She is a delegate and expert for the Organisation International de la Vigne et du Vin and served as Vice President of Commission IV Safety and Health and a member of the Scientific and Technical Committee. She is also an Associate Editor of *OENO-one*, and a member of the editorial board of the *International Journal of Wine Research, International Journal of Food and Fermentation Technology* and the *Austin Journal of Cardiovascular Disease and Atherosclerosis*, as well as a charter member of the International Scientific Forum on Alcohol Research, a member of the Advisory Board of the International Surveillance System on Mediterranean Diet (Spain), a member of the Scientific Board of the (European) Wine Information Council, a member of the European Food Safety Authority Expert Database and a member of the International Federation of Wines and Spirits Scientific and Technical Committee. Creina is also a member of the Scientific Committee for the WineHealth 2017 International Wine and Health Conference.

Matthew Wheal is the Secretary of the Australasian Plant and Soil Analysis Council.

Eric Wilkes is the acting Chair of the Interwinery Analysis Group committee and a member of the FIVS (International Federation of Wines and Spirits) Scientific and Technical Committee, Good Laboratory Practice Working Group. He chairs the APEC Wine Regulatory Forum Enhanced Risk Controls Working Group and is a member of the International Wine Technical Summit Authenticity and Counterfeit, Analytical Method Quality, Laboratory Quality and Expression of Limits working groups.

PROGRESS REPORTS

ENVIRONMENT AND SUSTAINABILITY

The success of the Australian grape and wine industry is strongly tied to its long-term custodianship of the natural environment. Soil, water, biodiversity, and climate all contribute to the success or failure of grape-growing across Australia and electricity, fuel, refrigeration, and waste disposal are all major costs in winemaking. Projects under this theme aim to assist producers to improve environmental and economic performance; to make the most of the grapevine clonal resources available; and to improve the management of pests and diseases.

Reduce inputs and environmental footprint across the value chain

Staff

Geoff Cowey, Marcel Essling, Matt Holdstock, Dr Mardi Longbottom.

Collaborators

Australian Vignerons (Andrew Weeks); Consilius (Rachel Barrett); De Bortoli (Rob Glastonbury); Finlaysons (Kyra Reznikov); Freshcare Ltd (Claire Hamilton-Bate); McLaren Vale Grape Wine and Tourism Association (Robyn Groffen); National Australia Bank (James Bentley); Pernod Ricard Winemakers (Stephen Cook, Angus Barnes); Perth NRM (Keith Pekin); St Hallett Wines (Megan Coles); Treasury Wine Estates (Gioia Small); Wine Australia (Stuart Barclay); Winemakers' Federation of Australia (WFA) (Tony Battaglene); Winemaking Tasmania (Jonathan Lord).

Capitalising on the carbon economy – Building resilience and sustainability in the grape and wine sector

Background

Efforts are under way across a range of industries to reduce greenhouse gas (GHG) emissions. To effectively achieve emissions reductions, industries need relevant and up-to-date technical and policy information. This project, funded by the Department of Agriculture and Water Resources (DAWR) as part of the 'Extension and Outreach' program, was set up to deliver technical information about GHG emissions, carbon storage and the Emissions Reduction Fund (ERF) to the Australian grape and wine sector. It has provided access to technology, skills and decision support and enhanced the adaptability of the grape and wine sector as it faces a variable climate and competition for natural resources.

Extension delivery

Twenty-one regional workshops were held across Australia. The workshops included regionally tailored benchmarking data from the Australian Wine Carbon Calculator which has been embedded into Entwine Australia. This information was used to assist workshop participants to identify opportunities to improve the efficiency of their water, energy and fertiliser use. Case studies were also developed to support the uptake of vineyard and winery strategies to reduce greenhouse gas emissions and also to save money. An independent assessment of this project found that the workshop series had successfully enabled informed decision-making about practice change within the grape and wine sector and that the workshops multiplied the extension efforts. Workshop participants shared workshop content within their networks and used it to provide advice and to support business decisions. Two workshops and some final case studies will be completed in July and August 2016 to conclude this project.

Improving the environmental and economic performance of the Australian wine supply chain (Entwine Australia)

Background

Entwine Australia is the Australian wine industry's sustainability program – set up to support growers and winemakers in demonstrating and improving the sustainability of their businesses. Entwine is endorsed by the industry peak bodies Australian Vignerons, WFA and Wine Australia. Entwine operates as an 'umbrella' sustainability program. Under the Entwine umbrella there are two components for members – the reporting of sustainability metrics to the AWRI and participation in an approved certification program. Entwine provides credentials that cover the fundamental components of sustainability and delivers benchmarking tools and resources to enable planning, evaluation, control and communication in vineyards and wineries. The structure, content and strategic direction of Entwine are guided by industry reference groups.

Membership and projects

In 2015 Entwine had more than 600 vineyard and winery members covering approximately 30% of the Australian wine-grape vineyard area and 30% of the national wine-grape crush. A significant upgrade was made to the Australian Wine Carbon Calculator enabling all Entwine members to benchmark greenhouse gas emissions, yield, vineyard area and water use against other members, based on production scale, region, GI zone or state. Results have been communicated using a combination of workshops (delivered under the DAWR's 'Extension and Outreach' program) and other regional presentations. Further communication is being supported by customised regional and individual online reports that showcase significant sustainability projects.

A pilot project was initiated to investigate the relationship between natural capital and business resilience. This will be undertaken in collaboration with the National Australia Bank over an eighteen-month period, focusing initially on wine-grape growers in the Langhorne Creek region.

JOHN GLEDHILL AND CON SIMOS

Capture the full value of clonal resources for key Australian varieties

Staff

Dr Anthony Borneman, Dr Michael Roach, Dr Simon Schmidt.

Collaborators

BC Genome Sciences Centre (Prof. Steven J.M. Jones, Justin Chu); Macquarie University (Prof. Isak S. Pretorius); South Australian Research and Development Institute (SARDI) (Dr Michael McCarthy); University of British Columbia (Prof. Hendrik J.J. van Vuuren, Prof. Jörg Bohlmann); Yalumba Wine Company (Nick Dry).

Assessing diversity and clonal variation of Australia's grapevine germplasm (Chardonnay and Shiraz)

Background

The AWRI is engaged in two projects that relate to grapevine clonal diversity. These projects aim to assess the genetic diversity of Chardonnay and Shiraz clones, and evaluate how this variation contributes to chemical and sensory variation in grapes and wine.

Chardonnay is one of the dominant white grape cultivars used for winemaking in Australia. The majority of Australian Chardonnay vineyards are monoclonal, with clone I10V1 dominating the Australian Chardonnay landscape. However, there are now many clones of this variety, some of which have only relatively recently become available in Australia. Grapevine clones can exhibit variation in a number of viticultural and oenological traits including fruit composition, flavour and aroma profile, ripening time, flower morphology (leading to seedless grapes), bunch morphology, yield and grape colour. The commercial availability of a significant number of clones affords the possibility of increasing the diversity within Chardonnay vineyards.

Shiraz is an iconic variety in Australia with plantings dating back more than 100 years. In a collaborative project with SARDI the aim is to assess the genetic diversity of some of Australia's heritage Shiraz material. SARDI is leading a national team evaluating clonal plantings of Shiraz at multiple sites. Wines made from these sources are undergoing sensory evaluation at the AWRI.

Understanding genetic variation in Chardonnay and Shiraz

A reference genome for Chardonnay has now been completed for clone I10V1 with the use of new data from a long read PacBio sequencing platform. High coverage sequencing data obtained from 15-50 kb insert libraries on an RSII machine was used to augment pre-existing data to create a hybrid assembly that resolved this highly heterozygous genome. Mapping of short read sequence data to the new, highly contiguous and haplotype-resolved reference assembly is now under way. Once complete this will permit a comprehensive cataloguing of genetic diversity between clones. Genomic comparisons will initially focus on single base changes that differentiate clones and could subsequently be used as markers for differentiation of clonal material in the field. Ultimately comparisons will also include variations in genome structure including insertions and deletions.

Comparative genomic evaluation of Shiraz has commenced. DNA from designated clones used in the SARDI winemaking trials has been extracted and sequencing has been initiated.

Understanding of the genetic differences among clones will be combined with knowledge about their different behaviour in the vineyard and winery. This will include both chemical and sensory data from winemaking trials of multiple different Chardonnay and Shiraz clones, evaluated across multiple sites in multiple vintages.

Reduce the economic and environmental impact of pests and diseases and the techniques used to manage them

Staff

Dr Anthony Borneman, Dr Markus Herderich.

Collaborators

Curtin University (Lincoln Harper, Dr Fran Lopez); National Wine and Grape Industry Centre (Dr Sandra Savocchia); SARDI (Dr Barbara Hall, Dr Suzanne McKay).

Understanding genetic variation in grapevine diseases and the genetic basis for pesticide resistance

Background

Grapevine diseases that are caused by fungal/oomycete pathogens such as *Botrytis* and powdery and downy mildews are responsible for significant crop losses. Current control measures rely on spraying with agrochemicals; however, there is growing evidence for resistance of fungal/oomycete pathogens to specific fungicides. By determining the genetic basis of these resistant phenotypes, DNA diagnostics to efficiently test for potential resistance prior to choosing an agrochemical will be developed and compared to established slow and complicated assays. This will provide impartial data on which to base agrochemical purchasing and spray decisions, and potentially guide the development of next-generation agrochemicals.

Investigating fungicide resistance in three pathogens

Powdery mildew (*E. necator)*, *Botrytis* bunch rot and downy mildew (*P. viticola)* are the three most economically important diseases in Australian vineyards. To determine the incidence and severity of fungicide resistance in Australia, samples of all three diseases were collected from vineyards in the main viticultural regions of Australia and tested against a range of commonly used fungicides. Representative samples were genotyped for the presence of known mutations conferring resistance. Results showed that resistance to quinone outside inhibitor (QoI) fungicides in powdery mildew was found in most viticultural regions. While phenotypic resistance of *E. necator* to the demethylation inhibitor group of fungicides was not widespread, the Y136F allele (a known genetic marker in resistant isolates) was present in approximately 60% of the isolates. Populations of *P. viticola* resistant to metalaxyl have been confirmed in all states except South Australia, and the allele conferring resistance to QoI has been detected. *B. cinerea* populations resistant to fenhexamid, iprodione, pyrimethanil, boscalid, tebuconazole and azoxystrobin were detected. While 38% of the 114 sites tested had no resistance detected, ten sites had populations resistant to four or more fungicides.

The results so far have confirmed the presence of populations of these three pathogens that are resistant to many fungicides throughout Australia. However, more work is needed to confirm how these results relate to the potential for field failure.

CONSUMERS, CUSTOMERS AND MARKETS

The Australian wine industry depends on producing wines that consumers value, trust and are able to access in both domestic and international markets. Projects under this theme aim to take a scientific approach to understanding consumer preferences; to inform consumers about health impacts of wine consumption; to provide technical guidance on agrochemical use to meet export market requirements; to investigate methods for assuring wine authenticity and to contribute technical expertise to national and international forums on wine regulation.

Build and safeguard brand Australia

Staff

Dr Martin Day, Dr Kerry DeGaris, Marcel Essling, Dr Markus Herderich, Dr Mardi Longbottom, Anne Lord, Con Simos, Dr Creina Stockley, Dr Tina Tran (to 21 October 2015), Dr Eric Wilkes.

Collaborators

Alcohol Beverages Australia (Stephen Riden, Fergus Taylor); Australian Vignerons (Andrew Weeks); CropLife Australia (Alastair James); DAWR (Gary Fan, John Power); Nufarm Australia Ltd (Ben Coombe); Plant Health Australia (Susie Collins); Sumitomo Chemical (Doug Paton); Vinehealth Australia (Inca Pearce); WFA (Tony Battaglene, Melissa Cheesman-Faull, Paul Evans); Wine Australia (Andreas Clark, Steve Guy).

Collecting and disseminating information regarding agrochemicals registered for use and maximum residue limits in Australian viticulture

Background

Governments around the world set limits for the amount of residue of agrochemicals that is legally allowed in foods, including grapes and wine. Up-to-date information on agrochemical management is needed to ensure that finished wines meet these limits and do not encounter trade barriers. The aim of this project is to enable grape and wine producers to manage agrochemical residue levels in their products by collating and providing accurate and timely information on regulatory and technical aspects of chemicals registered for use in Australian viticulture, and the maximum residue limit (MRL) requirements of those chemicals in domestic and key export markets.

The project team identifies potential pest, disease and agrochemical issues through a number of established information-gathering and support mechanisms and through liaison with key industry and government stakeholder networks. Up-to-date reference tools are maintained, including the AWRI MRL and agrochemical databases. A number of dissemination channels are employed to update stakeholders of changes. Chemical manufacturers and distributors are also consulted to keep abreast of changes in the range and supply of agrochemical products. The outcomes are made available in the publication *Agrochemicals registered for use in Australian viticulture* (known as the 'Dog book'), an online search portal and a smart phone agrochemical app.

Providing the latest information

The project team reviewed 199 Sanitary and Phytosanitary notifications from the World Trade Organization and 32 gazettes issued by the Australian Pesticides and Veterinary Medicines Authority (APVMA). The outcomes of these reviews included changes to MRLs for markets including Canada, the European Union and Taiwan. The APVMA gazettes highlighted issues such as the registration of new active constituents including amilsubrom, fenpyrazamine and flumioxazin.

Each year, post-harvest, the project team reviews the latest information on agrochemicals by liaising with regulators, chemical manufacturers, suppliers and end-users. Best practice recommendations are then incorporated into a new version of the 'Dog book'. In total, 10,000 copies of the 2016/2017 'Dog book' were produced and distributed by direct mail to all levy payers, via regional association networks, AWRI roadshow events, chemical retailers and an insert in the *Australian & New Zealand Grapegrower & Winemaker*. Further updates were also made to the online search portal, the smart phone agrochemical app and the electronic version of the publication. The 'Dog book' was expanded to include information on active constituents and new products. For the first time, information about re-entry periods for the active constituents listed in the booklet was also included. The 'Dog book' now lists the minimum amount of time that must pass before an area that has been sprayed can be re-entered without protective clothing or equipment. Four *eBulletins* were issued to provide timely information on agrochemical issues. For example, on 13 August 2015 it was recommended that the active constituent captan not be used for grapes destined for export wine, to reflect a notification that the EU was intending to change its regulations.

Origin verification and detection of counterfeit Australian wines

Background

Wine is periodically the subject of substitution or counterfeiting. While some cases can be easily detected, such as those involving spelling errors on labels, other cases suggest that an increasingly sophisticated approach to addressing counterfeiting is required. Efforts to establish the authenticity of a wine sample have been under way for many years, particularly in Europe, with mixed success. This project aims to protect the reputation of Australian wine and individual producer brands by:

- developing a robust way to quickly ascertain the authenticity of an unknown wine sample (using inherent product compositional attributes such as ratios of metal isotopes and elemental content)
- building an elemental database (and/or validating existing databases) of wines of known origin both domestically and internationally
- validating use of rapid spectral techniques to compare counterfeited wines against a known reference wine.

Pilot study

A pilot study, funded by Wine Australia, was conducted to assess whether a combination of strontium isotope ratios and selected trace metals could be used to determine a wine's origin. A number of finished, bottled Australian wines (194) were obtained for analysis through the Wine Australia Regulatory Services team, representing eight important production zones. For comparison, 37 wines from other countries were also analysed. The $^{87}Sr/^{86}Sr$ ratio and 25 trace elements were measured in all wines using thermal ionisation mass spectrometry and

PAULINE JORGENSEN AND KYLEE WATSON

inductively coupled plasma mass spectrometry. In addition, the near- and mid-infrared spectra were recorded for a subset of samples and attempts were made to isolate DNA from a set of commercially available wines with the aim of using the DNA to identify the grape variety the wines had been made from.

The most important trace metal elements were found to be lithium, rubidium and zinc (along with arsenic, beryllium, chromium, nickel and lead) and these, combined with the $^{87}Sr/^{86}Sr$ ratio, allowed 95% of samples to be correctly predicted as originating from Australia or not. The variance of the data within Australia allowed several zones to be discriminated from others (Figure 1). Importantly, the wine variety had little effect on the successful prediction rate. By comparison, the quality of the statistical separation observed from mid-, near- or UV spectroscopy was markedly lower and varied according to variety. Despite several attempts and a number of experimental improvements, DNA extraction from wine for polymerase chain reaction replication was not successful.

Further development of this pilot study will examine the isotope ratios of other metals, such as boron, lithium and lead as well as stable isotopes associated with water, for use as origin markers. Variation over time will be evaluated by looking at several vertical series of single-vineyard wines and the effect of different varieties will be studied using samples from variety blocks from several different regions.

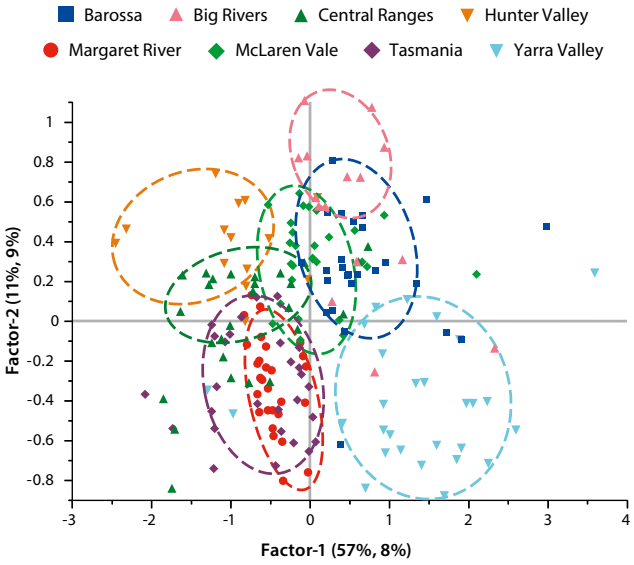


Figure 1. Grouping of Australian wines by production zone after statistical analysis of trace metal and strontium isotope data. Dotted ellipses are for clarity of groupings only and are not statistically derived.

Informing wine consumers through understanding issues of wine consumption, health and nutrition

Background

The aim of this project is to generate and disseminate credible, evidence-based and scientifically sound information on wine and health/nutrition, facilitating decision-making by the wine industry, policy makers and consumers.

Submissions

Project staff attended two workshops organised by the Federal Department of Health and subsequently prepared two comprehensive scientific submissions for the Intergovernmental Committee on Drugs responsible for drafting the *National Drug Strategy 2016-2025* and the *National Alcohol Strategy 2016-2021*.

Provision of scientific information

Scientific information and briefing papers were prepared for WFA and Alcohol Beverages Australia (ABA) for the Senate Standing Committee on Economics (References Committee) on personal choice and community impacts. Critiques of a number of publications were also prepared, including: the current Australian Bureau of Statistics alcohol consumption data and its alignment with Australian Institute of Health and Welfare data; the Foundation for Alcohol Research and Education's *Risky business - The alcohol industry's dependence on Australia's heaviest drinkers*; St Vincent's Health Australia's *Alcohol-Related Harm and Violence Policy*; the Legal and Constitutional Affairs References Committee Interim Report *Need for a nationally-consistent approach to alcohol-fuelled violence;* and the Health Council of the Netherlands *Draft Dietary Guidelines 2015*, as well as journal articles related to wine and human health. In addition, health policy papers on alcohol's impact on cardiovascular disease, cancer, diabetes, immunological disorders and obesity were reviewed and redrafted for ABA. Complementary to this, the content of the AWRI's wine and health fact sheets and frequently asked questions was updated. In preparation for the forthcoming review of the National Health & Medical Research Council's alcohol drinking guidelines, a literature review was undertaken on aspects of wine consumption and human health, including wine consumption compared with other risk factors associated with death from chronic diseases. Five position papers and two book chapters were published after peer review and another three articles were published in non-peer-reviewed publications (see Appendix 7 for details).

Increasing Australia's influence in market access, safety, regulatory and technical trade issues

Background

Maintaining market access or opening markets for Australian wine, nationally and internationally, is facilitated by managing and reducing current and potential barriers to trade. The Australian wine industry needs to anticipate, facilitate and influence regulation of wine composition, production, labelling and marketing. This project provides regulatory-related scientific and technical advice to support the activities of key industry stakeholders. In addition, representation at national and international industry forums raises awareness of matters of concern to the Australian wine industry.

Technical support

Scientific and technical advice continues to be provided for a number of ongoing issues. One such issue in international regulatory forums is the occurrence and sources of heavy metals such as arsenic, cadmium, copper, lead and manganese in wine. Trace amounts of heavy metals naturally result from soil and groundwater taken up by vines but can be considered barriers to trade in certain export markets. Other market access issues that continue to be investigated include adverse allergenic reactions to wine, the analysis of allergens in wine and associated labelling in different export markets, as well as the concentration and sources of phthalates in wine. The AWRI's databases of *Analytical requirements for the export or Australian wine* and *Permitted additives and processing aids for winemaking and wine importing countries* were updated regularly and now cover 43 and 22 individual countries respectively, in addition to information for regional trading blocs. Further information on technical support provided for regulatory issues can be found in the helpdesk section of this report.

The project team continued to participate at the Organisation International de la Vigne et du Vin (OIV) as members of the DAWR-led Australian delegation, together with a representative from WFA. During 2015/2016, comprehensive dossiers were prepared by the AWRI for DAWR, OIV and WFA on meta-tartaric acid, tannins and yeast mannoproteins. This followed a request for information and comments on the

priority list of substances proposed by Australia for evaluation by the Joint Expert Committee on Food Additives for the 49th Session of the Codex Committee on Food Additives. Additional information was prepared to support the Australian-initiated draft resolutions and dossiers on dimethylpolysiloxane, potassium carbonate and protease enzymes presented to the OIV expert groups, since although these processing aids are permitted in Australia, they not yet permitted for winemaking under OIV regulations. In addition, numerous draft OIV proposals were reviewed through participation in the Microbiology, Technology, Specifications of Oenological Products, Food Safety and Consumption and Nutrition and Health expert groups and the Methods of Analysis Sub-commission.

Biosecurity

Background

The AWRI delivers biosecurity management activities on behalf of Australian Vignerons. As a signatory to the Emergency Plant Pest Response Deed (EPPRD), Australian Vignerons has a national responsibility for biosecurity arrangements in the wine sector and undertakes this responsibility in close association with WFA, Wine Australia and other agricultural industries.

Collaboration on biosecurity issues and activities

The AWRI held regular meetings and ongoing dialogue with Plant Health Australia (PHA) and participated in categorisation exercises for exotic viticulture pest and diseases, a *Xylella* (Pierce's Disease) preparedness workshop and the Consultative Committee on Emergency Plant Pests. The National Viticulture Biosecurity Committee, to which the AWRI provides secretariat services, met twice during the year to establish and monitor an annual work plan and to establish communication networks with industry and government. One outcome of these meetings was the successful application to PHA for funds to undertake a review of the existing Phylloxera Exclusion Zone maintenance protocols. This project is being conducted in collaboration with Vinehealth Australia.

IMPROVING PRODUCTS AND PROCESSES

There are numerous processes involved in wine production, from grapegrowing through to delivery of finished product to consumers. Projects under this theme aim to optimise these processes and reduce costs, resulting in overall improvements to wine quality and business sustainability. Specific areas include target setting for wine style, optimisation of primary and secondary fermentation, assessing new winery processes, preventing and treating taints and faults and improving packaging and transportation.

Objective measurement and target setting of grape and wine style

Staff

Alice Barker, Sheridan Barter, Dr Keren Bindon, Dr Cory Black, Dr Dimitra Capone, Dr Wies Cynkar, Dr Leigh Francis, Richard Gawel, Dr Yoji Hayasaka, Dr Markus Herderich, Stella Kassara, Dr Jacqui McRae, Dr Agnieszka Mierczynska-Vasilev, Mango Parker, Wes Pearson, Alex Schulkin, Tracey Siebert, Mark Solomon, Dr Paul Smith, Joanna Verwey, Patricia Williamson.

Students

Liang Chen, Yu Hou, Sijing Li, Olaf Schelezki (University of Adelaide).

Visiting scientists

Dr Federica Blando (to 10 October 2015, Institute of Sciences of Food Production, CNR, Lecce, Italy), Dr Nadine Jaeckels (Johannes Gutenberg University, Mainz, Germany).

Collaborators

Accolade Wines (Alex Sas, Warren Birchmore); Angove Family Winemakers (Richard Angove); Australian Vintage (Dr Nick Yap, Jakub Rys); Bay of Fires (Peter Dredge); Brokenwood Wines (Simon Steel); Casella Wines (Steve Warne, James Wilson); CSIRO (Dr Rob Bramley, Peter Clingeleffer, Dr Shane Seabrook); De Bortoli Wines (Steve Webber); Hochschule Geisenheim, Germany (Dr Simone Mueller-Loose); Institut Francais de la Vigne et du Vin Sud-Ouest, France (Olivier Geffroy); Joseph Chromy Wines (Jeremy Dineen); Kingston Estate (Wayne Kiely); Lion (Brooke Halkett); McWilliam's Wines (Adrian Sparks); Mt Langi Ghiran (Damien Sheehan); Mt Majura (Dr Frank van de Loo); Pernod Ricard Winemakers (Dan Everitt, Kate Lattey, Sladjan Maksimovic, Don Young); Pfeiffer Wines (Jen Pfeiffer); Printhie Wines (Drew Tuckwell); Punt Road Wines (Behn Payten); SARDI (Lee Bartlett, Dr Barbara Hall); Shaw and Smith Wines (Adam Wadewitz); Stonier Wines (Michael Symons); The Lane Vineyard (Michael Schreurs); Treasury Wine Estates (Clare Flintoff, Melanie Chester, Sarah Dswonitzky; Dr Anthony Robinson, Dr Alison Soden, Dr Vanessa Stockdale); Tyrrell's Wines (Tom Lynar); University of Adelaide (Dr Cas Collins, Dylan Grigg, Dr David Jeffery, Assoc. Prof. Kerry Wilkinson); University of Bonn, Germany (Prof. Matthias Wust); University of Bordeaux Institut des Sciences de la Vigne et du Vin, France (Prof. Philippe Darriet, Dr Panagiotis Stamatopoulos); University of Melbourne (Prof. Snow Barlow, Dr Kate Howell, Dr Pangzhen Zhang); University of South Australia (Dr Miguel De Barros Lopes, Prof. Larry Lockshin, Dr Armando Corsi, Ava Huang, Svetlana Bogomolova, Prof. Peter Majewski, Dr Beatriz Simon); University of Tasmania, Tasmanian Institute of Agriculture (Dr Anna Carew, Dr Fiona Kerslake); Vasse Felix (Michael Langridge); Wine Australia (Willa Yang); Wines by Geoff Hardy (Shane Harris); Yalumba Wine Company (Brooke Howell, Louisa Rose, Dr Alana Seabrook).

Identification and origin of volatile compounds responsible for important wine sensory attributes

Background

The flavour of wine is determined to a large extent by volatile compounds that are perceived during consumption by the sense of smell. The overall flavour of a wine, as well as specific flavour notes, is provided by dozens of chemical compounds of widely varying potency and concentration. The key volatile chemical compounds causing some flavour properties of wines such as 'stone fruit' are not known, and this project aims to better understand 'struck match' and 'tropical fruit' flavour in Chardonnay, 'green' flavour in red wines, and the viticultural and winemaking influences on the concentration of the compounds, including the 'black pepper' compound rotundone. The sensory properties and consumer preferences for wines with different levels of these flavours is also an important aspect of this project.

'Stone fruit' and 'tropical fruit' flavour in white wines

Several lactone compounds have been investigated to assess their contribution to 'apricot' or 'peach' aroma in Chardonnay or Viognier wines. Lactones are understood to be key flavour compounds in peach and apricot fruits, and in peach flavour formulations. The aroma detection threshold of a little-studied lactone was determined, and found to be approximately 1 µg/L in white wine, with some people able to detect it well below this concentration. An accurate and precise GC/MS analytical method was developed and validated, and the concentration of this lactone in a set of wines with known intensities of 'stone fruit' aroma was analysed. A regression model was generated to relate the volatile composition of the wines to the sensory properties, and the results strongly suggest that this compound could be contributing to this important sensory attribute. Work conducted as part of a visit with Prof. Philippe Darriet's research team at ISVV, University of Bordeaux, assessed a technique known as recombination-GC, using HPLC fractions of enriched wine extracts from French Viognier wines with strong 'apricot' aroma. A series of sensory assessments to describe the aroma of various mixtures of several lactones, with and without the presence of other wine aroma compounds, provided further evidence that these compounds are of consequence to 'apricot' or 'peach' aroma in white wine.

Several polyfunctional thiols that are very substantial contributors to the flavour of Sauvignon Blanc wines have been investigated for their contribution to the aroma and flavour of Chardonnay. As discussed in the previous annual report, 106 commercially available Chardonnay wines (price range $3 to $120, median $19) were sourced from across Australia, with wines also made under controlled conditions from Chardonnay juices sourced from 16 vineyards across multiple regions. From these two sample sets, virtually all wines had concentrations above sensory threshold for all of the thiols measured, with clear relationships between the levels of the thiols and important sensory properties of the wines. In investigating the data more closely, there were trends that wines from Tasmania had higher amounts of 3-MHA and benzyl mercaptan, while Western Australian wines had a higher median level of 3-MH. The concentration of the 'tropical'/'grapefruit' 3-MHA was linked to cooler sites and younger wines (Figure 2), and the 'struck match' benzyl mercaptan compound was generally higher in wines from cooler regions, older and higher priced wines.

MANGO PARKER, LEIGH FRANCIS AND WIES CYNKAR

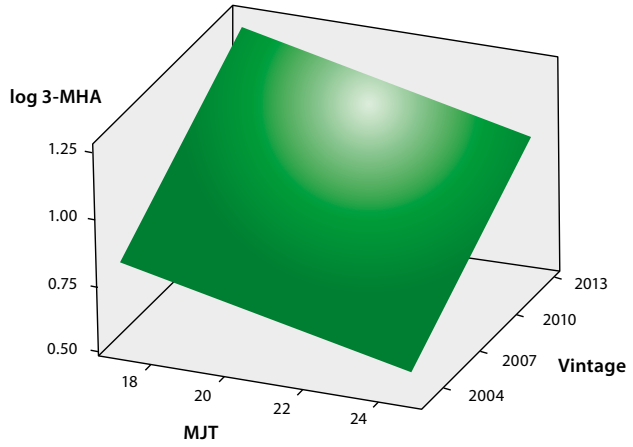


Figure 2. Fitted plane for the relationship between 3-MHA concentration of a set of 106 Chardonnay wines and mean January temperature (MJT) of the region and vintage of the wines, showing that at lower MJT and for younger wines there was generally higher 3-MHA

Pepper aroma in Shiraz

Variation in rotundone concentration across a single Shiraz vineyard in the Grampians region of Victoria was mapped in a collaboration with Dr Rob Bramley of CSIRO, and results from 177 vines gave a very similar spatial variation pattern to that observed in the 2012 and 2013 vintages. This strongly suggests that the variability across a vineyard is related to topographic features in the vineyard. In assessing grape samples from vineyards in the same geographic area, many were found to have appreciable rotundone levels, with the concentration found to be significantly associated with bunch temperature measured in January 2016. No correlations were found with other compositional measures such as total soluble solids, grape colour or tannin concentration.

'Green' flavour in red wines

To determine the chemical compounds that contribute most strongly to 'green' or unripe flavour in red wines, a sensory and instrumental analysis study was completed on 18 commercially available Shiraz wines. The wines were selected as exhibiting a range of 'green' aromas and flavours, and they were characterised by a trained sensory descriptive analysis panel with carefully defined attribute terms. The wines were found to vary widely in attributes such as 'vegetal', 'stemmy', 'pepper', 'eucalypt', 'acidity', 'astringency' and 'bitterness'. The same wines were tasted by 20 winemakers, who applied a projective mapping technique, which involved sorting and grouping the wines based on their sensory similarities and differences. As a final aspect of the sensory investigation, a subset of the wines was assessed by more than 100 consumers. The wines that were least liked by consumers had elevated 'vegetal' or 'stemmy' flavour, confirming that Shiraz wines with 'greener' attributes were not well accepted by consumers. Analysis of chemical data is still in progress.

A vintage trial was completed with fruit from three different vineyards in Victoria and South Australia located close to vegetation. The study aims to assess the effect of trees planted close to vines on wine sensory properties and volatile aroma composition.

Assessment of relationships between grape chemical composition and grape allocation grade

Background

A wide range of compounds that contribute to wine's appearance, aroma, flavour and texture are derived from grapes. Many of these compounds are known and measurable, and can be manipulated through viticultural and/or winemaking practices. Around the world, many wine companies use grape chemical measures to assess grape value or style; however, this approach has not been implemented widely in Australia.

By measuring a range of chemical compounds in multiple grape batches of different grades, this project aims to determine which compounds, independently or in combination, can differentiate between grape grades. The objectives are to determine how variable the chemical measures are across a wide range of fruit grades, if there is a relationship with fruit grade and if fruit can be clustered based on similarity of chemical composition. A primary aim of the project is to assess the practical application of grape grading measurements and to support wine producers who intend to apply these measures. Potential impacts for industry include the ability for grapegrowers to more efficiently produce grapes to defined specifications, and for winemakers to select fruit with greater confidence that it will be appropriate for a targeted wine style.

Can existing commercial grading allocations be predicted using previously identified and new chemical measurements?

Samples were sourced from regions across Australia and included 56 Cabernet Sauvignon, 62 Shiraz and 64 Chardonnay grape samples from up to nine commercially defined quality grades. Chemical analyses were selected based on a literature review and survey of the way local and international producers measure quality. Basic chemical measures included berry weight, titratable acidity (TA), pH, malic acid, °Brix and nitrogen content; potential negative quality markers included laccase, chloride and methoxypyrazine; targeted compositional measures (dependent on variety) included 'grassy, green' C-6 compounds, volatile thiol precursors, β-damascenone, the broad flavour measure phenol-free glycosyl-glucose, amino acid profile, phenolics and non-targeted spectral fingerprinting in mid- and near-infrared regions. Data were analysed with the multivariate statistical methods of partial least squares regression (PLS) and quadratic discriminant analysis (QDA).

PLS models developed for grade had R^2 values of validation between 0.55 and 0.84, showing that this was not always the best modelling approach. Due to the fact that grade is not numerically defined and the relationships within the datasets were found to be non-linear, QDA (which predicts categories not values) gave better accuracy of grade prediction. The QDA prediction for Shiraz was 85% and indicated that higher values for °Brix, alpha-amino nitrogen, total yeast assimilable nitrogen, certain amino acids, tannin, absorbances at 280 and 520 nm, C6 compounds and chloride concentrations were associated with higher grade fruit. The QDA prediction for Cabernet Sauvignon was 90% and indicated that higher values for °Brix, certain amino acids, tannin, absorbances at 280 and 520 nm, glycosyl glucose and chloride concentrations were associated with higher grade fruit. The QDA prediction for Chardonnay was 95% and indicated that higher levels of TA, ammonia, malic acid, volatile thiol precursors, C6 compounds, glycosyl glucose, chloride and β-damascenone were present in higher grade fruit.

Spectroscopic fingerprints from MIR and UV-Vis scans best predicted Cabernet Sauvignon and Shiraz grade, while targeted chemical analyses best predicted Chardonnay grade using QDA. However, for Chardonnay using a reduced analysis dataset of only basic berry measurements, including pH, TA, ammonia, alpha-amino nitrogen, °Brix, berry weight and targeted UV spectra, prediction accuracy was reduced only slightly, to 93%. This was a promising observation, since most of these measurements are readily accessible to producers.

There is clearly potential for objective chemical measures to be defined by both targeted and non-targeted methods. A relatively simple analytical grading tool is achievable for grapegrowers and winemakers willing to commit to implementation but will require some ongoing refinements by grape variety, and calibration across multiple vintages.

RICHARD GAWEL AND AGNIESZKA MIERCZYNSKA-VASILEV

In 2015 fruit batches for four style categories of Shiraz and Chardonnay were sourced from multiple vineyards and the trial was extended beyond the assessment of grape chemical composition to also include winemaking. The aim was to establish the relevance and predictive power of the identified grape compounds to forecast grape quality and wine style categories. Data analysis is being finalised for a final report due in December 2016.

Flavour precursors: contribution to wine aroma, in-mouth sensory properties and flavour release

Background

A critical aspect of wine quality from a consumer perspective is the overall impression of the wine in the mouth. Wine flavour is driven by volatile compounds (including ethanol), and also by non-volatiles such as sugars, salts, acids, phenolic compounds (including tannins), polysaccharides and proteins. Overall flavour is also potentially derived from non-volatile precursor compounds, such as glycosides (compounds joined to sugars) or amino acid conjugates that can be broken down in-mouth, thereby releasing volatile aromas. Individual wine components alone are not sufficient to achieve a desirable in-mouth perception; this can only be obtained through the interaction of multiple components.

This project has the overall aim of establishing the extent to which wine flavour is due to precursor compounds releasing flavour compounds in-mouth. The persistence and intensity of fruit flavour are very important aspects of wine quality, and grape-derived compounds that are non-volatile, but which can be degraded during the tasting process to produce flavour, are a potentially important source of desirable flavour that has not been previously investigated.

Enhancing flavour precursors in winemaking

Previous work in this project demonstrated the potential of non-volatile glycosides as flavour precursors. The results showed that there is a surprising ability of in-mouth enzymes, most likely from salivary bacteria, to quickly liberate volatile aroma compounds from their bound form during wine drinking, enhancing flavour and contributing to a lingering aftertaste. This mechanism of flavour release seems to be fairly variable across individuals, suggesting one reason for variation in people's sensory perception and preferences. To follow up this work, a vintage experiment was completed to address possible ways winemakers might increase the contribution of these precursors in their wines. Several sets of grape juices were treated to boost their level of glycosides and fermentations have been completed. Sensory studies will show whether these treatments have resulted in more intense or complex wines.

Factors affecting wine texture, taste, clarity, stability and production efficiency

Background

Wine texture is considered a major product differentiator both for wine style and value in the marketplace. In addition, clarity and colour stability (absence of haze development and the retention of colour) are generally considered essential for market success. Achieving desired textural qualities, clarity and stability can involve processing steps with significant costs. The ability to modulate these characteristics of wine while maintaining profitability is a significant challenge for the wine industry. This project aims to elucidate key compositional drivers of texture, bitterness, clarity, stability (protein and colour) and wine filterability, and seeks to develop strategies to modulate them in a production-based environment. This research will provide knowledge of grape and wine composition for polyphenols, polysaccharides and proteins and a clearer understanding of the impact of winemaking processes on macromolecule concentrations and colloidal profiles.

The following specific aspects are being investigated in this project:

- the compositional drivers of texture, hotness and bitterness
- the role of macromolecules such as tannins, polysaccharides, proteins and their aggregate colloids in the expression of texture, stability, clarity and filterability
- the impact of other wine matrix components on macromolecule function and expression
- the source of these molecules or their precursors in grapes and yeast and the impact of winemaking processes such as clarification, flotation, vinification and filtration on their retention and/or transformation
- the impact of filtration on macromolecules
- strategies for modulation of specific compositional drivers through the use of grape-based fining agents
- alternative strategies for achieving protein stability
- practical methods for wineries to determine likely extractability of macromolecules during winemaking
- strategies for the stabilisation of colour independent of vintage effects.

The knowledge generated by the project will provide a framework for the development of winemaking strategies, practical tools and recommendations for managing colour (and colour stability), astringency, viscosity, hotness, bitterness, filtration processes and protein hazes.

Impact of juice clarification on macromolecules and phenolics in white wine

Making wine from juices that contain grape solids is becoming a popular option amongst producers of fuller bodied white wine styles, as the practice improves fermentation kinetics and may also result in more 'textural' and complex wines. Previous research using laboratory-scale ferments revealed that wines produced from less clarified juices contained significantly higher concentrations of total polysaccharides, which could mostly be attributed to higher levels of mannoproteins. In 2015, a vintage experiment was conducted to further assess the effect of juice clarity on wine composition, but due to the larger scale of the trial, flavour and mouth-feel could also be determined. High and low solids Sauvignon Blanc and Chardonnay juices were produced by medium-sized wineries using typical crushing, draining and enzyme-assisted settling methods, and these juices were vinified under experimental conditions.

Higher juice solids content resulted in wines that were slightly more viscous, bitter and hot and these characteristics were most consistently associated with wine phenolic concentration and composition. Fermenting on solids resulted in wines with higher concentrations of esters, fatty acids, higher alcohols and (notably) thiols. In the case of Sauvignon Blanc, the fourfold increase in volatile thiol concentration in the wines produced by fermenting on solids was seen in significantly higher 'passionfruit' and 'flinty' characters.

Evaluation of the effects of juice solids content on wine composition and mouth-feel continued in vintage 2016 through a winery trial where juice clarity was achieved by the widely used method of flotation. Analysis of the wine from that trial is under way.

Molecular drivers of texture and taste

The perceived bitterness of 24 white wine fractions of varying hydrophobicity was previously modelled on their non-volatile composition using non-targeted analysis. A compound identified as an amino acid derivative by interpretation of its MS-MS spectrum was associated with the perceived bitterness of a number of fractions. A method of purifying this compound has been developed and sensory analysis to assess its potential for eliciting bitterness is scheduled.

Novel protein stabilisation strategies

A novel magnetic separation technology that allows for selective removal of pathogenesis-related proteins from wines was developed. Magnetic nanoparticles (MNPs) have previously been used in biotechnology to separate products or immobilised enzymes from reaction mixtures and to separate cells and microorganisms, including yeast. The aim of this research was to develop a rapid and selective method to separate pathogenesis-related proteins from unfined white wines. It was hypothesised that careful tuning of the surface functionality of magnetic particles could be used to selectively capture pathogenesis-related proteins from wines which could then be separated from the system by applying an external magnetic force. For protein haze removal, carefully controlled functional groups coated onto magnetic particles were used to bind protein molecules. Figure 3A presents a schematic of the magnetic separation process. In the first step of the process magnetic beads were coated by plasma deposition of acrylic acid vapour to generate COOH-rich surfaces. This coating was selected based on previous work investigating wine absorption onto different surfaces. The second step of the process involved adding the coated magnetic nanoparticles to white wines. The final step was a simple separation of the particles from wine using an external magnet.

Nine different unfined wines with varied protein concentrations (from 10 to 400 mg/L) were tested. Figure 3B shows the concentrations of thaumatin-like proteins and chitinases in a Verdejo wine after removal with coated MNPs compared to an untreated control. Treated white wines were analysed for protein and phenolic content to assess the performance of the functionalised surface. It was found that the surface was able to selectively bind pathogenesis-related proteins from wines and hence form stable wines without affecting phenolic content.

Investigation of proteases with potential to degrade haze-forming proteins also continued during the year. The main protease studied was BcAP8, an enzyme from *Botrytis cinerea* that has shown some promise in small-scale trials. Sufficient quantities of the enzyme were produced from *Pichia* yeast cultures but in all cases, the haze formed in the heat test increased with BcAP8 addition, which indicates that this protease is not as promising as first thought. Protein stability through use of enzymes is better achieved using a combination of aspergillopepsin (AGP) enzyme with flash pasteurisation, as previously reported.

Trials of flash pasteurisation alone (without AGP enzyme) were also investigated as an alternative stabilisation strategy (Figure 4 and Figure 5). Heating grape juice for one minute at 75°C was sufficient to produce stable Semillon and Sauvignon Blanc wines. The higher protein concentration of the Muscat Gordo required three minutes of heating to produce stable wine. Therefore, pasteurisation for one to three minutes may be sufficient to stabilise wines and may be a viable alternative stabilisation strategy for the wine industry. The protease and pasteurisation results have been submitted for publication.

The use of flash pasteurisation in industry is not always possible and therefore alternative protein unfolding strategies were also investigated. A vortex fluidic device (VFD) uses sheer force instead of elevated temperature to unfold proteins and has proven to be effective for unfolding and refolding some proteins. When used in grape juice though, there was no change in protein concentration in the treated and untreated grape musts. This suggested that unfolding had not occurred because unfolding would cause precipitation and hence a change in soluble protein concentration.

Carrageenan (a food-grade polysaccharide) is another potentially viable bentonite alternative for protein stabilisation of wine. Concerns have been raised in the past about the impact of this product on filtration. A trial was established in collaboration with industry partner,

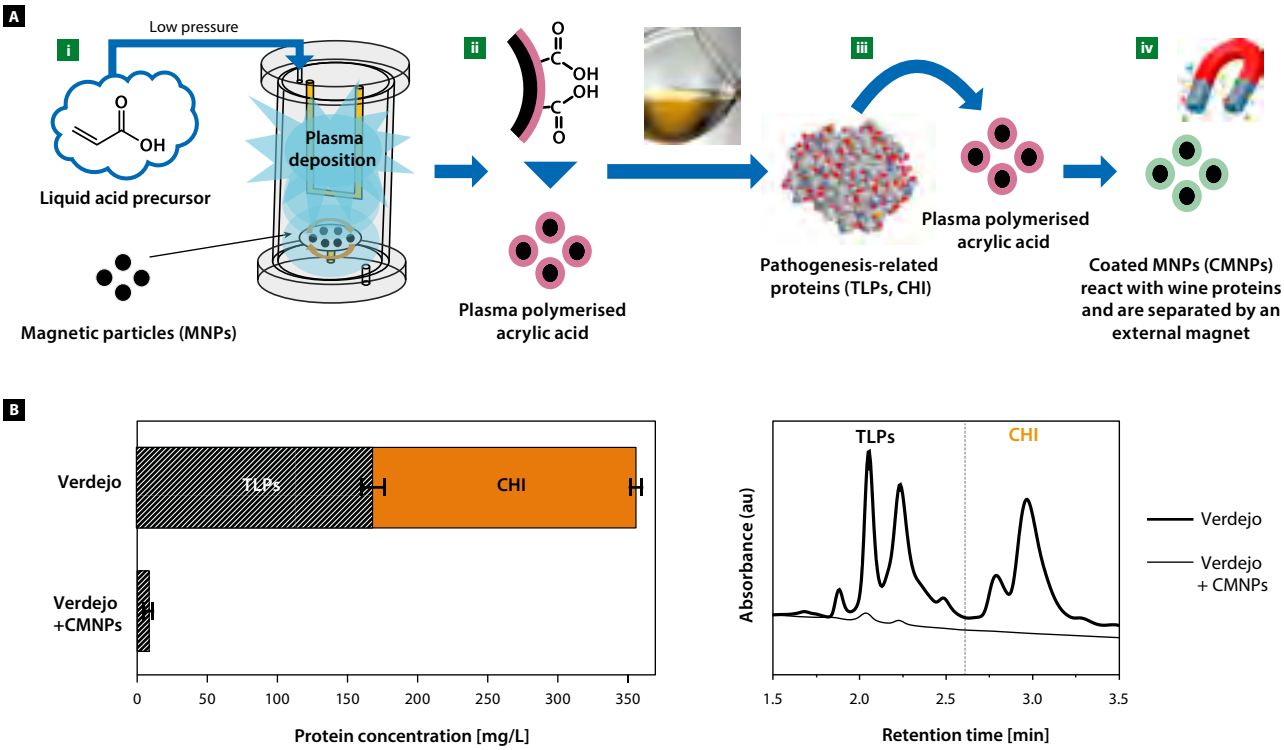


Figure 3. A. Schematic representation of i. plasma deposition of acrylic acid for generation of ii. COOH-rich ppAcrA coated surfaces; iii. functionalised surface made by depositing plasma and then reacting with wine proteins; iv. pathogenesis-related proteins in wine separated by means of an external magnetic field (a simple and rapid method)

B. Concentrations of thaumatin-like proteins (TLP) and chitinases (CHI) after removal with coated MNPs compared to control wine

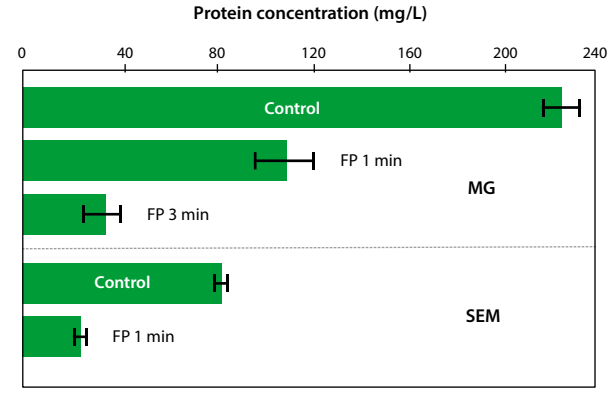


Figure 4. Protein concentration of Semillon (SEM) and Muscat Gordo (MG) wines after flash pasteurisation (FP) of grape musts (75°C for 1-3 mins)

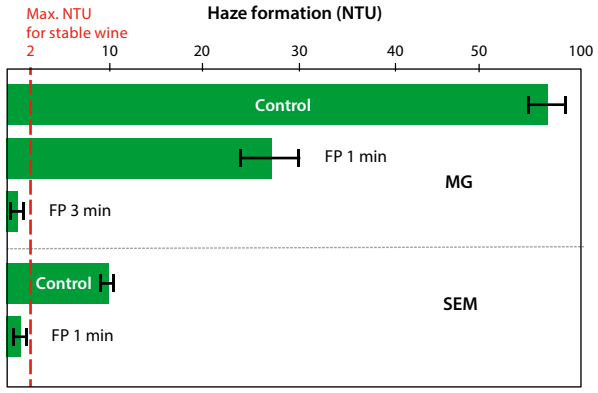


Figure 5. Haze formation of Semillon (SEM) and Muscat Gordo (MG) wines after flash pasteurisation (FP) of grape musts (75°C for 1-3 mins)

Treasury Wine Estates, to investigate the use of different settling agents and filtration aids following carrageenan use. The results of these trials will provide additional knowledge about the potential of carrageenan as a bentonite alternative.

Matrix effects on protein haze formation

The impact of matrix components (ionic strength, phenolic compounds, polysaccharides, sulfate) on the stability of chitinase proteins was investigated using nanoparticle tracking analysis (NTA). This study examined, via reconstitution experiments, the aggregation behaviour of purified chitinases and measured the size and concentration of individual particles formed by this protein before and after heating in the presence or absence of wine phenolics and/or polysaccharides and/or sulfates. The role played by ionic strength and sulfate in the aggregation of chitinases was also assessed. The study confirmed that protein haze formation in white wine is a multifactorial process where ionic strength, sulfate, phenolic compounds and polysaccharides all modulate the haze potential.

In addition, the strength of interactions between proteins and polysaccharides was assessed using isothermal titration calorimetry (ITC). When proteins were in their native state, there were limited interactions between these macromolecules. However, when proteins were unfolded, such as after heat exposure, there were weak interactions between proteins and polysaccharides. Investigation of the impact on particle formation is under way.

The influence of matrix parameters on protein stability was measured in multifactorial experiments conducted in collaboration with CSIRO. This involved exploring the influence of pH, ethanol, and salts on stability of four proteins. The results indicated that ethanol did not affect protein stability, however pH played a major role. This provides further evidence about the complexity of wine interactions and haze formation.

Impacts of filtration on wine macromolecules

Red wines (Cabernet Sauvignon and Shiraz from the 2013 and 2014 vintages) were filtered through winery-scale commercial filters in sequence, including crossflow, lenticulars, 0.65 µm and 0.45 µm membranes, with samples taken before and after each filtration grade. Macromolecules and colour parameters were measured within a few weeks of bottling, after 9 months' ageing and after 18 months' ageing. Chemical analysis indicated no change in the tannin, colour, polysaccharide concentration or composition with any grade of filtration. However, particle size did decrease with crossflow filtration (Figure 6). This was due to the removal of pre-formed complexes of tannin/protein/polysaccharides as well as residual microbes.

After 18 months of ageing, the particle size of the 2013 wines increased in all wine samples at all filtration grades. This trend was not observed in the 2014 wines. The reason for the difference in filtration recovery between the 2013 and 2014 wines is not clear and will be explored in future research.

Sensory analysis was undertaken on the pre-crossflow, post-crossflow and post-0.45 µm wines (Figure 7). There was no significant filtration-related difference in mouth-feel between samples. This suggested that winery-scale filtration does not significantly change wine macromolecules or mouth-feel but does remove the microbes associated with spoilage.

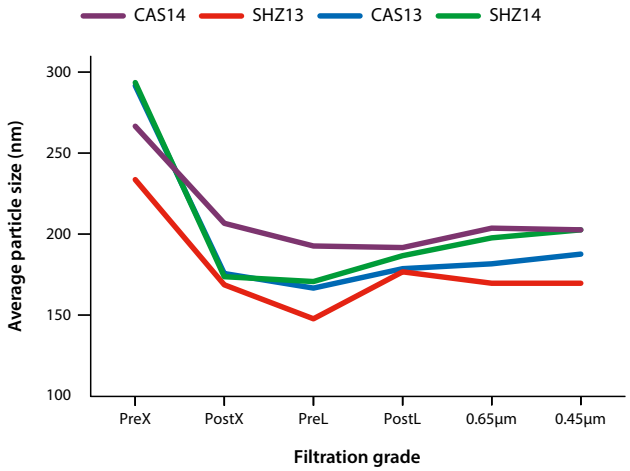


Figure 6. Effect of filtration on the average particle size of Cabernet Sauvignon (CAS) and Shiraz (SHZ) wines from 2013 and 2014. PreX (pre-crossflow), PostX (post-crossflow), PreL (pre-lenticular filters), PostL (post-lenticular filters), 0.65 µm and 0.45 µm membranes

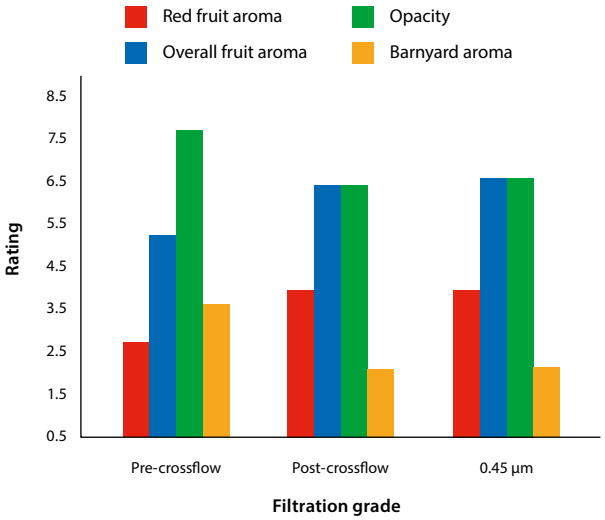


Figure 7. Effect of filtration on the sensory profiles of 2014 Shiraz wine

Development of a predictive model for determining white wine haze risk

To assess the potential for creating a predictive model for haze formation, over 100 protein-unstable 2015 vintage wines were sourced from industry partners including Kingston Estate, Treasury Wine Estates, Pernod Ricard Winemakers and Yalumba. These wines were analysed for compositional parameters of the matrix as well as protein concentration and composition. These parameters were then compared to the haze produced in a heat test. The strongest correlation with haze formation was the protein concentration, which suggests that predicting haze is best achieved with a heat test rather than through testing those particular compositional parameters.

The current heat test used in industry is both time-consuming and variable. Because of this, effort is being invested in creating a new heat test for industry that is more rapid and accurate. Preliminary trials assessed the impact of heating time and cooling time and temperature on haze formation. Longer heating and longer cooling times at lower temperature produced greater haze but it was uncertain how this affected the bentonite fining rate. A range of unstable wines from the 2016 vintage were obtained from Yalumba. Wines were fined at the bentonite concentrations predicted by different heat tests and have been stored at different temperatures to assess haze formation after 12 months' storage. The results of these trials will ultimately be used to refine the current heat test to be a more efficient measurement for the wine industry.

Macromolecule and colour extraction, stability and retention - influence on wine style and production practice

This project aims to understand how macromolecules are influenced by winemaking techniques, their relative stability and size in solution and how this ultimately affects wine production processes and texture. A range of maceration techniques were applied to determine their relative impact on the extraction of tannin, polysaccharide and colour. The techniques applied either alone or in combination were: microwave maceration, macerating enzyme, extended maceration, yeast selection and marc addition. Large differences in tannin, colour and polysaccharide concentration were achieved using these diverse maceration approaches.

For the study of microwave maceration, and other maceration techniques to improve macromolecule extraction in Pinot Noir, collaboration with Dr Anna Carew and Dr Fiona Kerslake (Tasmanian Institute of Agriculture) continued. For multiple Pinot Noir fruit sources,

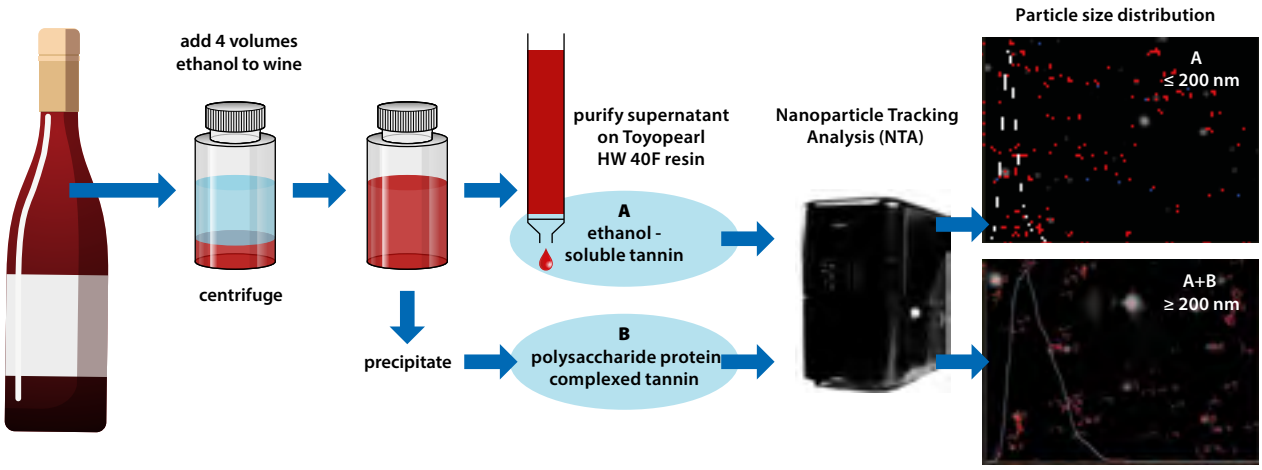


Figure 8. Technique to measure particle size of defined combinations of wine macromolecules using Nanoparticle Tracking Analysis (NTA)

microwave maceration was found to be more successful in the extraction of tannin and anthocyanin and the development of stable colour than other maceration techniques. These microwave-macerated wines were also of interest in the study of colloid formation and stability using NTA (Figure 8) (Bindon et al. 2016a). The application of microwave maceration increased the concentration of wine protein, polysaccharide and tannin, leading to increases in total particle concentration. There was no effect of microwave maceration on particle size, suggesting that the complexes formed were stable (≈ 200 nm).

The effect of maceration was also studied in a large trial on Shiraz investigating the interactive effect of maceration time (7 and 30 days), macerating enzyme and yeast strains (high-tannin versus low-tannin). Macerating enzyme application decreased both polysaccharide and particle size and concentration, but only during short maceration times (7 days). Extending maceration facilitated increased extraction of tannin, and both grape and yeast polysaccharides, and under these conditions this particular enzyme application had a limited effect on wine composition. Particle size averages ranged from 130 to 160 nm, suggesting that the selected maceration techniques were unlikely to affect wine colloidal stability.

To better understand the impact of enzyme on macromolecule extraction and stability, a more in-depth study was performed using model fermentations and purified cell walls. A visiting scientist, Dr Federica Blando from the Institute of Sciences of Food Production in Lecce, Italy was involved with this project under an OECD fellowship grant. Enzyme application was found to increase tannin extraction primarily by a drastic deconstruction of the cell walls, leading to reduced total marc recovery by weight but interestingly, no increase in lees biomass. Model cell wall studies and wines made by PhD student Sijing Li (University of Adelaide) showed that this was because the enzyme increased polysaccharide concentration initially, but depolymerisation to sugars was ongoing, leading to a large release of galacturonic acid (from pectin) and reduced final polysaccharide concentration. Enzyme application reduced the ability of grape cell walls to adsorb tannin, but at the same time resulted in an increased release of protein from grape mesocarp (pulp) cell walls. This protein, although a minor component of the cell wall, could remove up to 50% of tannin from solution by the formation of unstable complexes. These complexes eventually precipitated, and were too large for an accurate size to be determined by NTA, but could be visualised by microscopy (Figure 9). This identified a potential mechanism by which extracted grape tannin may be lost from wine during vinification, theoretically proceeding until all protein (or all tannin) is removed from solution. This might explain why enzyme application does not always result in significant increases in tannin concentration.

In the 2016 vintage, macerating enzyme application was explored further, along with addition of white marc as another way to modulate tannin during Shiraz maceration. Wines were made from two fruit parcels at different ripeness, achieving target alcohol levels of 11% (lower alcohol wine) and 14.6%. Investigation of the impacts of this experiment on a range of chemistry and sensory outcomes is under way.

References

Bindon, K.A., Carew, A.L., Mierczynska-Vasilev, A., Kassara, S., Kerslake, F., Smith, P.A. 2016a. Characterization of macromolecular complexes in red wine: Composition, molecular mass distribution and particle size. *Food Chem. 199*: 838-846.

Bindon, K.A., Kassara, S., Smith, P.A. 2016b. Toward a model of grape tannin extraction under wine-like conditions: the role of suspended mesocarp material and anthocyanin concentration. *Aust. J. Grape Wine Res.*, in press.

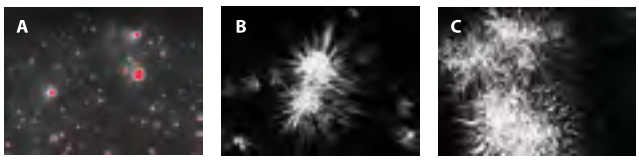


Figure 9. Formation of insoluble tannin-protein complexes leading to precipitation in model wine. A. Soluble mesocarp material (containing grape proteins); B. Complexes formed 5 min after tannin addition; C. Complexes formed 60 min after tannin addition

Optimise primary and secondary fermentation for effective production of targeted wine style

Staff

Caroline Bartel, Dr Eveline Bartowsky, Jenny Bellon, Dr Anthony Borneman, Dr Paul Chambers, Dr Toni Garcia Cordente, Dr Peter Costello, Dr Chris Curtin, Simon Dillon, Angus Forgan, Radka Kolouchova, Jane McCarthy, Dr Simon Schmidt, Mark Solomon, Dr Peter Sternes, Dr Cristian Varela.

Students

Lisa Hartmann, Federico Tondini (University of Adelaide).

Visiting scientist

Dr Federica Blando (to 10 October 2015, Institute of Sciences of Food Production, CNR, Lecce, Italy).

Collaborators

Accolade Wines (Matt Caldersmith, Nicholas Bowen); Bolney Wine Estate, UK (Liz Morgan); Deviation Road (Kate Laurie); Gusbourne Estate, UK (Charlie Holland); Nyetimber, UK (Cherie Spriggs); Pernod Ricard Winemakers (Nick Bruer, Tony Hooper); Plumpton College, UK (Dr Matteo Marangon).

Are there regional microorganisms and can they be harnessed to produce regionally distinct wine styles?

Background

Regional wine style expression has been identified as one way that wine companies can differentiate their products in the market. An important aspect of terroir, particularly where spontaneous fermentations are performed, may be differences in wine microbiota. Focused microbiological research has shown that both vineyards and spontaneous fermentations contain diverse mixtures of microbial species (often with species being represented by multiple strains). However, the inability to efficiently and accurately assess the large numbers of samples required to understand such complex systems has limited subsequent insights.

Recent advances in metagenomics (genomic sequencing of mixed microbial communities), can address these issues by providing detailed identification of species, and their proportions, in complex microbial mixtures in a high throughput manner. In addition, through detailed genomic assembly of these datasets, the genetic make-up of individual strains within these mixtures can also be obtained to provide direct links between novel genetic and phenotypic characteristics. This type of metagenomic analysis has been refined for studies of wine fermentation at the AWRI and now provides the technical platform to answer important questions regarding Australian wine microbial terroir.

Vintage 2016

Metagenomic analysis is currently being performed on more than 100 samples (Chardonnay and Shiraz) sourced from thirty wineries across Australia during the 2016 vintage. This analysis will determine both the identity and proportions of yeast and bacteria that were present throughout the fermentation of these wines.

This represents the beginning of a highly detailed map of the microbial landscape of Australia's wine-producing regions. Furthermore, by providing an understanding of the relationship between specific wild microorganisms and terroir, this could provide the means to exploit desirable winemaking attributes, while inextricably linking these wines to their place of origin.

Enhanced winemaking outcomes and wine style diversification through provision of fit-for-purpose yeast starter cultures

Background

It is common practice for winemakers to choose particular yeasts in pursuit of desired wine styles. New yeasts that impart novel flavour profiles or that accentuate specific varietal characters can provide winemakers with an expanding array of options to achieve stylistic flexibility. This project aims to facilitate the development of wine styles with distinctive flavour profiles and the production of existing

SIMON DILLON AND ANTHONY BORNEMAN

wine styles with lower input costs, with a particular focus on the contribution of yeast to red wine flavour. A broad approach is being taken to microbial modulation of wine flavour, including harnessing the overall genetic diversity of yeast germplasm (both within and outside the *S. cerevisiae* species) with the objective of establishing yeast 'flavour profiles' and accompanying genomic markers. Classical breeding, mutagenesis and interspecies hybridisation, guided by genomic insights into 'what each genome brings to a wine strain', are being applied to generate novel wine strains that modulate red wine flavour, display appropriate flocculation behaviour, produce low levels of off-flavours and exhibit stable performance.

Benchmarking yeast strain impact on wine composition

Building on the previous year's work in which the fermentation characteristics of approximately 100 genome-sequenced yeast strains were evaluated, correlations have been established between genomic datasets and, for example, the production of volatile sulfur compounds. In addition, 54 spores of wine yeasts have been trialled in fermentations. Data from these ferments is being processed and will contribute to the mapping of wine-relevant traits to genomic datasets. Knowledge gained will provide a foundation for future development of novel fit-for-purpose starter cultures.

Boosting floral aromas in red and white wines

Using a non-GMO approach, AWRI scientists have generated variants of an industry workhorse wine yeast (AWRI796) that produce enhanced levels of 2-phenylethanol (2-PE) and 2-phenylethyl acetate (2-PEA). These compounds impart 'rose'/'floral' aromas in wines. Fermentation trials using one of the variants in a range of juices consistently showed large increases in the levels of 2-PE and 2-PEA in the resultant wines. Descriptive sensory analysis was generally favourable for the white varieties, with Chardonnay in particular scoring highly for desirable 'floral' aroma. In reds, however, the descriptors were more varied and not always positive. Further work is required to determine the potential applications of this novel yeast particularly in the context of red wine.

Novel application for interspecific hybrid wine yeast

A small number of interspecific wine yeast hybrids (two already commercialised and three currently at research status) have been evaluated for sparkling wine production in Australian and UK wineries. A collaboration with Plumpton College in the UK led to winemaking trials with three of Britain's premier sparkling wine manufacturers: Nyetimber, Gusbourne Estate and Bolney Wine Estate. A selection of the resultant wines from the above trials was successfully showcased in a workshop at the International Cool Climate Wine Symposium held in Brighton, UK in May 2016. This has led to considerable interest in using interspecific wine yeasts for sparkling wine production.

Defining the nutritional drivers of yeast performance and matching yeast to must

Background

From the AWRI's extensive experience in the rescue of suboptimal fermentations, it has become increasingly clear that the ability to predict problematic fermentations, beyond an understanding of the impacts of sugar and nitrogen, is extremely poor. Work is therefore in progress to develop a greater understanding of the interactions of yeast strains with their environment. While currently over 200 yeast strains are available to the wine industry, there is limited detail available on how they perform in different contexts. This project aims to expand knowledge of yeast strain performance under a range of environmental conditions (i.e. in grape juices of widely varying composition as used for a range of wine styles) and inform winemakers about how they can reduce the risks of suboptimal fermentations through yeast strain choice.

Defining yeast strain relationships through whole genome sequencing

Whole genome sequence data is now available for 200 wine yeast via the National Center for Biotechnology Information short read archive under the accession number SRP066835. This data archive contains genomic sequence information on wine, ale and cider yeasts of commercial and environmental origin, including species of *Saccharomyces cerevisiae*, *Saccharomyces uvarum* and hybrids of *S. cerevisiae* with non-*cerevisiae Saccharomyces* yeast including *S. eubayanus*, *S. paradoxus* and *S. kudriazevii*. The comparative analysis of this data has been published in the journal *Genes|Genomes|Genetics*.

Parallel phenotypic assessment using barcoded strains

A barcoded wine yeast collection developed in previous years is now being used to assess strain fitness in a variety of environments that reflect the natural compositional variation in winery-produced grape juice. Variables such as nitrogen, sugar, copper and vitamin concentrations and a range of temperatures and pH levels have been evaluated individually and in combination. Some individual factors were strong discriminants of yeast performance whereas combinations of difficult conditions had a levelling effect on competitive fitness rather than allowing the fittest to rise to dominance. Following the determination of individual yeast fitness profiles, more traditional genetic approaches, such as mating and phenotyping of progeny, are being used to identify the determinants of fitness in different environments.

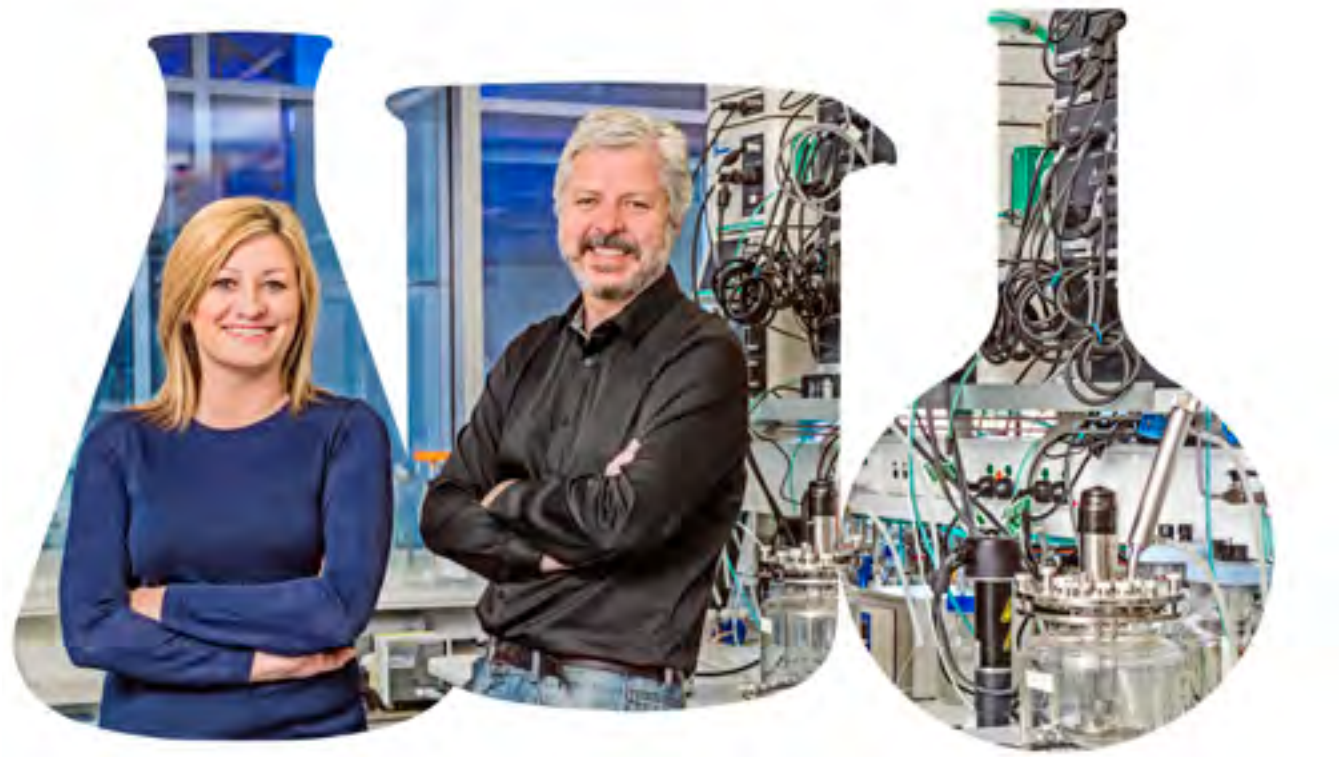
Efficient and reliable malolactic fermentation to achieve specification wine style

Background

Malolactic fermentation (MLF) is an important but sometimes unreliable stage in the winemaking process, with the potential to significantly affect wine quality. In recent years, research at the AWRI has improved MLF efficiency by developing co-inoculation strategies (yeast and bacteria inoculated together) that have been demonstrated to reduce overall fermentation time. However, achieving a reliable MLF still provides winemakers with challenges from time to time. One contributing factor is the lack of MLF starter strains specifically suited to Australian winemaking conditions, as commercially available strains have largely been selected and developed for overseas markets. In addition, while MLF is primarily used for wine deacidification, there is a significant but largely hidden pool of grape and wine aroma compounds in wines that can be released during MLF to influence wine style and enhance complexity. In previous research the AWRI identified compounds and potential enzymatic pathways that enable some *O. oeni* strains to enhance berry aromas in red wine. More recently, the genomes of many *O. oeni* strains have been sequenced and this revealed extreme genetic diversity across the species. While a high level of genetic diversity provides a promising opportunity to identify MLF strains with unique properties, there is currently little information available regarding genomic markers for wine-relevant phenotypes.

Novel AWRI isolates of Oenococcus oeni *showing potential in industry trials*

After screening a large cohort of genomically sequenced AWRI isolates of *O. oeni* strains for tolerance to a range of stresses typically encountered during malolactic fermentation (MLF), seven robust strains were chosen for further analysis at laboratory scale. These strains proved to be efficient at performing MLF and from a comparative genomics perspective represented a broad range of genotypes. Trials were conducted in red, white and sparkling base wines. Only one of the seven strains was problematic in that it produced a red wine with slight reduced character; this strain was eliminated from further trials. Two of the strains that performed well at laboratory scale in all wines and



JELENA JOVANOVIC AND ANGUS FORGAN

produced fault-free wine were selected for trialling at winery scale with industry partners. Data from these trials is being processed but preliminary feedback from winemakers is promising. At least one of the strains will be used in much larger scale fermentations next vintage, in part because of positive sensory attributes that it imparted.

Safeguarding and realising the potential of the Australian wine microbial germplasm collection

Background

The AWRI Wine Microorganism Culture Collection (AWMCC) originates from early microbiological investigations in Australian wines by John Fornachon in the 1940s and the earliest days of the AWRI. Since that time ongoing additions from wineries and researchers across Australia have created a repository that houses the Australian wine industry's microbial germplasm heritage. The AWMCC currently holds more than 2,900 yeast and more than 1,100 bacterial strains, with an electronic database used to record information about each strain and to manage their movement and intellectual property.

In its large collection of microbes, the AWMCC holds reference strains, research strains and a large number of Australian indigenous yeast and bacterial isolates. Many of these have yet to be identified and characterised for what they can bring to winemaking. This largely untapped resource has the potential to provide Australian winemakers with novel yeast and bacterial winemaking strains for efficient and reliable fermentations; it also offers a means to shape unique wine styles or to more fully express regional characters.

Identification, storage and distribution of microbial strains

In 2015/2016, 310 yeast and bacterial strains were submitted to the AWMCC from researchers and wineries. All strains submitted were checked for purity, had their identity determined and were placed into cryogenic storage at -80°C. An additional 67 strains already present in the AWMCC were identified. During the year the AWMCC distributed 401 yeast and bacterial strains from cryogenic stocks.

Novel products and effective processes

Staff

Dr Anthony Borneman, Dr Paul Chambers, Dr Chris Curtin, Dr Martin Day, Dr Markus Herderich, Radka Kolouchova, Dr Simon Schmidt, Dr Paul Smith, Dr Cristian Varela, Dr Eric Wilkes.

Collaborators

Hentley Farm (Siobhan Wigan); Yalumba Wine Company (Louisa Rose, Luke Wilson, Matt Zadow).

Technologies and strategies for the production of lower-alcohol wine

Background

There is interest from some consumers in wines with lower alcohol concentration that maintain robust aroma and flavour profiles. Producers may also face financial penalties for higher alcohol wines in markets where taxes are levied on the basis of alcohol concentration.

The microbial biodiversity of spontaneous fermentations contains great potential for shaping wine style, including the production of wine with reduced alcohol concentration. Harnessing this diversity in controlled, inoculated ferments may provide winemakers with simple, cost-effective and low risk strategies for tailoring wines to market demands. Non-conventional yeast (yeast other than *Saccharomyces cerevisiae*) have the potential to remove some fermentable sugar from must prior to inoculation with *S. cerevisiae*.

Sensory profile of wines produced by 'lower-ethanol' non-conventional yeasts

Semillon and Merlot musts were fermented with two non-conventional yeasts *Saccharomyces uvarum* and *Metschnikowia pulcherrima*. Both yeast strains were marginally effective in reducing alcohol concentration in fresh grape must due to competition with indigenous yeast populations. Dimethyl dicarbonate was therefore used to treat

musts to reduce the indigenous microflora. Several treatments produced wines with lower ethanol concentration than control *S. cerevisiae* wines. Formal sensory analysis revealed that while wines fermented with *S. uvarum*, alone or in combination with *M. pulcherrima*, were lower in alcohol concentration, they were associated with negative sensory attributes. Wines fermented with *M. pulcherrima* were associated with positive sensory attributes and were lower in alcohol concentration than *S. cerevisiae* wines. Overall the results suggest that further work is required to render low-alcohol non-*Saccharomyces* yeasts more robust, and to ameliorate their potential negative sensory impacts.

Influencing wine style through management of oxygen during winemaking

Background

Effective management of oxygen during winemaking can help to create diverse wine styles that appeal to a range of consumers. Many approaches are currently practised; however understanding of the impact of oxygen management practices has largely been confined to those used post-fermentation, during bottling and relating to the effects of closure selection on post-bottling development. The effects of oxygen management during the process of winemaking (from crushing through to fermentation) are in contrast not well understood, with the limited information that exists relating mostly to the management of fermentation efficiency and reliability.

The role of oxygen during winemaking is likely, however, to have a profound effect on the final wine, and thus a significant opportunity exists for winemakers to use oxygen management before or during fermentation to influence critical aspects of winemaking, such as wine aroma, texture and post-bottling stability. This project combines small-scale laboratory and winery-scale experimental work, aiming to provide new insights into the timing and amount of oxygen required to achieve desirable outcomes in red and white winemaking, including the prevention of 'reductive' odours. The science and technique of adding oxygen in the early stages of fermentation is relatively new in wine science terms, and more widely accepted and used in countries such as France. Anecdotal evidence suggests, however, that small-scale work is being undertaken in this area by Australian wineries, with positive results.

Impacts on white wines of oxygen exposure during juice preparation and handling

The choice of pressing technique can have a noticeable effect on the resultant aroma and phenolic composition of white wine. Prevention of very early passive oxygen exposure during 'inert' pressing was compared with normal 'aerobic' pressing in Chardonnay wines. The large amounts of oxygen to which white grapes are exposed during pressing (in this case whole-bunch) resulted in a juice with lower phenolic load, increased higher alcohols, and modified fermentation esters, amino acids and volatile organic acids.Both resultant juices (inert and aerobic) were subsequently vinified using either reductive or oxidative handling techniques until the end of post-ferment racking. Compositional differences, resulting from either pressing mode (particularly for total phenolics) were far greater than the differences brought about by using reductive handling techniques (with extensive dry ice cover) compared to passive oxidative techniques. This was particularly the case for aerobically pressed juice where the chemical differences between handling techniques were not statistically valid. There were, however, subtle differences between reductive and oxidative handling techniques. Subsequent work from the 2016 vintage, looking at different oxygen concentrations (0, 5, 10, 15, 20%) during the pressing of Pinot Gris, indicates that increased oxygen exposure at pressing results in a longer time to complete fermentation.

Efficiency, chemistry and sensory impacts of oxygen exposure during white wine fermentation

Oxygen is a key nutrient in the context of fermentation despite wine fermentation being conducted largely anaerobically. Supplementation of ferments with oxygen has been shown to be beneficial to fermentation progress, especially if added at key growth stages. The effects of oxygen addition during white wine fermentation outside of these narrowly defined time points, have been examined, looking particularly at efficiency and chemistry impacts. Small (250 mL) and winery-scale (500 L) fermentations were used to evaluate the impacts of oxygen addition on fermentation performance and sensory characteristics of Chardonnay. Must oxygen concentration at the time of inoculation had no impact on fermentation duration or the concentration of yeast-derived aroma compounds in wine. However, aeration of ferments later than might normally be recommended still had a stimulatory effect on fermentation performance without negative consequences for wine

PAUL SMITH, ALEX SCHULKIN AND JACQUI MCRAE

sensory attributes. As such, if required (e.g. for stimulation of sluggish/stuck ferments), the use of oxygen outside the previously defined narrow window (24-72 hours post-inoculation) can be considered beneficial for ferment performance with limited risk to the sensory outcome.

Impacts of timing and duration of oxygen exposure during red wine fermentations

In 2012 it was established that stylistically diverse red wines could be created by use of macro-oxygenation during fermentation in rotary tanks using air (21% oxygen) or 40% oxygen. These wines showed bright red fruit characters, softer astringency, no reductive aromas and much lower residual metal concentrations than the wines made without oxygen. In 2016 macro-oxygenation was further explored using air in red fermentations (during pump-overs), examining the timing of addition as well as the duration or treatment. Results are currently being collated.

Reduce cost of production

Staff

Tadro Abbott, Dr Anthony Borneman, Kieran Hirlam, Dr Josh Hixson, Dr Darek Kutyna, Stephen Johnson, Dr Simon Nordestgaard, Dr Vince O'Brien, Gregoire Patacq, Dr Eric Wilkes.

Student

Lisa Hartmann (University of Adelaide).

Collaborators

Coriole Vineyards (Mark Lloyd); d'Arenberg (Chester Osborn); Dowie Doole (Chris Thomas); Macquarie University (Dr Natalie Curach, Prof. Ian Paulsen, Prof. Isak Pretorius, Dr Tom Williams); Pernod Ricard Winemakers (Dr Jean Macintyre); Tarac Technologies (Brenton Mengersen); SARDI (Dr Zhangli Du, Dr Steven Lapidge, Dr Keith Jones, Dr Sasi Nayar, Jessica Tan); Synthetic Yeast 2.0 Consortium (Prof. Jef Boeke); University of New England (Prof. Roger Hegarty).

Genomics innovation initiative

Background

Synthetic biology and metabolic engineering are frontier areas of biological research. These cutting-edge technologies represent exciting new opportunities in areas such as the creation of plant-derived pharmaceuticals, production of economically feasible sources of biofuels and major improvements in current food and beverage production.

The yeast *Saccharomyces cerevisiae* represents an obvious target for synthetic engineering. It is an established and prominent industrial microorganism, used to produce a diversity of high-value food, beverage and biotechnology products such as biofuels, pharmaceuticals, wine and beer. In addition, yeast is a key model organism for the development of new technologies in fundamental research, including genomics, transcriptomics, metabolomics and systems biology. The existing fundamental knowledge provides an extensive base on which to build a synthetic biology strategy that can be applied in an industrial setting to address key opportunities. Specific objectives of this project are to engineer *Saccharomyces cerevisiae* with new metabolic pathways to enable biosynthesis of compounds such as monoterpenes, raspberry ketone, anthocyanins and lactic acid during fermentation.

In partnership with Macquarie University, the AWRI is also a member of the international Sc2.0 collaboration that is building the world's first synthetic yeast. Macquarie and the AWRI are responsible for chromosome XIV. Other collaborating institutions on the project are located in the USA, China, the UK and Singapore.

Production of raspberry ketone by wine yeast

Raspberry ketone is the primary aroma compound found in raspberries and naturally derived raspberry ketone is a valuable flavouring agent. The economic incentives for the production of raspberry ketone, combined with the very poor yields from plant tissue, make this compound an excellent target for production by synthetically engineered microbial strains.

A *de novo* pathway for the production of raspberry ketone was assembled using four genes from other species, encoding phenylalanine/tyrosine ammonia lyase, cinnimate-4-hydroxlase, coumarate-CoA ligase 2 and benzalacetone synthase, in an industrial strain of *Saccharomyces cerevisiae*. Synthetic protein fusions were also explored as a means of increasing yields of the final product.

The highest raspberry ketone concentration achieved in minimal media exceeded 7.5 mg/L when strains were fed with 3 mM p-coumaric acid or 2.8 mg/L for complete *de novo* synthesis, both of which utilised a coumarate-CoA ligase 2, benzalacetone synthase synthetic fusion protein that increased yields more than sixfold compared to the native enzymes. In addition, this strain was shown to be able to produce significant amounts of raspberry ketone in wine, with a raspberry ketone concentration of 3.5 mg/L achieved after aerobic fermentation of Chardonnay juice or 0.68 mg/L under anaerobic winemaking conditions. This paves the way for further pathway optimisation to provide an economic alternative to raspberry ketone derived from plant sources.

Sc2.0 international collaboration

Work is in progress on the synthesis of the chromosome allocated to the Macquarie/AWRI partnership; two chromosomes are being prepared, with both due for completion during the next 12 months. The AWRI's focus is on additional work needed to ensure that the new knowledge gained about yeast through the project has relevance to yeasts used in industries such as wine, beer, sake, baking or biofuels. A pan genome for the new Yeast 2.0 platform is now approximately 50% complete and due for completion in the next 12 months. Efforts to engineer the metabolic pathways of yeast to produce flavours and aromas are also yielding results, with laboratory strains of yeast able to undertake novel transformations and/or produce novel compounds.

Using grape marc as a feed additive in commercial settings

Background

Grape marc has been identified as a potential feed additive for the livestock industry able to improve productivity and reduce methane emissions. In order for grape marc to be widely used in the livestock industry, some practical barriers regarding storage and distribution need to be overcome. This project commenced in September 2013, building on earlier AWRI research investigating grape marc tannin. Funded through the DAWR 'Action on the Ground' program, this project aims to address the practicalities of feeding grape marc to livestock. Specific areas of focus are: preventing mould formation during storage and feed-out through small-scale storage trials; developing effective large-scale storage solutions that preserve both tannin and nutritional content for year-round feeding; and integrating storage solutions and mould inhibition into realistic on-farm practices that can be applied and refined during feeding trials.

TADRO ABBOTT, KIERAN HIRLAM AND AMY RINALDO

Use as a feed additive

When grape marc was compared with maize silage (a common feed additive) over a 100-day feeding trial, no significant differences were observed for feed intake, feed use efficiency and daily live weight gain, showing that grape marc can be used in feedlots without detrimental effects on animal performance. The effects on daily methane production were modest (consistent with previous studies), with observed suppression likely due to additional oil content in the feed from the inclusion of grape marc.

Spreading the message

A series of case studies were developed in conjunction with businesses that use grape marc in their feeding regimes, focusing on practical aspects as well as reasons for using grape marc as a feed additive. The studies span both dairy and beef cattle producers, and promote the effectiveness of grape marc with the aim of achieving wider industry uptake. The case studies represent the final activities in this project. A final report will be submitted to the DAWR early in the next financial year.

Transforming Riverland food loss and industry waste into profit

Background

A substantial proportion of horticultural production is lost pre-farm gate, or removed as an industrial waste stream. These losses and wastes are often directed into low value applications such as animal feed or simply dumped; however, if waste can be regionally aggregated there is potential for higher value applications to be realised. A collaborative project with SARDI, funded through the South Australian River Murray Sustainability (SARMS) Program, will investigate opportunities to add value to food losses and industry wastes through aggregation across agricultural sectors in the Riverland, Murraylands and Murray Mallee regions.

Wine industry waste mapping

An extensive review was conducted of wine industry wastes in the Riverland and Langhorne Creek. This included an assessment of current technologies that have been applied to wine industry waste streams and those with the potential to add value. The review also considered the average chemical composition of individual waste streams and estimated production quantities. Waste mapping was initiated through region-wide surveys of producers and processors, and through site visits to establish key infrastructure that could potentially transform waste.

Reducing wine movements during production

Background

Clarification is a major reason for moving juice and wine between tanks at wineries. Each movement requires a destination tank for the clarified product and uses labour, water and cleaning chemicals, as well as creating wastewater that needs to be managed. Furthermore, significant quantities of juice/wine can be 'tied up' in lees and are commonly subject to significant quality downgrades when processed by rotary drum vacuum filtration (RDVF).

This project has investigated the possibility of 'reverse racking' as a new way to achieve clarification with fewer tank transfers. This concept involves removal of the small quantity of lees in tanks from underneath the clear juice or wine so that the bulk of the liquid can remain in the same tank. In an idealised configuration, the lees would be clarified concurrently back into the top of the same tank using an RDVF alternative that did not result in any quality degradation.

Studies of lees removal using scale-model tanks

Experiments were performed with a range of scale-model tank designs. Cylindroconical brewery-style tanks (55° sloped bottom cone) showed some promise but are not a realistic industry solution because of the investment in new tanks required. Winery-style tanks (5° bottom slope from back to the front of the tank) performed poorly due to severe channelling of wine through the lees. Baffles, moving suction feet, acoustic and other vibration equipment fitted to winery-style tanks did not

address this. However, sweeping arms at the bottom of winery-style tanks prevented channelling and allowed removal of lees until the lees level dropped below the top surface of the sweeper. As an industry solution, a sweeping arm is again not desirable as while it is compatible with winery-shaped tanks, it is a major retrofit that would need to be made to every tank and would still not allow the removal of a considerable portion of the lees. Some means of achieving the effect of the sweeping arm with a non-permanent fixture/technique would be the ideal solution. Efforts to achieve this have so far been unsuccessful. This project will now be put on hold but may be revisited in the future. As part of the wrap-up of the project, a workshop on lees will be convened at the Australian Wine Industry Technical Conference at which videos and data from the project will be presented alongside presentations from wine companies on their experiences with a range of RDVF alternatives.

Identifying cost reduction opportunities by mapping the grape and wine value stream

Background

As part of the its mission to support the profitability of the Australian wine sector, the AWRI, with the South Australian Government's Department of State Development, the McLaren Vale Grape Wine and Tourism Association and Scholle Packaging, established a design thinking program to showcase the development of business initiatives that engage consumers on attributes other than price. It was decided to progress one of the concepts (the VALO program) to commercialisation to demonstrate how innovation can rapidly generate demand for wine at a high premium. This program also aims to cultivate new opportunities for Australian wine producers to access and exploit business innovation tools.

VALO

The VALO program is centred on the creation of an iconic wine from McLaren Vale. To develop the VALO wine, a call was made for barrel samples of the best available 2014 McLaren Vale Shiraz and a total of 25 samples were received for screening. A winemaking panel screened the barrel samples and finalised the VALO blend.

The first VALO event was successfully completed and received very strong positive feedback from participants and collaborators. The event included:

- A sensory insights session informing participants of their supertaster status and their sensitivity to various flavour compounds and retronasal olfaction effects
- A 'meet the winemaker' session where four winemakers introduced barrel samples
- A wine blending session
- A fine dining lunch with the VALO winemaking panel at which a tailored flight of wines was presented.

A production replica of the VALO amphora has been built, designed by celebrated glass artist Nick Mount. The VALO amphora incorporates a titanium stem sealed to a glass grape with a unique magnetic coupling. The amphora is currently undergoing testing to ensure the integrity of the magnetic seal and slight design adaptations to enhance the opening experience.

Spin-off benefits from the VALO project to date include:

- Ongoing interest in the product from the Chinese market
- Grants supporting applications of design thinking and luxury business strategy to develop a bespoke wine for the Chinese events market and target the creation of consumer value for the Barossa Valley.

Reduce the economic impact of taints and faults

Staff

Gayle Baldock, Caroline Bartel, Dr Marlize Bekker, Dr Anthony Borneman, Dr Toni Garcia Cordente, Adrian Coulter, Geoff Cowey, Dr Chris Curtin, Yoji Hayasaka, Matt Holdstock, Dr Michael Roach, Con Simos, Dr Mark Smith, Dr Paul Smith, Dr Cristian Varela, Dr Eric Wilkes.

Student

Ryan Zeppel (University of Adelaide).

Collaborators

Charles Sturt University (Dr Andrew Clark); University of Adelaide (Dr Paul Grbin, Dr Joan Kelly, Nick van Holst); University of New England (Dr Peter Lye); Yalumba Wine Company (Dr Alana Seabrook).

Fault and taint remediation strategies and technologies – smoke taint background study

Background

During the 2010 and 2011 vintages, a survey was conducted of the baseline concentrations of volatile phenols and phenolic glycosides in grapes with no history of smoke exposure. The results of this study were used to develop a 'traffic light' smoke taint interpretation system, which is based on statistical analysis of the baseline data. The 'traffic light' system has greatly improved the helpdesk's ability to determine whether grapes have been exposed to smoke and provide advice to stakeholders. However, the 2010/2011 baseline data is limited to five varieties (Cabernet Sauvignon, Shiraz, Pinot Noir, Chardonnay and Riesling) and experience from using the 'traffic light' system has shown that baseline levels of smoke taint compounds for one variety cannot be applied to another. This makes interpretation of smoke taint analysis for other varieties challenging and means that it can be difficult for helpdesk staff to provide producers with the information they need to make harvesting decisions. During meetings held between the AWRI and a number of industry stakeholders to identify RD&E priorities in smoke taint, there was unanimous agreement that the 'traffic light' system should be expanded. Accordingly, the AWRI has commenced another baseline study to expand the current 'traffic light' system database to include five more varieties.

2016 baseline study

During vintage 2016, more than 160 grape samples of the varieties Sauvignon Blanc, Pinot Gris, Semillon, Merlot and Grenache were collected for the AWRI by industry. These varieties were chosen based on consultation with industry stakeholders and the area of plantings in Australia. In the second half of 2016, the frozen grape samples will be thawed and analysed for the concentration of volatile phenols and phenolic glycosides. Small-lot fermentations will be conducted and the resulting wines will also be analysed. The new data obtained from the 2016 samples will be subjected to statistical analysis and the 'traffic light' database will be updated with the data for the five new varieties in time for the 2017 vintage.

Ensuring the continued efficacy of *Brettanomyces* control strategies for avoidance of spoilage

Background

Brettanomyces yeast cause wine spoilage by producing 4-ethylphenol and 4-ethylguiacol which are responsible for 'phenolic', 'leather', 'sweaty' and 'medicinal' aromas (collectively known as 'Brett' character). Although wine spoilage from this yeast was a major issue in Australian red wines produced during the late 1990s and early 2000s, the risk of 'Brett' spoilage is now commonly managed via a multi-faceted strategy developed by the AWRI, enabling winemakers to significantly decrease levels of 'Brett' spoilage compounds in finished wines. Yet, *Brettanomyces* has not been eliminated from Australian wineries, and loss of wine value still occurs. To ensure Australian winemakers' continued ability to manage *Brettanomyces* in a cost-effective manner, the control strategy must be future-proofed against market pressures to minimise levels of sulfite in wine, and augmented with rapid detection methods.

The potential for emergence of sulfite-tolerant Brettanomyces *strains*

In order to determine if the genetic plasticity exists within *Brettanomyces* for it to become resistant to current control measures, several different environmental lineages of *Brettanomyces bruxellensis* have undergone long-term growth experiments under ever-increasing amounts of sulfite. Populations evolved from all of the different strains of *Brettanomyces* were shown to possess the ability to adapt to increased levels of sulfite, with many showing a doubling of their original levels of sulfite resistance. In addition, for many of these populations this resistance was stably inherited, ever after long-term growth in the absence of the selective agent. Genomic analysis of these populations and individuals from these populations, is now under way in an attempt to associate specific genetic alterations with these resistant phenotypes. Once established, these differences will provide genetic markers that may be used as an early alert mechanism to determine if resistance is developing in the field before problems with the control of *Brettanomyces* are encountered by winemakers.

Formation and fate of positive and negative sulfur compounds and copper speciation

Background

Volatile sulfur compounds (VSCs) can contribute both positive and negative attributes to wines, and their control in a winery environment is an important avenue to increasing wine value either by increasing positive attributes or avoiding negative characters. The occurrence of VSCs can be influenced by factors including: yeast selection and fermentation conditions; the nature and quantity of precursor compounds; the availability or absence of oxygen at different points of the winemaking process; and availability and speciation of transition metal ions such as copper.

Winemakers are familiar with the practice of adding copper sulfate to wines that exhibit 'rotten egg' or other 'reduced' characters when in tank. Many winemakers have also seen these 'reduced' characters disappear from their wines in the short term, only to see them return at a later date, sometimes after bottling. By exploring the chemistry of VSC formation and the important role played by metals, these common winemaking observations can be better understood, potentially leading to recommendations for ways to reduce the risk of undesirable 'reduced' aromas.

HEATHER TOSEN, KERRY PINCHBECK AND MELISSA AITCHISON

ADRIAN COULTER, PAUL PETRIE AND GAYLE BALDOCK

Origin of volatile sulfur compounds

It is generally considered that yeast metabolism is the underlying source of most sulfur-based volatile compounds in wine, either through the production of precursors or of the compounds themselves. Fermentations conducted using 100 yeast strains in a synthetic grape juice and a red must as part of the AWRI's yeast research were analysed for low molecular weight sulfur compounds and volatile thiols. The analytical results, combined with genomic data on these yeast strains, revealed that the potential of a particular strain to release the volatile thiols 3MH and 4MMP from cysteine-bound precursors correlates with certain alleles (versions) of the gene *IRC7*. The majority (75%) of yeast strains analysed were classified as low thiol releasers, and it was established that the cause for this phenotype was the presence of inactivating mutations in the *IRC7* gene.

Managing the nature of copper in wine

It has commonly been thought that when sulfides in wine interact with copper, they simply precipitate out and are removed from the wine through racking and filtration. Recent work by collaborators at Charles Sturt University has shown, however, that this is not necessarily the case. This finding, along with increased understanding of the risks of residual copper species in wine, has made it important to gain a more thorough understanding of the nature and role of copper sulfides formed in wine.

Many wine compounds have the capacity to bind copper, including organic acids (such as tartaric acid), tannins, polyphenols, and VSCs. The binding of copper to these various compounds may affect the particle size of the copper-complexes, which in turn may affect the binding sites of copper that are available to catalyse the formation of VSCs. To investigate this, the impacts of different ratios of H_2S and copper in model wine were studied using nanoparticle tracking analysis (NTA).

A decrease in the mean particle diameter was seen as the ratio of H_2S to copper increased. Furthermore, the copper-tartrate complex concentration increased with H_2S addition. At equimolar concentrations of H_2S and copper the particle size was smaller than in the other treatments, suggesting strong and uniform binding of H_2S and copper that prevented copper from further interacting with other compounds to produce larger particles. As the ratio of copper was increased in relation to H_2S, the particle size increased, suggesting that the unbound copper was available to interact with other compounds (in this case tartaric acid) to form larger particles. Further studies are needed to determine whether the smaller particle size is associated with lower catalytic ability, that is if all the binding sites of copper are occupied and prevented from further interaction with other wine compounds.

The impact of pH on complex formation was also investigated. Lower pH decreased copper-tartrate complex size and lower particle concentrations were measured when compared to copper-tartrate complexes produced at higher pH. The difference in particle size and concentration of copper-tartrate complexes suggests that the type of copper-tartrate complexes that are produced at varying pH levels may affect the binding sites of copper that are available to either catalyse the formation of VSCs such as H_2S, or quench the thiols produced to form copper sulfide complexes. Current work has shown that wine pH, copper additions and the interaction between pH and copper significantly influence VSC formation in Chardonnay and Shiraz wines post-bottling.

The chemical speciation of copper in wine

A collaborative project with Charles Sturt University (CSU) investigated the speciation of the copper found in a range of 52 commercially available wines. Using anodic stripping voltammetry Dr Andrew Clark and co-workers at CSU were able to show that levels of electrochemically labile copper as low as 25 µg/L correlated with the inhibition of free H_2S. While confirming the ability of copper to bind H_2S, the study also showed that in the vast majority of the wines tested the copper was present in non-labile forms and was not available to inhibit the formation of free H_2S. This correlates with earlier findings that residual copper in wine rarely serves to inhibit the formation of volatile sulfur compounds and in many cases appears to facilitate it.

The impact of timing of copper additions

Copper additions made immediately before bottling were found to lead to significant increases in H_2S 12 months after packaging in comparison to equivalent additions made directly after fermentation. Interestingly, these differences did not become evident until the 12-month time point, with earlier time points showing essentially equivalent results for both treatments. This work highlights the weakness of traditional benchtop trials used to determine copper additions, where only the immediate effects are assessed and not the long-term impacts in-bottle.

Methods for managing the impacts of copper

While the risks of residual copper in packaged wine are becoming increasingly apparent, copper is still an important tool for winemakers dealing with volatile sulfur characters. For this reason it is important to identify ways to manage residual copper after it has been added to wine. One possibility is to bind copper to chelating compounds that completely remove it from the wine matrix or chemically isolate it so that it can no longer participate in the formation of reductive characters. To investigate this, a range of possible chelating agents were trialled in wine. A commercial polyphenol extract was found to suppress H_2S formation at the 12-month time point in comparison to controls. As seen in the trial on the timing of copper additions, this suppression did not become evident until the 12-month time point, suggesting an interesting interaction of polyphenols, metals and other wine components occurring over time in bottle. Ethylene diamine tetraacetic acid, a common chelation agent used in food production, also demonstrated significant effects both at equimolar concentrations (to copper and iron) and in excess. The results suggest that differing metal chelation environments can be present and that these can have a significant effect on the mechanism of H_2S generation.

EXTENSION AND ADOPTION

The value of research and development is only realised in industry when outcomes are effectively and efficiently implemented by practitioners. For this to occur, both extension and support for adoption are required. Projects under this theme apply a range of proven mechanisms to communicate research outcomes, solve industry problems, provide access to relevant technical resources, educate tertiary students, foster industry adoption and bridge gaps between research and practice.

Drive productivity, sustainability and profitability through facilitating rapid adoption of R&D outcomes

Staff

Gayle Baldock, Linda Bevin, Francesca Blefari, Maria Calabrese, Adrian Coulter, Geoff Cowey, Michael Downie, Dr Peter Dry, Marcel Essling, Dr Kerry DeGaris, Dr Yoji Hayasaka, Dr Markus Herderich, Matt Holdstock, Dr Mardi Longbottom, Anne Lord, Dr Paul Petrie, Virginia Phillips, Ella Robinson, Con Simos, Dr Creina Stockley.

Collaborators

Institute of Masters of Wine (Annette Scarfe); New South Wales Department of Primary Industries (Assoc. Prof. Greg Dunn, Adrian Englefield, Darren Fahey); Bureau of Meteorology (Gary Allan, Felicity Gamble, Agata Imielska, Darren Ray, Kevin Smith); state and regional wine industry associations.

The staging and conduct of extension programs

Background

The key objectives of the AWRI's extension programs are to raise awareness and facilitate uptake of research outcomes, assist producers to understand the practical value of these outcomes and overcome any potential barriers for adoption. These aims are achieved by extending research outcomes in forms that encourage adoption by Australia's grapegrowers and winemakers. These efforts include many of the trusted and successful extension initiatives undertaken by the AWRI, for example the long-standing roadshow program, held on a rotational basis across Australian wine regions. In addition, a wide variety of training and educational programs in viticulture, winemaking, environmental sustainability and wine evaluation are delivered, including the AWITC workshop program, Research to Practice workshops, the Advanced Wine Assessment Course and other tasting events. Staff that contribute to extension programs also produce content for many of the AWRI's publication commitments. See Appendices for more details.

Roadshow seminars and workshops

During the year, 19 days of roadshow seminars and 8 days of roadshow workshops were held in the following Australian winemaking zones and regions: Bendigo, Barossa Valley, Canberra District, Clare Valley, Coonawarra, Geographe, Goulburn Valley, Granite Belt, Great Southern, Hunter Valley, Langhorne Creek, Limestone Coast (Kangaroo Island), McLaren Vale, Mudgee, Murray Darling, Orange, Pyrenees, Riverina, Riverland, Rutherglen, South Burnett, Tasmania and Yarra Valley. These events included three smoke taint seminars that were delivered in response to bushfires that occurred in Frankland River, Geographe and Tasmania and a stuck fermentation seminar held in Yarra Valley in response to stuck fermentation issues occurring in central Victoria.

In order to maximise attendance, events are publicised via a range of mechanisms including the Australian Grape and Wine Events Calendar, the AWRI website, social media, state and regional association websites and local press. In addition, staff liaise with the local association(s) to coordinate local promotional efforts within the region(s), including discussion at local association meetings, direct email notification and often placements in print media. A total of 581 participants attended seminars across the 19 events, and a total of 193 participants attended the 8 workshops this year.

Electronic events and communications

The AWRI webinar series complements other extension events and is considered an effective method for disseminating information and knowledge to people located across multiple regions at one time. A comprehensive program was presented by AWRI staff and external experts during 2015/2016, with topics including soil health, cover crops, the use of unmanned aerial vehicles in viticulture, sugar to alcohol conversion and closure technologies.

Extension staff are also responsible for contributing a significant amount of content to the AWRI's communication platforms including the AWRI website, *eBulletins, eNews, Technical Review,* Wine Australia's *RD&E News* and a regular column in the *Australian & New Zealand Grapegrower & Winemaker.* See Appendix 7 for further details.

Advanced Wine Assessment Course

Three Advanced Wine Assessment Courses (AWACs) were held at the AWRI during the year, with 16 participants in each course. The course is delivered over four days with more than 40 hours of content. Participants evaluate more than 300 wines under simulated wine show conditions. Lectures are presented by AWRI staff and the course features guidance from a range of wine show judges, journalists and winemakers.

At each course, the top performing participant (based on statistical analysis of scores, verbal skills and group interaction) is named dux of the course and given the opportunity to participate as an associate judge at a national wine show. This year the dux winners for AWAC 36, AWAC 37 and AWAC 38 were announced: Tim Perrin (Oakridge Wines), Tim Bourne (Sons of Eden) and Stephanie Dutton (Penfolds). The three dux recipients were all offered associate judging positions at the 2016 Royal Adelaide Wine Show.

Continuous improvement is an important part of AWAC. This year electronic scoring software was successfully integrated into the course; this software is being developed further so that it can be used by wine shows.

Wine judges program

To provide further insight into wine show judging, the AWRI launched a new one-day wine judging course. Three highly respected current or former national wine show chairs lead the program. Each participant is allocated into a panel and under the guidance of the panel chair, each panel tastes and scores a number of classes of wines selected from a recent national show. Wines are judged under conditions that replicate those followed by the Australian wine show system. Two courses were delivered in July and November. There has been strong interest in this program and it is likely that it will be held annually.

Tailored tasting events

For the fourth consecutive year, the AWRI teamed up with the Barossa Grape and Wine Association to offer a 1.5-day 'Wine Assessment Tasting' in June 2016. From the twelve participants in the course, six were selected as associate judges for the 2016 Barossa Wine Show. This partnership is working well as a mechanism to identify and develop talent at a regional level.

Collaborations with Wine Australia

The AWRI continues to support the promotion of Australian wine, and was invited by Wine Australia to participate in the Vinexpo event held in Hong Kong. The AWRI provided a booth with a wine education focus, presenting common wine aromas, both positive and negative, including 'Brett', 'cork taint', 'pepper' and 'eucalypt' characters. The booth had a high profile with both trade and consumers, and received very positive feedback. A masterclass was also presented on pepper and spice characters in Australian Shiraz.

Institute of Masters of Wine

The AWRI's continuing collaboration with the Institute of Masters of Wine (IMW) includes an opportunity for AWRI staff to participate in IMW events in Europe and the USA. Adrian Coulter travelled to the UK and Bordeaux in February to deliver a number of presentations to students as part of the IMW international seminar.

Research to Practice

The Research to Practice (RtP) training model provides practical, themed, user-pays training sessions for the wine sector. AWRI staff and external providers contribute to the design and delivery of the programs. One module on grapevine nutrition, attended by 20 participants, was presented during 2015/2016 (see Appendix 2 for details).

NSW weather station network

The NSW weather station network forms part of a broader electronic pest and disease warning system, a key initiative of the Skills Development Program for NSW grapegrowers and winemakers. In 2015/2016, 22 weather stations located at Griffith, Hunter Valley, Orange, Tumbarumba and Canberra were added to the online network available via the AWRI website, bringing the total number of weather stations to 32. NSW grapegrowers and winemakers have around-the-clock access to weather data such as air temperature, soil temperature, rainfall, wind speed, wind direction and frost hours.

Specialised technical troubleshooting and responsive helpdesk services for the Australian wine sector

Background

The AWRI's technical helpdesk is a key service offered to grapegrowers and winemakers across Australia. It provides rapid, confidential support on a wide range of topics including winemaking, viticulture, health, regulatory and trade issues, delivered by a team with extensive industry experience and detailed knowledge of grape and wine technical issues. Industry personnel are able to contact the helpdesk by phone or email to ask advice, seek information or discuss issues. Samples can be submitted for problem solving investigations which may involve sensory, chemical or microbiological analysis. By identifying and quickly resolving issues as they arise, the helpdesk assists producers to minimise volume, quality and reputational losses while maintaining strict confidentiality.

Over 2,000 enquiries were received during 2015/2016 (Table 1), approximately 10% more than the previous year. A database of all queries allows trends and spikes to be monitored, and appropriate responses coordinated and implemented as required. More than 80% of enquiries received during the year were answered within 24 hours.

Table 1. Enquiries received by the AWRI helpdesk in 2015/2016

	Number of enquiries
Winemaking	1,336
Viticulture	657
Regulatory	99
Total	**2,092**

Winemaking enquiries

The majority of the winemaking enquiries received during the year were from wine companies and suppliers closely aligned with the wine industry, with the remaining queries originating from government organisations, students, legal practitioners and journalists. Approximately 20% of winemaking-related enquiries resulted in investigations, with samples requested and further analysis performed to identify the problem and recommend a process for remediation. Figure 10 shows the sources of winemaking enquiries in relation to the proportional volume of wine-grape production for each state/territory.

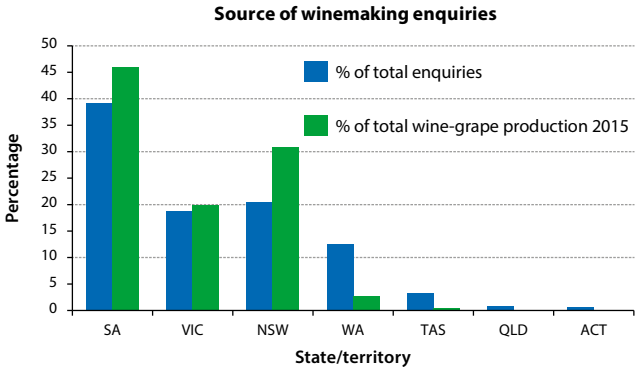


Figure 10. Winemaking enquiries received by the AWRI helpdesk team in 2015/2016 by state/territory, compared to wine-grape production

The type and number of enquiries received by the helpdesk varied considerably, largely dependent on the time of year. Vintage 2016 was another rapid and compressed vintage across many wine regions in Australia. Above average yields due to higher bunch numbers (caused by warm conditions in spring 2014) and a compressed vintage again placed stress on harvest and processing infrastructure. There was a delay in harvesting some blocks which resulted in high baumé fruit and higher alcohol wines. Ferment speeds tended to be fast, either to turn tanks over quickly to be prepared for the next batch of fruit or because of insufficient refrigeration capacity to cool both grapes and ferments. Some fermentation problems were also observed, with winemakers having little time or spare tank space to deal with stuck or sluggish ferments promptly.

During January and February, bushfires occurred in some states, with Western Australia affected early in the season, and Tasmania following later, with some vineyards experiencing lingering smoke haze in the lead-up to harvest. Again this created significant concern among growers and winemakers about smoke taint. A number of factors can influence the likelihood of a smoke event causing smoke taint in wine. Analytical data from testing volatile phenols and their non-volatile glycoside precursors can give a good indication as to whether or not fruit has been exposed to smoke. Sensory and chemical analysis of small-scale ferments can also assist in assessing the likely impact on final wines; however, this does take additional time to complete. Many calls to the helpdesk were taken during this period requesting assistance with interpreting analytical results. In some cases, where the results indicated that the wine contained only slightly higher levels than might be expected for non-smoke exposed vineyards, some winemakers very sensitive to smoke taint still saw signs of smoke-related characteristics.

For vintage 2016 the majority of analytical results were found to be similar to, or only slightly higher than, levels that might be expected for non-smoke exposed vineyards, making it difficult to use analytical data alone to determine the extent of any taint.

Viticultural enquiries

During the year, the viticulture team responded to 657 viticulture-related enquiries, an increase of about 35% on the previous year. Around one-third of viticulture queries related to sustainability matters. The next most common topics for queries were agrochemicals (16%), vineyard pests/diseases (9%), vineyard practices (8%) and viticulture in general (7%). Other common queries covered weather, grapevine varieties and smoke taint.

Agrochemical queries were dominated by questions about captan, a commonly used fungicide that was removed from the list of 'recommended' products for export wine due to a regulatory change proposed by the European Union. Fungal diseases made up about two-thirds of the pest/disease-related queries with most of the remainder being about insects. Issues with *Botrytis* were seen particularly from NSW following the wet weather shortly before harvest. Queries about trunk diseases were also relatively common.

For the most part viticulture queries to the AWRI helpdesk service followed national plantings, that is to say that about half of the queries were generated in SA where 50% of vineyard plantings are located. The exception to this was in Victoria where less than 10% of queries originated, even though that state is home to over 17% of the vineyard area. The states/territories with a larger share of queries than their planted area would suggest are those with smaller plantings, namely the ACT, Tasmania and Queensland.

Regulatory enquiries

There were 99 regulatory-related enquiries during 2015/2016. One area of interest during the year was questions about health and nutrition labelling for wine and wine products. Broadly these questions can be divided into the topics of alcohol, allergens, preservatives and health and nutrition statements for Australia, which all fall under the auspices of the Australia and New Zealand Food Standards Code. As the incidence of food allergies and intolerances is increasing worldwide, sensitive consumers are looking into all aspects of their daily diet and this includes wine consumption. Common misconceptions about allergens in wine relate to histamine and sulfur dioxide. Other regulatory queries included:

- migration of phthalates from various packaging materials and consequent concentrations in wine including available analyses
- concentration and potential toxicity of elements such as arsenic, copper, fluoride, iron, lead and manganese in wine
- accuracy and legality of glucose-fructose measurements versus other methods for sugar measurement in wine
- methods for measurement of titratable acidity in wine
- Australian and international status of water additions in winemaking
- Australian and international methanol limits for wine and related toxicity
- organic wine standards and certification
- product specifications for DAP and tartaric acid preparations
- legality of compounds such as ascorbic acid versus erythorbic acid, aspergillopepsins, carboxymethyl cellulose, copper sulfate, dimethyl dicarbonate, resveratrol and tea tannins in Australia and international markets, including natural versus synthetic products.

Winemaking problem solving investigations

In 2015/2016 the AWRI helpdesk team conducted 247 winemaking problem solving investigations. This figure is more than 20% higher than the previous year and the highest number since 2006/2007 when 278 investigations were conducted. The extra investigations included more sensory assessments and taint/contamination investigations. The number of samples analysed as part of these investigations also increased by more than 10% this year (Table 2). A breakdown of the investigations conducted by state/territory is shown in Table 3. Trends are generally similar to previous years, with SA, Victoria and NSW accounting for the highest numbers of investigations. The number of investigations conducted for wineries located in Tasmania increased for the third year in a row. The sources of the winemaking investigations conducted compared with the volume of wine-grape production of the different states/territories is shown in Figure 11.

Table 2. Winemaking investigations conducted, and samples analysed, by the AWRI helpdesk team during the past three years

Type of investigation	2013/2014	2014/2015	2015/2016
Identification of hazes and deposits	63	53	55
Microbiological investigations	26	23	29
Sensory assessments	36	48	68
Taint and contamination problems	37	47	61
Other investigative analyses	31	29	27
Closure-related investigations	8	4	7
Total number of investigations	**201**	**204**	**247**
Total number of samples analysed	**1,059**	**1,152**	**1,291**

Table 3. Winemaking investigations from the past three years broken down by state/territory

State/territory	2013/2014	2014/2015	2015/2016
SA	97	102	107
VIC	35	34	57
NSW	39	36	51
WA	19	19	20
ACT	5	1	1
TAS	4	8	11
QLD	2	4	0
Total	**201**	**204**	**247**

The total number of investigations conducted on wines affected by hazes and deposits continues to be substantial and was slightly higher than the previous year (Figure 12). More than 20% of the deposits identified this year were crystalline, with slightly more potassium hydrogen tartrate deposits than calcium tartrate deposits. Other deposits identified in significant numbers were protein hazes from heat-unstable wines (>15%) and yeast cells (>15%), most likely caused by ineffective filtration or contamination during packaging. There were two investigations which identified the presence of quercetin dihydrate crystals, which are easily distinguished by their fibrous and needle-like crystalline appearance. Quercetin dihydrate is one of the flavonol compounds that occur naturally in grape skins and leaves. Flavonol deposits in wine are relatively rare, but some viticultural practices such as increased sun exposure of fruit and machine harvesting can contribute to elevated levels of these compounds in wine (Ziemelis 1982). Quercetin glycosides are extracted from grape skins during fermentation and then hydrolyse under acidic wine conditions to release the free quercetin. The quercetin may then crystallise, incorporating water molecules in the process, and form a deposit. No predictive tests for quercetin dehydrate crystal formation are available.

The number of investigations conducted into microbiological instabilities also increased slightly this year (Figure 13). Stuck and sluggish fermentations were the most common of these. It is quite difficult to pinpoint the reason(s) behind stuck or sluggish fermentations due to the dynamic nature of grape juice fermentation; however early in vintage 2016 the helpdesk team began investigating stuck ferment wines to see if any specific compositional factors might be important this year. In particular, the team looked for unusual acidity or nutrient profiles, higher baumé levels and unusual vineyard microbial populations or agrochemical residues present due to rapid ripening of fruit. Several wine regions were also visited later in the vintage to try to understand the root causes behind stuck fermentation issues.

For the ferments that were examined, results revealed:

- Agrochemical residues from late sprays had not impeded fermentation.
- Sulfur dioxide levels in grapes and ferments were within acceptable ranges and therefore unlikely to have caused fermentation problems.
- Acidity levels, including organic acid profiles, were within typical ranges compared to other vintages. Compressed vintages can lead to pH and TA imbalances. A few wines did have volatile acidity levels >0.8 g/L which can have a negative effect on fermentation.
- Nutrient levels (YAN and amino acids) were considered typical and no sulfide issues occurred during fermentation.

All of these 'typical' results suggested that higher sugar and alcohol levels were likely to be the main causes of this year's stuck or sluggish fermentations. Most winemakers had inoculated with alcohol-tolerant yeast strains, so strain choice did not appear to be a major factor, but winemakers did report that fermentations had been faster than usual. This may have increased stress on yeast, making it more difficult for them to finish fermenting the last 1-2 baumé of ferments. Lack of time and tank space to deal with stuck ferments immediately was also an issue.

Other issues investigated under the category 'microbiological instabilities' included wines with high volatile acidity, mousiness, stuck malolactic fermentations, wines not holding free sulfur dioxide (typically due to yeast growth), wines containing viable yeast and bacteria, and wines affected by *Brettanomyces* spoilage.

During 2015/2016 there were seven investigations relating to closures, compared to four the previous year. Most of the closure investigations related to wines leaking for reasons including refermentation, cork

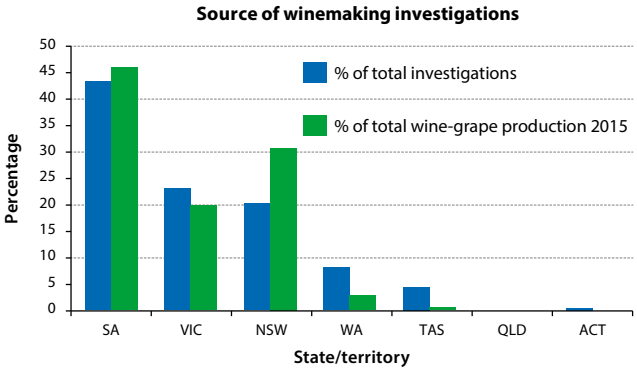


Figure 11. Winemaking investigations undertaken by the AWRI helpdesk team by state/territory, compared to wine-grape production

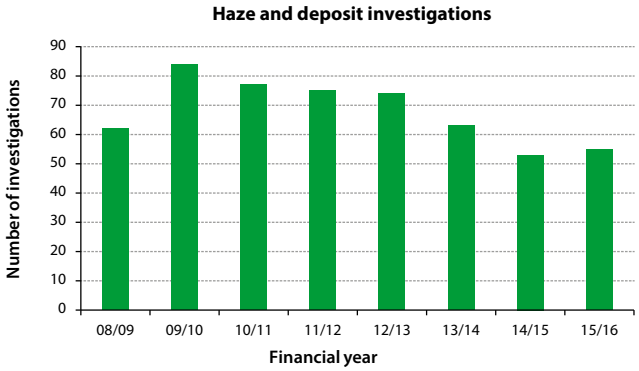


Figure 12. Haze and deposit investigations conducted by the AWRI helpdesk team between 2008/2009 and 2015/2016

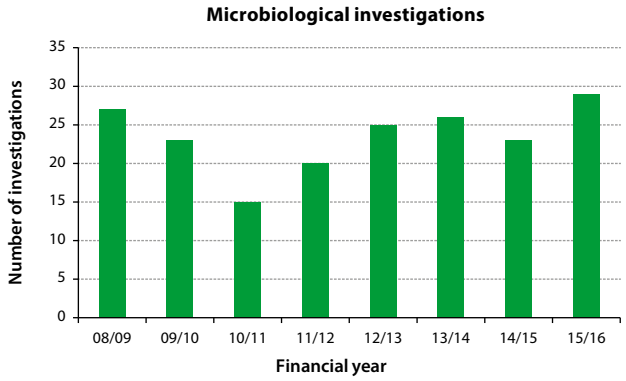


Figure 13. Microbiological investigations conducted by the AWRI helpdesk team between 2008/2009 and 2015/2016

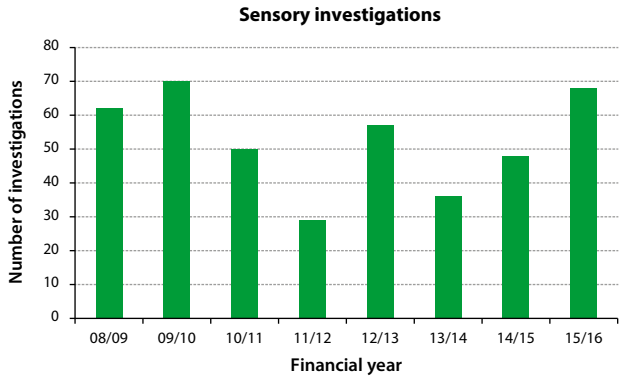


Figure 14. Sensory investigations conducted by the AWRI helpdesk team between 2008/2009 and 2015/2016

quality, damage during insertion or incorrect fill heights. In one investigation several different products were observed to have leaked upon arrival in China. After an extensive investigation looking at a number of physical parameters as well as chemical analyses, it was determined that the underlying cause of the leakage was related to insufficient ullage levels and the effects of temperature during transit. Ullage distance is the distance from the surface of the wine to the underside of the cork closure, with the bottle in an upright position. For wine bottled under vacuum, Amon and Simpson (1980) recommend a minimum ullage distance of at least 13 mm (measured at 20°C). If the ullage is too low and a wine is heated, the wine volume will expand, leaving no space, and the bottle pressure can increase to levels above 50 kPa.

Sixty-eight sensory investigations were carried out in 2015/2016 (Figure 14), an increase of >40% compared to the previous year. The types of problems were again quite diverse, and included wines exhibiting reductive characters, smoke taint, *Brettanomyces* spoilage characters, elevated levels of volatile acidity, indole, oxidation and mousiness. A small number of investigations related to dissolved carbon dioxide levels in both sparkling wines and still white and red wines.

Sixty-one 'taints and contaminations' investigations were carried out during 2015/2016 (Figure 15), a number that was nearly 30% higher than the previous year (47) and above the long-term average from 1999/2000 to 2015/2016 (46). This increase is concerning; however when the cases were reviewed, apart from TCA (trichloroanisole or 'cork taint'), which accounted for approximately 25% of the investigations, there was not one consistent issue but instead many different and varied problems. To address the problems being observed, *eNews* articles and discussions during workshops were used to inform winemakers about the taint/contamination issues seen, in particular the number of cases of 'musty'/'TCA-like' characters identified in wines. Interestingly, a large percentage of these investigations identified winery water as the source of the contamination. A large proportion (~85%) of the investigations were carried out using GC-MS techniques. Of these, sixteen investigations were related to TCA taint from various sources, the most in this category. Other taints included hydraulic oil (seven investigations), grapeseed oil, cleaning products, brine contamination, halophenols, paint-related contamination (two investigations), turpentine and diesel contamination, burnt stator and smoke taint from bushfires. There was also one investigation into a wine with millipede taint and one where a frog was found in a wine tank.

Investigations conducted under the category 'other' included pinking, questions of authenticity, filtration, polysaccharides, copper, tartaric acid purity and sparkling wine gushing upon opening.

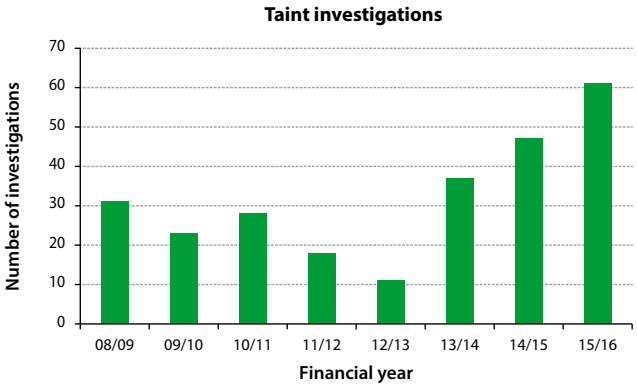


Figure 15. Taint investigations conducted by the AWRI helpdesk team between 2008/2009 and 2015/2016

Most unusual investigation

The year's most unusual investigation involved an empty sparkling wine bottle and a fly – with an outcome that was somewhat unexpected. The empty bottle had been submitted containing clumps of black sediment on the inside of the bottle, and the winery requested for the clumps to be identified. The wine had been tiraged and disgorged and it was only then that the black clumps had been noticed. The deposit was isolated and viewed under the microscope revealing what appeared to be insect pupae cases. Digital photographs (Figure 16) were taken of this unusual deposit and sent for identification by SARDI's Entomology Department. The insect pupae cases were then identified as *Drosophila* pupae. *Drosophila* is a genus of small flies, belonging to the family Drosophilidae, whose members are often called fruit flies, pomace flies or vinegar flies. The growth stage of the pupae suggested that these might have been in the bottle before it was filled with wine.

Figure 16. Digital photograph of deposit isolated from empty sparkling wine bottle, 10x magnification (*Drosophila* or vinegar fly pupae)

References

Amon, J.M., Simpson, R.F. 1986. Wine corks: a review of the incidence of cork related problems and the means for their avoidance. *Aust. Grapegrower Winemaker* 268: 63-80.

Ziemelis, G. 1982. Flavonol haze—a new form of wine instability arising from technological change. Clarke, J. ed. *The Institute of Brewing (Australia and New Zealand section): Proceedings of the Seventeenth Convention; 7–12 March 1982; Perth, WA.* Sydney, NSW: The Institute of Brewing: 75–76.

Library service

Background

The John Fornachon Memorial Library holds the largest knowledge base of grape and wine technical resources in the southern hemisphere. The library continues to support the Australian grape and wine sector through strategic sourcing, management and dissemination of relevant and useful electronic and print resources covering vines to wines. Over 86,355 items (including books, journals, article reprints, conference proceedings, reports, theses, standards and legislation, as well as a reference collection of directories, foreign dictionaries and atlases) are available to levy payers, industry organisations, students and AWRI staff. Members of the Australian grape and wine industry can search the library catalogue online via the AWRI website.

eBook collection

While traditional print resources remain popular, the recent introduction of an eBook platform has seen a shift towards accessing books digitally. eBooks can be read on mobile devices or downloaded for offline use. The collection is currently 70 titles strong, steadily growing and easy to use. Planning is under way to launch a second eBook platform to expand the number of titles available.

Staff publications database

The AWRI staff publications database contains over 1,800 citations of publications authored by AWRI staff. This useful tool, accessible from the AWRI website, received more than 7,598 hits this year with 828 staff publications requested. This database is updated regularly to ensure the latest publications are available.

Online information packs

Online information packs are collections of relevant references and other resources focused on a single topic. They have been developed to help users easily locate information on common topics in areas of oenology, viticulture, sustainability and wine and health. The website received more than 1,900 hits on information packs and the library delivered over 619 journal articles from information packs, an increase of 70% from 2014/2015.

Library reference and information requests

The library responded to more than 1,500 reference and information requests and delivered 2,138 articles. Over 80% of the requests were completed within one business day. Table 4 outlines the types of articles requested.

Table 4. Number of articles supplied from library collections

Article type	Number of articles supplied
AWRI staff publications	828
Technical Review Current Literature	749
Library reprint collection	561
Total	**2,138**

Specialised information services

The library has access to a range of databases and external resources, and offers specialised information services such as literature searches for in-depth retrieval of information. Forty-four literature searches were conducted in 2015/2016 on topics including consumer studies, marketing, winemaking chemistry, winery operations and wine storage.

Communication with stakeholders

Background

Communication with Australian grape and wine producers is a key priority for the AWRI, with aims including:

- keeping industry up to date with current research
- providing advice to grapegrowers and winemakers
- sharing news, events and ideas
- seeking feedback or interaction.

Content is derived from across the AWRI's research and extension projects, and delivered through a variety of different channels. The AWRI communicates directly with stakeholders via its *eNews, eBulletins,* webinars and social media*;* publishes the bi-monthly *Technical Review;* and contributes regularly to other industry publications. Activities within this project complement the communication objectives of all AWRI staff – the details of presentations delivered and articles published by AWRI staff in 2015/2016 can be found in the Appendices.

AWRI website

The AWRI website is a major platform for communicating with stakeholders, students, potential employees and the general public. Approximately 69,000 visitors accessed the AWRI website during the year with more than 353,686 page views (a 27% increase in page views from the previous year). A new version of the website was launched in January 2016. In the lead-up to the launch, a major review of the site's content and structure was conducted, including new information on the AWRI's research projects, a re-structure of the winemaking advice section and a complete update of the fact sheet collection.

eBulletins *and* eNews

Electronic communications are an increasingly important mechanism to reach grape and wine industry producers across Australia. The *eBulletin* format is used to send out alerts on emerging issues, agrochemical updates and notifications about *Technical Review* and the webinar program. Eighteen *eBulletins* were delivered during the year and are shown in Table 5. The *eBulletin* mailing list included more than 3,370 addresses by the end of the year.

The AWRI's electronic newsletter, *eNews*, was distributed bi-monthly to an audience that has grown to 3,627 subscribers. This publication provides an avenue to communicate about upcoming events, brief updates on research projects and a general snapshot of the AWRI's activities. The distribution of *eNews* in alternate months to *Technical Review* means that stakeholders hear from the AWRI on at least a monthly basis.

Social media

The AWRI's Twitter following grew by more than 270 during 2015/2016 to 3,093. Twitter is a popular social media platform within the wine industry and can be an excellent forum for interacting with stakeholders on an informal basis. The AWRI's Facebook presence also grew by more than 100 likes during the year. While the AWRI's following on Facebook is much smaller than on Twitter, Facebook still works very well for sharing images and reaching a different audience.

Table 5. *eBulletins* issued during 2015/2016

Date	Topic	Author
30/07/2015	AWRI webinar series kicks off with four webinars in August	Michael Downie
5/08/2015	*Technical Review* August 2015 issue now available online	Linda Bevin
13/08/2015	Agrochemical update August 2015	Marcel Essling
4/09/2015	Agrochemical update September 2015	Marcel Essling
8/09/2015	AWRI webinars – what's on in September?	Michael Downie
8/10/2015	*Technical Review* October 2015 issue now available online	Linda Bevin
10/11/2015	AWRI webinars – what's on in November?	Michael Downie
1/12/2015	AWRI webinars – what's on in December and January?	Michael Downie
8/12/2015	*Technical Review* December 2015 issue now available online	Linda Bevin
21/12/2015	Christmas closure	Linda Bevin
20/01/2016	Managing late season wet weather	Helpdesk team
11/02/2016	*Technical Review* February 2016 issue now available online	Linda Bevin
3/03/2016	Agrochemical update March 2016	Marcel Essling
11/04/2016	AWRI webinars – what's on in April and May?	Michael Downie
13/04/2016	*Technical Review* April 2016 issue now available online	Linda Bevin
19/04/2016	Stuck ferments need rapid response	Helpdesk team
9/06/2016	*Technical Review* June 2016 issue now available online	Linda Bevin
22/06/2016	Agrochemical update June 2016	Marcel Essling

Webinars

The AWRI webinar series continued during 2015/2016 with 23 webinar sessions and 446 participants. Approximately half of the webinars were presented by AWRI staff, with the remainder delivered by guest presenters from other research organisations and industry partners. Webinars provide a convenient format to reach industry practitioners across the country in a single session. Participants have the opportunity to speak with subject experts, ask questions and share experiences. Recordings of all webinars are available from the AWRI website.

Annual report

For the past 61 years, the AWRI has produced a printed annual report such as this one, as its formal report to Australian winemakers and grapegrowers. Since 1999, the annual reports have also been made available on the AWRI's website. The AWRI also publishes a four-page summary of the annual report in the *Australian & New Zealand Grapegrower & Winemaker*, and offers to deliver an annual presentation to the board or executive of each major state-based winemaking body. This formal activity complements the vast range of presentations and publications undertaken by AWRI staff members throughout the year (see Appendices).

Technical Review

Technical Review publishes abstracts of the latest grape and wine-related technical literature. It also includes technical articles from staff of the AWRI and information about AWRI events. *Technical Review* is published six times a year, and is available to grape and wine producers via the AWRI website or in hard copy. A total of 749 articles featured in the *Technical Review* Current Literature section were requested by and provided to readers during the year.

Editorial support

The AWRI contributes regular articles to every edition of the *Wine and Viticulture Journal*, *WBM* and *Australian & New Zealand Grapegrower & Winemaker*, while also contributing other papers to Australian and international industry journals. All articles authored by AWRI staff for non-peer-reviewed publications are edited by the AWRI Communication Manager. (Details of the articles published are presented in Appendix 7.)

60th birthday commemorative publication

The special issue of the *Australian Journal of Grape and Wine Research* to mark the AWRI's 60th birthday was published in December 2015. It contains 18 review articles authored by AWRI staff on topics including greenhouse gas emissions in viticulture, smoke taint, consumer sensory science, effects of elevated storage temperature on wine and trends in Australian wine composition.

Media liaison

The AWRI is regularly approached for comment regarding wine technical matters from national and international media. This provides an excellent opportunity to ensure accurate information is published, and to generate further opportunities to communicate with the AWRI's stakeholders. Many requests from the media were handled during the year, with specific details provided in Appendix 6. Two media releases were prepared and distributed during the year (Table 6). A media highlight for the year was the participation of two AWRI scientists in an episode of *ABC Catalyst* about the isolation of yeast from bottles of beer found during the excavation of a shipwreck.

Table 6. Media releases prepared and distributed during 2015/2016

Announcement	Date distributed
Australian wine industry's environmental scheme enters new era	3/07/2015
Toasting three terrific tasters	24/06/2016

Align supply chains with industry needs

Staff

Tadro Abbott, Simon Nordestgaard.

Ferment simulator upgrade

Background

The AWRI Ferment Simulator, originally developed by Richard Muhlack, is being updated and redeveloped into a simple and powerful web application to support winemakers in time for vintage 2017. The application will allow users across the winery to have access to ferment data wherever they are, across a range of devices.

User interface upgrade

Work is currently under way with a web developer to design a new user interface for the system, which will be integrated into the AWRI's WineCloud platform. The Ferment Simulator will allow users to model the impacts of temperature, nutrients, mixing and re-inoculation and identify problematic ferments quickly and take corrective action.

AWRI Technical Survey

Background

The Australian wine industry has good data on the quantities of grapes and wine produced, but not on the prevalence of the different techniques used in grapegrowing and winemaking. Examples include trellis types, pruning methods, yeast types and juice clarification methods. The AWRI Vineyard and Winery Practices Survey aims to address the lack of data on these and many other practices. The results will allow producers to compare their practices with regional and national averages and will assist organisations like the AWRI in tailoring research and extension activities for different regions.

Survey development

During the year, consultations were held with industry bodies, regional associations, and technical committees about the questions to be included in the survey and the best approaches for distributing it. The survey will be distributed in August/September 2016 and it is intended that it will be repeated every five years to track changes in practices and adoption of new technologies/techniques. A final report detailing the results from the 2016 survey will be distributed to stakeholders in 2017.

Enhance national outreach and promote regional engagement

Staff

Dr Mark Krstic, Virginia Phillips.

Collaborators

Department of Economic Development, Jobs, Transport and Resources Victoria (Dr Michael Crawford, Dr Sze Flett, Ricky James, Dr Rachel Kilmister, Sue McConnell, Dr Ian Porter, Dr Kevin Powell, Jenny Treeby, Dr Michael Treeby); Murray Valley Winegrowers (David Coombes, Mike Stone); University of Melbourne (Prof. Snow Barlow, Dr Sigfredo Fuentes, Dr Kate Howell, Prof. Angela Paladino, Dr Pangzhen Zhang); Wine Victoria (Damien Sheehan, Rachel Sweeney).

Victorian node

Background

The AWRI's Victorian node delivers high quality extension and practice change services to Victorian wine-grape growers and wineries through a partnership between Wine Victoria (WV), the Murray Valley Winegrowers (MVW), Wine Australia, the Department of Economic Development, Jobs, Transport and Resources (DEDJTR) and the AWRI. The project activities are overseen by a Victorian Winegrowers Liaison Committee, which agrees on an annual work plan of activities under funding from DEDJTR and Wine Australia's regional program.

Node activities

The establishment of the Wine Ministerial Advisory Committee in Victoria, and involvement of the AWRI Victorian node, has been integral in the development of a new Victorian wine industry strategy, focusing on all facets of the value chain, regulatory issues, tourism, trade, research, development and extension, and the establishment of the wine growth fund. The new strategy will be publicly released later in 2016.

In 2015/2016 the key outcomes for the Victorian node included the delivery of 11 unique extension events across Victoria, over and above the AWRI's existing national roadshow seminar and workshop program. These extension activities were delivered in partnership with Wine Victoria and the regional grape and wine industry associations across Victoria. More details can be found in Appendix 2.

The Victorian node has also been active in securing additional funding for smoke taint research through the Rural R&D for Profit program in collaboration with the DEDJTR/Agriculture Victoria and Wine Australia. This project aims to build on past research programs within the AWRI and DEDJTR to develop improved risk assessment, mitigation and amelioration tools to assist the wine industry to better deal with smoke taint.

SERVICE CAPABILITIES AND FOUNDATIONAL DATASETS

The research, development and extension activities of the AWRI are underpinned by an efficient service capacity that provides and supports infrastructure; provides technical support; manages governance, legal and financial affairs, information technology and workplace safety; and facilitates the exchange of international scientists for the benefit of Australian grape and wine science.

Staff

Alice Barker, Sheridan Barter, Dr Cory Black, Catherine Borneman, Mark Braybrook, Dr Dimitra Capone, Alfons Cuijvers, Dr Chris Curtin, Dr Wies Cynkar, Chris Day, Shiralee Dodd, Dr Leigh Francis, Annette Freeman, Jeremy Hack (to 8 December 2015), Dr Markus Herderich, Adam Holland, Dr Vilma Hysenaj, Dr Dan Johnson, Pauline Jorgensen, Esther Kristianto, Dr Mark Krstic, Dr Natoiya Lloyd, Dr Vince O'Brien, Jennifer O'Mahony, Wes Pearson, Dr Paul Petrie, Tracey Siebert, Con Simos, Dr Mark Smith, Dr Peter Sternes, Fang Tang (currently on maternity leave), Deborah Thornton-Wakeford, Joanna Verwey, Kylee Watson (from 17 August 2015), Patricia Williamson.

Visiting scientists and students

Jing Wu (University of Bordeaux, France), Neele Glameyer (Rheinische Friedrich-Wilhelms-Universität Bonn, Germany), Kathrin Vollmer (Hohenheim University, Germany), Yevgeniya Grebneva (Technical University of Dresden, Germany).

Collaborators

Fondazione Edmund Mach, San Michele all'Adige, Italy (Dr Fulvio Mattivi); Hochschule Geisenheim, Germany (Prof. Manfred Grossmann, Prof. Doris Rauhut, Prof. Simone Mueller-Loose, Prof. Hans Schulz, Dr Manfred Stoll, Melanie Brandt); ISVV, Bordeaux, France (Dr Warren Albertin, Marta Avramova, Prof. Phillippe Darriet, Prof. Serge Delrot, Dr Philippe Pieri, Prof. Isabelle Masneuf-Pomarède, Dr Takis Stamatopoulos, Jing Wu, Julie Drapier); IFV Sud-Ouest, France (Olivier Geffroy); SARDI (Dr Mike McCarthy, Dr Victor Sadras); University of Adelaide (Stephen Clark); University of South Australia (Svetlana Bogomolova, Dr Armando Corsi, Ava Huang, Prof. Larry Lockshin); Weincampus Neustadt, Germany (Prof. Ulrich Fischer).

Chemistry, sensory, chemometrics and development capacity

Background

Access to advanced and highly specialised equipment and staff is essential for the high quality, multidisciplinary research which is a trademark of the AWRI, and for collaborative projects with other research organisations and industry partners. This is especially the case where projects require access to highly specialised technical and scientific skills, such as those of a synthetic organic chemist or sensory scientist. In addition, the provision of sensory analysis requires a pool of screened, trained and experienced sensory assessors operating under the leadership and supervision of a professional sensory specialist who tracks performance and assesses training needs. Before and after a sensory experiment, highly specialised skills in experimental design, software for the acquisition of complex sensory data, data analysis and interpretation are required. Similarly, complex chemical analysis requires specialised analytical chemists with expertise in modern chromatography and mass spectrometry as well as skills in method development, optimisation and validation to produce reliable, accurate and precise data, and to ensure instrumentation remains operational around the clock.

Sensory analysis

Sensory science involves great care in experimental design; panel recruitment using qualified judges; careful control of all aspects of the test procedure; leadership and people skills to ensure judges are highly motivated and unbiased; and a high degree of knowledge of aspects of psychology, physiology, statistics and wine science. The AWRI runs four main types of sensory testing: an expert technical quality panel; trained sensory descriptive analysis; difference testing, and consumer hedonic testing.

The technical quality panel provides detailed tasting notes and fault scores for wines submitted through AWRI helpdesk investigations, as preliminary screenings for research projects, and for clients of AWRI Commercial Services. During 2015/2016, the panel evaluated 262 wines, as well as numerous training samples, and more than 400 wines in preliminary bench tastings. The 17 judges on this panel have extensive general wine tasting expertise and technical knowledge of wine production and composition, with most having commercial industry experience, formal oenology qualifications and/or having completed the AWRI Advanced Wine Assessment Course. All judges, no matter how experienced, are required to pass a probationary period before being admitted as reportable judges.

A large study was completed involving 108 wines assessed for closure-related faults, as well as several studies with a specialist smoke taint panel, including a set of wines with a project conducted by DEDJTR Victoria to determine the severity of smoke taint and the links to smoke compounds.

In 2015/2016, 25 major descriptive analysis studies were completed using the AWRI's highly trained part-time external sensory panel – the highest number of such studies ever completed in a year at the AWRI, surpassing last year's record. Eight new sensory judges were recruited in January/February, allowing two panels to be run per day during periods of high demand to ensure high quality sensory data could be obtained to meet project timelines. The new panellists were screened for sensory acuity and skill, and were given training and experience in sensory methodology prior to their assimilation into the existing panel. The studies included two large projects with SARDI assessing the effect of grapevine clone on wine flavour, with Chardonnay and Shiraz wines made from grapes from vineyards in Victoria, South Australia and Western Australia.

ESTHER KRISTIANTO, VILMA HYSENAJ AND NATOIYA LLOYD

Difference testing, generally using the method of triangle testing, is also an important sensory technique to find if a treatment has had a perceptible effect on wine aroma or flavour. Approximately 50 AWRI staff are screened and qualified to perform this task, usually assessing two or three sets per session. Twelve tests were completed.

Consumer testing for degree of liking was conducted for a major study on 'green' flavour in Shiraz wines, involving more than 100 consumers. Projects were also completed for commercial clients to obtain customer feedback on product perceptions, and investigations were finalised regarding the validity of a 'discrete choice' methodology for understanding Chinese consumers' wine preferences.

In addition, previous work completed with UniSA on "Understanding Chinese sensory preferences for varied wine styles and the language used to describe them" has resulted in an Australian Wine Flavours Card produced by Wine Australia, to assist exporters, retailers and consumers to match wine flavours with useful descriptive words.

Spectral measures of grape and wine composition

The application of mid-infrared, near infrared, ultraviolet and visible spectroscopy continues to be important for research projects and for contract studies at the AWRI. Fingerprinting the spectral signature of samples for authentication purposes has been a key element of studies over the last 12 months. In addition, assistance has been provided to a University of Adelaide project led by Prof. Eileen Scott for rapid assessment of powdery mildew.

Synthetic organic chemistry

The synthesis of important analytical standards and other chemical compounds required for mechanistic studies or sensory investigations is of great benefit to the AWRI's research. When compounds are not available commercially, or are prohibitively expensive, the ability to produce them in-house is invaluable. Projects requiring synthesised compounds have included those investigating smoke taint, in-mouth flavour release and sulfur off-flavours.

Aroma compound analysis

State-of-the-art analytical instruments, including GC-MS and LC-MS, are carefully looked after to ensure they are in optimal operational order and capable of being used continuously in periods of high demand to give timely results. Analytical methods for targeted aroma compounds were applied in many projects. Important compounds such as norisoprenoids ('fruity', 'violets', 'kerosene'), thiols ('tropical fruit', 'struck match', 'box hedge'), monoterpenes ('citrus', 'floral'), rotundone ('pepper'), oxidative compounds ('honey', 'bruised apple') and C6 compounds ('green', 'grassy') were quantified in more than 500 samples. These analyses are also available on a fee-paying basis through AWRI Commercial Services.

Metabolomics (South Australian Metabolomics Facility)

The AWRI established the South Australian node of Metabolomics Australia in 2008 with funding from Bioplatforms Australia and the South Australian State Government that enabled the purchase of five dedicated GC-MS and HPLC-MS instruments. The South Australian Metabolomics Facility is part of a national network with partners in WA, Victoria and Queensland who support and service private and public sector R&D in their respective states. It operates as a collaborative service platform, providing access to infrastructure and specialist expertise to academia and industry across all interested sectors.

In 2015/2016, the facility delivered more than 5,000 sample analyses for researchers and other clients across the agriculture, biomedical and environmental sectors. A new LC-MS method was developed to analyse carotenoids in grapes and another method was set up to detect ^{34}S-labelled H_2S to monitor related metabolite pathways during grape fermentation. The facility has provided assistance in project work and instrument training to a number of visiting international students from Germany and Bordeaux. The platform is advancing in the area of bioinformatics for metabolomics with a unique automated data processing workflow developed using the R programming language. This workflow is tailored for metabolomics analysis of data captured on both GC-MS and LC-MS platforms and is useful for the wider metabolomics community.

Wine Innovation Cluster Winemaking

Background

Wine Innovation Cluster (WIC) Winemaking Services is based at the Hickinbotham-Roseworthy Wine Science Laboratory, and is a joint venture between the AWRI and the University of Adelaide that was established in 2010. Its location within the University of Adelaide's purpose-built small-lot and pilot-scale winemaking facility enables the delivery of high quality research and small-scale commercial winemaking services.

Vintage 2016

WIC Winemaking Services processed a total of 420 (20-1,000 kg) ferments during the 2016 vintage. Grapes were sourced from many South Australian wine regions as well as from Victoria and Western Australia. A further 20-30 ferments will be conducted on fruit and juice that was collected and frozen during vintage. The vintage coincided with the largest ever intake of University of Adelaide winemaking students which meant the winery building was very busy and there were some limitations of capacity and equipment. Some new storage vessels and a small batch crossflow filtration system have been acquired that will increase the flexibility and capability of the services offered.

A new five-year agreement was successfully negotiated with the University of Adelaide to continue WIC Winemaking Services. WIC Winemaking customers include all of the WIC partners, industry research bodies and commercial wine companies.

Efficient management and administration

Background

The AWRI's management and administration is carried out by a dedicated team of specialists who work together to provide leadership, infrastructure, financial, human resources, legal, contract management, work health and safety (WHS), corporate governance and IT services in a seamless manner. The team's objective is to enable AWRI staff to focus on their core capabilities to ensure that the organisation is able to meet its business objectives and in turn the expectations of its stakeholders. The team works closely with the AWRI Board which provides additional leadership and oversight to all of the AWRI's activities.

Finance

The finance team, led by Chris Day (Group Manager - Corporate Services), built upon the AWRI's previous year's exemption from payroll tax in South Australia through achieving similar exemptions in Victoria and Queensland (the other states in which the AWRI currently has staff), assisted by its advisors PricewaterhouseCoopers. Other significant activities included the appointment of Ord Minnett as the AWRI's external investment manager, and transitioning the organisation's investments from solely term deposits to a more diversified (but nevertheless conservative) portfolio of financial assets, including equities and interest rate securities, while retaining a component of the more traditional instruments. Other finance activities encompassed financial management, budgeting and reporting to the AWRI Board, funding organisations (particularly Wine Australia) and government.

ALFONS CUIJVERS AND CATHERINE BORNEMAN

Human resources

Alfons Cuijvers, the Human Resources Coordinator, maintains responsibility for a broad range of functions including recruitment, employment contract management, visa, payroll and compliance activities. In addition, during the year Alfons invested significant effort in leading a comprehensive review of the AWRI's Operational Risk Register, covering all aspects of the organisation. This year saw a further expansion of the AWRI's Employer of Choice program, including the addition of subsidised in-house Pilates/yoga classes, the implementation of a workplace banking program and access to a number of preferential wine programs in conjunction with industry partners. The AWRI's positive working environment is well reflected in the results of a June 2016 staff survey, with 96% of respondents confirming that 'all things considered, the AWRI is a great place to work'. Many of the AWRI's directors make a substantial contribution to employees' access to professional development opportunities, through nominating for their directorship fees to instead be applied towards supporting such activities - their assistance in this respect is gratefully acknowledged.

Operations

The Operations Manager, Mark Braybrook, manages all AWRI infrastructure, equipment and engineering requirements and represents the AWRI's interests, in partnership with the other occupants of the WIC building, on the WIC Management Committee. Cost-effective custom designed and manufactured engineering solutions are provided to support a range of AWRI projects, with recent examples including extensive modifications to pilot-scale fermentation tanks to support research into the role of oxygen during red winemaking, and developing solutions to support trials of packaging materials and vineyard-based experiments. During the year the AWRI was subject to an external WHS review, for which the input of Treasury Wine Estates is gratefully acknowledged. Pleasingly, the outcomes of this review highlighted the AWRI's strong commitment to workplace health and safety, while identifying a number of opportunities for incremental improvement in areas such as driver training, contractor management and records management, which have since been addressed.

Corporate governance

The Company Secretary, Shiralee Dodd, assists the effective functioning of the AWRI Board while providing legal support to the management team and ensuring that the organisation continues to meet its legal obligations. A particular area of focus for the year was the implementation of a framework for regular policy review, with numerous AWRI policies updated and reviewed by management and/or the AWRI Board. In addition, the AWRI was successful in its application to the Australian Charities and Not-for-profits Commission, with recognition as a registered charity effective since 1 January 2016.

Information technology

During the year Adam Holland received a promotion to IT Manager, and marked this transition through the development of a three-year IT Strategic Plan. This plan is supported by the IT Strategic Reserve created by the AWRI's directors during the previous financial year, as well as the AWRI's status as a Microsoft Qualified Nonprofit Organisation which was confirmed this year. A number of significant milestones under this plan were completed during the year, including migration to the current versions of Microsoft operating platforms and applications, increased use of cloud-based services, improved storage, back-up and Wi-Fi capabilities and significant investment in desktop hardware. Feedback from AWRI staff has highlighted the significant value already delivered by these initiatives at an operational level.

International scientific exchange program

Background

This project builds on the many formal and informal collaborations occurring between the AWRI and scientists in other countries to formalise institution-level links, facilitate data exchange on pre-competitive topics, develop joint projects and encourage world-class scientists to conduct sabbaticals at the AWRI.

LEANNE HOXEY AND ERIC WILKES

The BAG Alliance

The BAG Alliance is a trilateral partnership with L'Institut des Sciences de la Vigne et du Vin (ISVV), **B**ordeaux, France and Hochschule **G**eisenheim (HSG), Germany, and the **A**WRI, that aims to enhance research capability, accelerate research and improve the quality of technical outcomes for the wine industry.

Key areas of activity for the BAG Alliance during the year were:

1 Creation of foundational datasets
In collaboration with HSG and ISVV, foundational datasets were created through genome sequencing, transcriptome and metabolite analysis from materials provided by all BAG partners. The datasets include:
- » microsatellite markers for the rapid and reliable genotyping of the spoilage yeast *Brettanomyces bruxellensis* at strain level, and full genome sequence data for a broad range of industrial and spoilage-associated *Brettanomyces* strains. These data are key to achieving a better understanding of how this spoilage yeast becomes sulfite-tolerant.
- » transcriptome and metabolite profiles which characterise the response of Cabernet Sauvignon to increases in temperature during the growing season, as predicted under current climate change scenarios.
- » grape metabolite profiles, wine compositional data and sensory profiles showing the effects of temperature and light exposure. These data are key to understanding how undesirable sensory characters can be reduced or minimised in Riesling wine.

2 HEATBERRY Riesling project – investigating impacts of climate change on Riesling production
Two commercially available spray-on sun protectants were evaluated in the 2015/2016 growing season in vineyards in the Barossa and Eden Valley and compared to the effects of shade cloth and canopy structure. Metabolite data indicated positive effects for two of the three viticultural management options, and the results will be validated through sensory analysis of wine made in 2016 from these treatments.
Improved methods for measuring bunch exposure to aid vineyard management decisions were also evaluated. Bunch exposure is known to dramatically influence grape composition and wine sensory aspects. However, measuring fruit exposure with current methods can be onerous, requiring repeated point measurements of light to account for changes in the canopy and position of the sun during the season and day respectively. Optical and chemical measurement tools that allow the easy and accurate measurement of light interception by bunches were compared to standard point measurements. The two new methods tested were found to be relatively rapid and consistent in assessing fruit exposure.

Knowledge exchange programs with European research networks

Ongoing participation by the AWRI as a partner institution in the OENOVITI, OENODOC and InnoVine networks is providing an opportunity to gather insights into new grape varieties, breeding and wine research and development currently being undertaken across Europe and to identify opportunities for collaboration between Australian and European researchers. OENOVITI is a European Union-funded Marie Skłodowska-Curie network action focused on the exploitation of autochthonous vine varieties with focus on "genetic characterisation, phenotyping and pedigrees", "tolerance to abiotic stress", "diseases to control", and "exploitation". OENODOC is a three-year international doctoral program in oenology and viticulture. This network fosters cooperation in teaching and research, and supports exchange programs, conferences and student placements. It involves a consortium of partner institutions from France, Germany, Italy, Spain, Portugal, Hungary, Chile, and South Africa, with Bordeaux University as the coordinator of the program. InnoVine, a European innovation in the vineyard program, has 27 partner organisations with over 100 participating grape and wine researchers and a total budget of 6 million Euro over four years.

COMMERCIAL SERVICES

Staff

Tadro Abbott, Melissa Aitchison, Elyce Batchelor, Karl Forsyth (to 29 January 2016) Robyn Gleeson, Kieran Hirlam, Dr Josh Hixson, Leanne Hoxey, Erin Kearsley (to 8 April 2016), Jillian Lee, Oliver Lovat (to 24 June 2016), Brigitte Lynch (from 6 June 2016), Bryan Newell, Candice Newton (to 3 July 2015), Dr Simon Nordestgaard, Dr Kerry Pinchbeck, Tim Reilly, Dr Amy Rinaldo (from 16 November 2015), Marco Schoeman, Neil Scrimgeour, Pamela Solomon, Alana Spears, Randell Taylor, Dr Tina Tran (to 21 October 2015), Heather Tosen, Dr Matthew Wheal (from 18 January 2016), Dr Eric Wilkes.

AWRI Commercial Services continues to serve an important role in the wine industry, providing internationally recognised and accredited reference laboratory services, proof of performance testing, consulting services, microbiological auditing and the design and implementation of trials and research for industry. Commercial Services also continues to be actively involved in precompetitively funded research projects, in applied areas such as bulk wine transport and management of solids in the winery.

This was another successful year for the analytical component of Commercial Services, underpinned by continued increases in the number of samples processed. For the first time the laboratories processed more than 23,000 samples in a year, an increase of 2% over the previous record year. This continued demand for commercial laboratory services has driven the acquisition of new and improved equipment and increased offerings. The laboratory can now offer analysis for 23 different metals of interest to the wine community using the new ICP-MS instrument installed late last year. Testing for the presence of *Brettanomyces* in wine has also been improved, with the group now offering a 48-hour turnaround time using molecular biology techniques, compared to 10 days using traditional plating.

The importance of the long and consistent history of commercial wine analysis at the AWRI was highlighted by Commercial Services' contribution to the underlying data in the review article 'Trends in the composition of Australian wine 1984 -2014' which appeared in the special edition of the *Australian Journal of Grape and Wine Research* celebrating the AWRI's 60th anniversary. This review included data on trends in alcohol, sulfur dioxide, pH and TA and gave valuable insights into changes in wine production in the Australian context.

Access to such data will become even easier in the future with implementation of the new laboratory information management system which, after a year of development, is slated to go live in early October. This major IT project will not only improve data management and efficiency in the laboratory but will also provide significant benefits to customers. Online sample submission will reduce time and the potential for errors, and once analysis has been completed results and certificates will be accessible online by customers. Rollout and training for the customer interface of the system will begin in the last quarter of 2016.

Regulatory support

AWRI Commercial Services' close relationship with Australian regulatory and peak bodies continues, with technical presentations and datasets provided to support export and regulatory activities. This included a survey of more than 500 samples for chemical residues and metals content. This type of data is important to demonstrate the safety of Australian wine and to support arguments against the imposition of regulatory barriers to trade. Commercial Services also teamed up with the Interwinery Analysis Group to provide information on the accuracy of sugar measurement and the comparative performance of a range of peak laboratories in APEC nations involved in the import and export of wine for presentation at a number of international meetings. The excellent reputation of Commercial Services' laboratories was demonstrated by a request to present a workshop on best practice wine analysis to representatives from regulatory laboratories for APEC nations at an international meeting in the US.

Technology assessment and development

AWRI Commercial Services continues to build on its reputation as an independent assessor of the performance of wine-relevant technology in all stages of production. In the area of wine packaging alone, the team has tested the performance of eight new innovative wine closures and two new packaging solutions. Commercial Services provides an independent assessment of the performance of these technologies and gives confidence to end-users that the products meet the claims of suppliers and can be used safely. The team has also been involved in the assessment of performance of a novel small-scale fermenter meant to reduce handling and microbial issues in small wineries and a new vineyard spray that aims to improve grape colour and quality.

Increasingly the team's expertise is being recognised by requests to be involved in the actual development of new technologies rather than just the proof of performance stage. Examples include novel closure technologies that can scavenge reductive characters from wine as they form in bottle or other closures which allow the consumer to alter wine sweetness or remove preservatives upon opening. The team is also conducting research for suppliers looking to find novel ways of extending the shelf life of wine once it goes into package or providing different methods of presenting sparkling wines to the customer. In all of these areas the depth of the AWRI's scientific knowledge and historic understanding of the requirements of wine customers provide an important channel to the development of new and relevant technologies.

Unique datasets and services

The team is also continuing its development of fundamental datasets and research on the performance of wine processes and technologies. Currently three consortium-based trials on long-term closure performance are under way for different wine types and closures. One recently initiated trial has been designed to give ten years of data on the development of wine under specific closures. Late last year the team also presented the final report on the largest and most comprehensive study of bulk wine transport ever conducted. The trial report, which describes the findings from 44 separate bulk wine containers and over a million litres of wine shipped to Europe, is now available to Australian wine levy payers.

AWRI Commercial Services also continues to offer a range of high level services for individual producers and suppliers. These include Life Cycle Analysis (LCA) to define the environmental footprint of products, and winery and packaging line audits to assess the microbial and oxygen status of the processes involved. These services are tailored to the unique requirements of the wine industry to ensure that they provide relevant and actionable outcomes.

FINANCIAL STATEMENTS – DIRECTORS' REPORT

The directors present this report to the members of the Australian Wine Research Institute Limited (the Company) for the year ended 30 June 2016.

Directors

The names of each person who has been a director during the year and to the date of this report are:

	Date of appointment	Cessation date	Board meetings	
			A	B
Ms Louisa E. Rose (Chair)	1 Jan 2011	–	5	5
Mr Toby J. Bekkers	1 Jan 2014	–	5	5
Dr John S. Harvey	1 Jan 2016	–	3	3
Mr Kim R. Horton	1 Jan 2015	–	4	5
Dr Daniel L. Johnson	1 Dec 2011	–	5	5
Mr Brett M. McKinnon	1 Jan 2008	–	4	5
Dr Stuart C. McNab	1 Jan 2015	–	5	5
Ms Mary J. Retallack	1 Jan 2015	17 Nov 2015	1	1
Ms Elizabeth A. Riley	1 Jan 2012	–	5	5
Prof. Brian P. Schmidt	25 Feb 2014	–	3	5
Mr Mark R. Watson	24 Jun 2008	–	5	5

A – Number of meetings attended
B – number of meetings held during the time the director held office during the year

Directors have been in office since the start of the financial year to the date of this report unless otherwise stated.

Overview of result

For the year ended 30 June 2016 the Company recorded a deficit of $657,423 (2015: surplus of $2,683,336). This deficit primarily relates to the Company's annual depreciation and amortisation expense recorded in relation to its property, plant, equipment and interest in the Wine Innovation Cluster Central building, net of funding received for such capital items during the period. The directors note that the 2015 accounting surplus was primarily the result of a once-off reimbursement of State taxes from the South Australian Government, and that the reported 2016 accounting deficit is in line with expectations and reflective of a number of strategic investments made by the Company in order to further support its stakeholders in view of the capacity afforded by the Company's reserves position.

Objectives and strategy

The organisation's long-term objective is to support the Australian grape and wine industry through world class research, practical solutions and knowledge transfer.

The organisation's short-term objectives are reflected in its 5-Year Research, Development and Extension Plan *The AWRI 2013-2018*. This plan articulates fifty research projects designed to contribute to the achievement of the Company's vision, grouped within four main researchable themes:

- *Environment and sustainability*
- *Consumers, customers and markets*
- *Improving products and processes*
- *Extension and adoption.*

A fifth theme *Service capabilities and foundational datasets* supports the delivery of the above researchable themes.

For each active project a project plan specifies relevant objectives, outputs, milestones and expected outcomes of benefit to the Australian wine industry as well as approaches and methodologies for their achievement.

The Company's strategy for achieving the above objectives is to maximise its available funding to enable the delivery of projects within its Research, Development and Extension Plan, while optimising its internal operations and resources to ensure that such funding is applied as effectively and efficiently as possible. This strategy is implemented through a suite of initiatives, collectively described in the internal document *AWRI Directions – Business and Operational Initiatives 2014-2018*, clustered into six projects:

- Best practice governance
- Execute the AWRI's mission, values and behaviours
- Increase the funding base and economic flexibility of the AWRI
- Improve infrastructure, systems and processes
- Build/retain capabilities and services in areas of strategic importance
- World class people and culture.

The 5 Year Research, Development and Extension Plan *The AWRI 2013-2018* is available online at awri.com.au.

Principal activities

The Company's principal activities during the year were:

Research activities that strive for scientific excellence and industry relevance

Development activities that seek to bridge the gap between scientific discovery and value adding technology or processes

Extension activities that seek to disseminate research and development outcomes to facilitate rapid uptake by the viticultural and winemaking sectors

Commercial services aimed at providing competitive specific and/or tailored solutions for individual entities across all industry sectors which leverage the other key activities of the AWRI.

These activities collectively constitute a mechanism to implement the strategies outlined in *AWRI Directions – Business and Operational Initiatives 2014-2018*, enabling the achievement of the long- and short-term objectives of the organisation as articulated above.

Performance measures

The Company measures its performance through considering the number, quality and impact of the AWRI's scientific publications; its research and development outcomes; the extent to which those outcomes have been adopted by industry practitioners to improve the quality and consistency of wine produced in Australia; and the extent to which that new knowledge has enabled the Australian wine industry to be successful in new and emerging markets. Progress against specific objectives is monitored though the achievement of specific milestones, outputs and performance targets as articulated in *AWRI Directions – Business and Operational Initiatives 2014-2018*, the 5-Year Research, Development and Extension Plan and individual project plans, combined with measures of use of the AWRI's extension platforms and feedback provided through surveys distributed to service end-users. Financial performance measures include the value of funding and grants received, demand for the organisation's commercial services and contract research capabilities and performance relative to budget. From time to time the Company or parts of its operations are subject to independent review against externally established criteria, with the outcome of such reviews contributing to the Company's assessment of its own performance.

Information on directors

Ms Louisa E. Rose
Chair (non-executive)
Qualifications: BAppSc (Oenology) BSc GAICD
Experience: Head of Winemaking The Yalumba Wine Company and Hill-Smith Family Vineyards, Chair of the Australian Alternative Varieties Wine Show, member of the Alumni Council of the University of Adelaide and member of the Council of Barons of Barossa. Previously director of the Barossa Grape and Wine Association, member of Wine Barossa and Co-Chair of the South Australian Wine Industry Council. National wine show judge, 25 years' technical, winemaking, viticultural and commercial experience in the Australian wine industry.
Special Responsibilities: Ms Rose is the Chair of the Personnel committee.

Mr Toby J. Bekkers
Non-executive director
Qualifications: BAppSc (Ag) (Hons) GCertMgt
Experience: Principal of Bekkers Consulting and Bekkers Wine. Active as a viticulture and wine business consultant across Australia. Twenty-two years' experience in viticulture and wine business. Formerly General Manager/Senior Viticulturist of Paxton Wines and former Board member of McLaren Vale Grape, Wine and Tourism Association. Graduate of the Australian Wine Industry Future Leaders Program.
Special Responsibilities: Mr Bekkers is a member of the Audit committee.

Dr John S. Harvey
Non-executive director (since 1 January 2016)
Qualifications: BSc (Hons) PhD MBA GAICD
Experience: Managing Director and owner of Bathe Wines Pty Ltd and Australian Grape and Wine Authority regional mentor for McLaren Vale. Former President of the Adelaide Hills Wine Region, member of the South Australian Wine Industry Association Executive and Executive Director of the Grape and Wine Research and Development Corporation. Sixteen years' wine industry research, R&D management and commercial experience. Current director of Business Development at BioInnovation SA, non-executive director of Studio Nine Architects and Rural Business Support, Deputy Chair of the Can:Do 4 Kids Group of Charities.

Mr Kim R. Horton
Non-executive director
Qualifications: BAppSc (Wine Science)
Experience: Senior Winemaker Willow Bridge Estate, previously Chief Winemaker Ferngrove Vineyards Estate Pty Ltd. Twenty-two years' technical and winemaking experience in the Australian wine industry.

Dr Daniel L. Johnson
Managing Director
Qualifications: BSc (Hons) PhD MBA GAICD
Experience: Chair of the Australian Wine Industry Technical Conference, director of the National Wine Foundation, member of the International Scientific Council of L'Institut des Sciences de la Vigne et du Vin (ISVV) Bordeaux (France), member of the WFA Innovation Policy Committee, member of the *Australian Journal of Grape and Wine Research* Journal Advisory Committee, member of the *World of Fine Wine* Editorial Board, member of the Wine Innovation Cluster Leadership Group, member of the Waite Strategic Leadership Group, graduate of the Harvard Business School Authentic Leadership Development Program, graduate of the INSEAD Blue Ocean Strategy Program, graduate of the Australian Wine Industry Future Leaders Program, graduate of the IESE Creative Negotiation program, Honorary Adjunct Professor at the Macquarie Graduate School of Management, 19 years' experience in research, development and innovation.

Mr Brett M. McKinnon
Non-executive director
Qualifications: BAgSc (Oenology) (Hons)
Experience: Global Operations Director Pernod Ricard Winemakers, 28 years' technical, winemaking, viticulture and commercial experience, Chair of WFA Innovation Policy Committee, director of Barossa Grape and Wine Association, professional member of the ASVO, graduate of the Leadership in Innovation Program INSEAD (France).
Special Responsibilities: Mr McKinnon is a member of the Personnel committee.

Dr Stuart C. McNab
Non-executive director
Qualifications: BAgSc (Hons) PhD
Experience: Wine industry and agribusiness consultant, 24 years' experience in the Australian and global wine sectors across technical, winemaking, viticulture, marketing, logistics, operations, commercial and research functions. Director of the National Wine Centre. Previously Chief Supply Officer for Treasury Wine Estates managing global wine production, with past roles including Chair of the Wine Innovation Cluster, member of the Executive Committee and President of the South Australian Wine Industry Association, member of the South Australian Wine Industry Council and member of WFA Board.
Special Responsibilities: Dr McNab is a member of the Audit committee.

Ms Mary J. Retallack
Non-executive director (to 17 November 2015)
Qualifications: BAppSc (CPM) PGradDip (NRM) BEd GradDip (Viti) PCert (Arb) CPAg GAICD ARLF
Experience: Managing Director/Viticulturist Retallack Viticulture Pty Ltd, 21 years' wine sector experience in a wide range of practical, extension and consultancy roles. Director of Wine Australia, member of Adelaide University Wine Alumni Steering Group, member of the *Australian & New Zealand Grapegrower & Winemaker* editorial panel, founding member of Wine Grape Growers' Australia – Decision Support Network, member of 'Women of the Vine' Global Symposium Advisory Board. Graduate of Australian Institute of Company Directors, graduate of the Australian Wine Industry Future Leaders Program, fellow of the Australian Rural Leadership Foundation. Past director of Wine Communicators of Australia, past non-executive director of the Grape and Wine Research and Development Corporation, member of South Australian Wine Industry Council. RIRDC Rural Woman of the Year 2012, recognised in 100 Women in Australian Agribusiness 2014 and Len Evans Tutorial Scholar 2014.

Ms Elizabeth A. Riley
Non-executive director
Qualifications: BAppSc (Wine Science)
Experience: Nuffield Farming Scholar, Managing Director and Viticulturist Vitibit Pty Ltd, professional member of the ASVO, associate member of the Hunter Valley Wine and Tourism Association and member of the Viticulture Subcommittee, Executive member of the New South Wales Wine Industry Association and Chair of the Research and Development Committee. Member of the Decision Support Network for Wine Grape Growers Australia. Previously a Viticulturist with Southcorp Wines between 1993 and 1999 in national and NSW-based roles, 24 years' experience in the Australian wine industry.

Prof. Brian P. Schmidt
Non-executive director
Qualifications: BS BS AM PhD
Experience: Owner and operator of Maipenrai Vineyard and Winery, Vice Chancellor and Distinguished Professor of the Australian National University, member of the Intergovernmental Australian – German Advisory Group, member of the Commonwealth Science Council, member of One Disease at a Time Advisory Board, member of the Canberra District Vignerons Association and member of Life Letters Advisory Board. Previously Australian Research Council Laureate Professor, Chair of Astronomy Australia Limited, member of Questacon Advisory Board and member of Australian Academy of Science Council. Recipient of the 2011 Nobel Prize in Physics.
Special Responsibilities: Prof. Schmidt is a member of the Personnel committee.

Mr Mark R. Watson
Non-executive director
Qualifications: MBA BEc ACA RITP MAICD
Experience: Managing Director of Blue Sky Alternative Investments (Adelaide office), Chief Executive Officer of Water Utilities Australia, previously Partner Corporate Finance KPMG, Chief Financial Officer Wirra Wirra and Manager, Corporate Strategy and Development FH Faulding & Co Ltd.
Special Responsibilities: Mr Watson is the Chair of the Audit committee.

Indemnification of officers and auditors

During the financial year, the Company paid a premium in respect of a contract insuring the directors of the Company (named above), the Company Secretary, all members of the Company's Executive Management Group and members of the Biosafety Committee (a committee including two representatives who are not employees of the Company, charged with oversight of matters pertaining to the development and use of genetically modified organisms and required to be appropriately indemnified by the Office of the Gene Technology Regulator) against a liability incurred in their capacity as a director, secretary, executive or committee member to the extent permitted by the *Corporations Act 2001*. The contract of insurance prohibits disclosure of the nature of the liability and the amount of the premium.

The Company has not otherwise, during or since the end of the financial year, except to the extent permitted by law, indemnified or agreed to indemnify an officer or auditor of the Company or of any related body corporate against a liability incurred as such an officer or auditor.

Members' guarantee

In accordance with the Company's constitution, each member (both during the time he or she is a member and within one year afterwards) is liable to contribute $2 in the event that the Company is wound up. The total amount members would contribute is $22 (2015: $28).

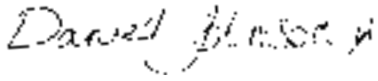
Auditor's independence

The auditor's independence declaration as required under section 60-40 of the *Australian Charities and Not-for-profits Commission Act 2012* is attached and forms part of the directors' report for the financial year ended 30 June 2016.

Dated at Urrbrae on this the 20th day of September 2016.

This report is made in accordance with a resolution of the directors, pursuant to subsection 60.15(2) of the *Australian Charities and Not-for-profits Commission Regulation 2013*.

Louisa E. Rose
Chair



Daniel L. Johnson
Managing Director

FINANCIAL STATEMENTS

Declaration of independence under section 60-40 of the Australian Charities and Not-for-profits Commission Act 2012 by Paul Gosnold

To the responsible entities of the Australian Wine Research Institute Limited

As lead auditor of the Australian Wine Research Institute Limited for the year ended 30 June 2016, I declare that, to the best of my knowledge and belief, there have been:

1 No contraventions of the auditor independence requirements of the *Australian Charities and Not-for-profits Commission Act 2012* in relation to the audit; and
2 No contraventions of any applicable code of professional conduct in relation to the audit.

Paul Gosnold
Director
BDO Audit (SA) Pty Ltd
Adelaide, 20 September 2016

The Australian Wine Research Institute Limited

A Company limited by guarantee

Statement of profit or loss and other comprehensive income

For the year ended 30 June 2016

	Note	2016	2015
Revenue from operating activities			
Wine Australia			
Investment agreement project funding		5,860,889	5,767,856
Investment agreement capital funding		157,624	129,148
Other project funding		2,019,980	2,447,772
Other capital funding		–	284,712
Capital specific grant funding		7,355	57,847
Other grant funding		1,346,883	1,191,295
Commercial services analytical and consulting income		2,832,878	2,881,360
Contract research and other commercial income		1,383,148	1,558,162
Other revenue		161,899	183,854
Total revenue		13,770,656	14,502,006
Other income	*2*	31,206	2,336,010
Expenses from operating activities			
Personnel expenses	*3*	9,623,777	8,897,411
Analytical and project operating expenses		2,369,196	2,802,025
Infrastructure and general services expenses		1,400,350	1,352,643
Depreciation and amortisation expense	*8, 9*	1,009,644	1,047,923
Travel expenses		400,881	393,174
Total expenses		14,803,848	14,493,176
Results from operating activities		(1,001,986)	2,344,840
Finance income		344,563	338,496
Profit (loss) for the period		(657,423)	2,683,336
Other comprehensive income			
Items that will be reclassified subsequently to profit or loss when specific conditions are met			
Net change in fair value of available-for-sale financial assets		3,793	
Total comprehensive income for the period		(653,630)	2,683,336

The notes on pages 62 to 69 are an integral part of these financial statements.

The Australian Wine Research Institute Limited

A Company limited by guarantee

Statement of changes in equity

For the year ended 30 June 2016

	Retained earnings	Co-investment reserve	Strategic IT investment reserve	Fair value reserve	Total equity
Balance at 1 July 2014	13,884,433	–	–	–	13,884,433
Total comprehensive income for the period					
Profit or loss	2,683,336	–	–	–	2,683,336
Other comprehensive income	–	–	–	–	-
Total comprehensive income for the period	2,683,336	–	–	–	2,683,336
Transfers between retained earnings and other reserves					
Transfers to (from) reserves	–	1,000,000	350,000	–	1,350,000
Transfers to (from) retained earnings	(1,350,000)	–	–	–	(1,350,000)
Balance at 30 June 2015	15,217,769	1,000,000	350,000	–	16,567,769
Balance at 1 July 2015	15,217,769	1,000,000	350,000	–	16,567,769
Total comprehensive income for the period					
Profit or loss	(657,423)	–	–	–	(657,423)
Other comprehensive income					
Net change in fair value of available-for-sale financial assets	–	–	–	3,793	3,793
Total other comprehensive income	–	–	–	3,793	3,793
Total comprehensive income for the period	(657,423)	–	–	3,793	(653,630)
Transfers between retained earnings and other reserves					
Transfers to (from) reserves	–	(12,500)	(207,257)	–	(219,757)
Transfers to (from) retained earnings	219,757	–	–	–	219,757
Balance at 30 June 2016	14,780,103	987,500	142,743	3,793	15,914,139

Nature and purpose of reserves

Co-investment reserve

The objective of the co-investment reserve is to provide funds for co-investment in specific funding opportunities, enabling the Company to access certain funding programs subject to the following requirements:

(i) That any co-investment be matched on at least an equal basis from externally sourced funds
(ii) That co-investments create value over the medium to long term for the ultimate benefit of the Australian grape and wine sector
(iii) That co-investments be made only in instances whereby the overall grant funds available to the Australian grape and wine sector are expanded – that is, excluding grant funding programs which already exist for the benefit of that industry.

Strategic IT investment reserve

The objective of the strategic information technology (IT) investment reserve is to ensure that sufficient funds are available for appropriate strategic investment in the Company's IT capabilities, consistent with relevant strategic plans as developed and amended from time to time, approved by the Board of Directors. Resourcing to meet the Company's day-to-day operational IT requirements, as distinct from its strategic IT requirements, is provided by other funding sources as identified within the Statement of profit or loss and other comprehensive income.

Fair value reserve

The fair value reserve comprises the cumulative net change in the fair value or available-for-sale financial assets until the investments are derecognised or impaired.

The notes on pages 62 to 69 are an integral part of these financial statements.

The Australian Wine Research Institute Limited

A Company limited by guarantee

Statement of financial position

As at 30 June 2016

	Note	2016	2015
Assets			
Cash and cash equivalents	4	3,714,688	4,499,417
Held-to-maturity investments	5	3,725,000	8,773,958
Trade and other receivables	6	1,551,038	2,211,938
Inventories	7	91,902	81,171
Prepayments		299,348	330,593
Total current assets		9,381,976	15,897,077
Available-for-sale financial assets	5	6,210,688	–
Property, plant and equipment	8	2,468,043	2,252,584
Interest in WIC Building	9	4,555,951	4,759,289
Total non-current assets		13,234,682	7,011,873
Total assets		22,616,658	22,908,950
Liabilities			
Payables and accruals	10	4,497,146	4,397,829
Project funds not expended	11	372,228	150,945
Provisions	12	1,504,693	1,551,460
Total current liabilities		6,374,067	6,100,234
Provisions	12	328,452	240,947
Total non-current liabilities		328,452	240,947
Total liabilities		6,702,519	6,341,181
Net assets		15,914,139	16,567,769
Equity			
Retained earnings		14,780,103	15,217,769
Co-investment reserve		987,500	1,000,000
Strategic IT investment reserve		142,743	350,000
Fair value reserve		3,793	–
Total equity		15,914,139	16,567,769

The notes on pages 62 to 69 are an integral part of these financial statements.

The Australian Wine Research Institute Limited

A Company limited by guarantee

Statement of cash flows

For the year ended 30 June 2016

	Note	2016	2015
Cash flows from operating activities			
Cash receipts from project grants and other income		14,371,620	16,426,246
Cash paid to suppliers and employees		(13,438,138)	(13,157,706)
Net cash from operating activities		933,482	3,268,540
Cash flows from investing activities			
Cash receipts from capital specific funding		242,877	144,297
Interest and dividends received		412,066	280,889
Proceeds from sale of property, plant and equipment		1,364	273
Acquisition of property, plant and equipment		(1,210,845)	(581,968)
Acquisition of held-to-maturity investments		–	(715,146)
Proceeds from disposal of held-to-maturity investments		5,048,958	–
Acquisition of available-for-sale investments		(6,206,895)	–
Payment of transaction costs related to financial investments		(5,736)	–
Net cash used in investing activities		(1,718,211)	(871,655)
Net increase (decrease) in cash and cash equivalents		(784,729)	2,396,885
Cash and cash equivalents at 1 July		4,499,417	2,102,532
Cash and cash equivalents at 30 June	4	3,714,688	4,499,417

The notes on pages 62 to 69 are an integral part of these financial statements.

NOTES TO AND FORMING PART OF THE FINANCIAL STATEMENTS

1. Significant accounting policies

The Australian Wine Research Institute Limited (the "Company") is a company limited by guarantee, domiciled in Australia, incorporated under the *Corporations Act 2001* and registered as a charity under the *Australian Charities and Not-for-profits Commission Act 2012*. The address of the Company's registered office is the corner of Hartley Grove and Paratoo Road, Urrbrae, South Australia.

The financial statements were authorised for issue by the Board of Directors on the 20th day of September 2016.

Australian Accounting Standards set out accounting policies that the AASB has concluded would result in financial statements containing relevant and reliable information about transactions, events and conditions. Material accounting policies adopted in the preparation of these financial statements are presented below and have been applied consistently to all periods presented in these financial statements, and have been applied consistently by the Company.

Where necessary, comparative information has been reclassified to achieve consistency in disclosure with current financial year amounts and disclosures.

(a) Basis of preparation

(i) Statement of compliance

The financial statements of the Company are Tier 2 general purpose financial statements which have been prepared in accordance with Australian Accounting Standards – Reduced Disclosure Requirements (AASB-RDRs) (including Australian Interpretations) adopted by the Australian Accounting Standards Board (AASB) and the *Australian Charities and Not-for-profits Commission Act 2012* and *Regulation 2013*. The Company is a not-for-profit entity for financial reporting purposes under Australian Accounting Standards.

The Company is exempt from income tax under Section 50-5 of the *Income Tax Assessment Act 1997*, and accordingly no provision for income tax is included in these financial statements.

(ii) Basis of measurement

The financial statements, except for the cash flow information, have been prepared on an accruals basis and are based on historical costs except for available-for-sale financial assets which are measured at fair value, and do not take into account changing money values.

(iii) Functional and presentation currency

The financial statements are presented in Australian dollars, which is the Company's functional currency.

The Company is of a kind referred to in ASIC Legislative Instrument 2016/191 dated 1 April 2016 and, in accordance with that Legislative Instrument, all financial information presented has been rounded to the nearest dollar unless otherwise stated.

(iv) Use of estimates and judgements

The preparation of financial statements in conformity with Australian Accounting Standards requires management to make judgements, estimates and assumptions that affect the application of accounting policies and the reported amount of assets, liabilities, income and expenses. The estimates and associated assumptions are based on historical experience and various other factors that are believed to be reasonable under the circumstances, the results of which form the basis of making judgements about the carrying value of assets and liabilities that are not readily apparent from other sources.

The estimates and underlying assumptions are reviewed on an ongoing basis. Revisions to accounting estimates are recognised in the period in which the estimates are revised. The Company has identified the allowance for impairment in respect of trade receivables (note 6), the useful lives of property, plant and equipment (note 8), amortisation period of interest in WIC building (note 9) and provisions for employee entitlements (note 12) and their respective note 1 accounting policies as areas under which significant judgements, estimates and assumptions are made, and where actual results may differ from those estimates under different assumptions and conditions.

(v) Changes in accounting policies

Due to changes in the nature of its investments, starting as of 1 July 2015 the Company has implemented new accounting policies in the area of accounting for available-for-sale financial assets. The Company has not implemented any other changes to its accounting policies for the year ended 30 June 2016 which would have a material impact upon the financial statements.

(b) Financial instruments

The Company initially recognises loans and receivables and deposits on the date that they are originated. All other financial assets are recognised initially on the trade date at which the Company becomes a party to the contractual provisions of the instrument.

The Company derecognises a financial asset when the contractual right to the cash flows from the asset expire, or it transfers the rights to receive the contractual cash flows in a transaction in which substantially all the risks and rewards of ownership of the financial asset are transferred.

Financial assets and liabilities are offset and the net amount presented in the statement of financial position when, and only when, the Company has a legal right to offset the amounts and intends either to settle on a net basis or to realise the asset and settle the liability simultaneously.

The Company has the following financial assets: held-to-maturity financial assets, loans and receivables and available-for-sale financial assets.

Held-to-maturity financial assets
If the Company has the positive intent and ability to hold debt securities to maturity, then such financial assets are classified as held- to-maturity. Held-to-maturity financial assets are recognised initially at fair value plus any directly attributable transaction costs.

Subsequent to initial recognition, held-to-maturity financial assets are measured at amortised cost using the effective interest method, less any impairment losses.

Loans and receivables
Loans and receivables are financial assets with fixed or determinable payments that are not quoted in an active market. Such assets are recognised initially at fair value plus any directly attributable transaction costs. Subsequent to initial recognition, loans and receivables are measured at amortised cost using the effective interest method, less any impairment losses. Loans and other receivables comprise trade and other receivables (see note 6).

Cash and cash equivalents comprise cash balances and call deposits with original maturities of three months or less. Bank overdrafts that are repayable on demand and form an integral part of the Company's cash management are included as a component of cash and cash equivalents for the purpose of the statement of cash flows.

Available-for-sale financial assets
Available-for-sale financial assets are non-derivative financial assets that are designated as available-for-sale and that are not classified in any of the previous categories. The Company's investments in equity securities and certain debt securities are classified as available-for-sale financial assets. Subsequent to initial recognition, they are measured at fair value and changes therein, other than impairment losses (see note 1(g)(i)) are recognised in other comprehensive income and presented within equity in the fair value reserve. When an investment is derecognised, the cumulative gain or loss in equity is transferred to profit or loss.

The fair value of investments that are actively traded in organised financial markets is determined by reference to quoted market bid prices at the close of business on the reporting date.

(c) Property, plant and equipment

(i) Recognition and measurement

Items of property, plant and equipment are measured at cost less accumulated depreciation and accumulated impairment losses. Cost includes expenditure that is directly attributable to the acquisition of the asset, including borrowing costs directly attributable to the acquisition, construction or production of a qualifying asset. Cost also may include transfers from other comprehensive income of any gain or loss on qualifying cash flow hedges of foreign currency purchases of property, plant and equipment. Purchased software that is integral to the functionality of the related equipment is capitalised as part of that equipment.

When parts of an item of property, plant and equipment have different useful lives, they are accounted for as separate items (major components) of property, plant and equipment.

Gains and losses on disposal of an item of property, plant and equipment are determined by comparing the proceeds from disposal with the carrying amount of property, plant and equipment and are recognised net within other income in profit or loss.

(ii) Subsequent costs

The cost of replacing a part of an item of property, plant and equipment is recognised in the carrying amount of the item if it is probable that the future economic benefits embodied within the part will flow to the Company, and its cost can be measured reliably. The carrying amount of the replaced part is derecognised. The costs of the day to day servicing of property, plant and equipment are recognised in profit or loss as incurred.

(iii) Depreciation

Depreciation is calculated over the depreciable amount, which is the cost of an asset, or other amount substituted for cost, less its residual value.

Depreciation is recognised in profit or loss on a straight-line basis over the estimated useful lives of each part of an item of property, plant and equipment, since this most closely reflects the expected pattern of consumption of the future economic benefits embodied in the asset. Leased assets are depreciated over the shorter of the lease term and their useful lives unless it is reasonably certain that the Company will obtain ownership by the end of the lease term.

The estimated useful lives for the current and comparative periods are as follows:

- buildings and improvements 30 years
- plant and machinery 3 – 10 years
- office furniture and IT 3 – 10 years
- laboratory equipment 3 – 10 years

Depreciation methods, useful lives and residual values are reviewed at each financial year-end and adjusted if appropriate.

(d) Intangible assets

Intangible assets that are acquired by the Company and have finite useful lives are measured at cost less accumulated amortisation and accumulated impairment losses.

Amortisation is calculated over the cost of the asset, or another amount substituted for cost, less its residual value. Amortisation is recognised in profit or loss on a straight-line basis over the estimated useful lives of intangible assets from the date that they are available for use, since this most closely reflects the expected pattern of consumption of the future economic benefits embodied in the asset. Amortisation methods, useful lives and residual values are reviewed at each financial year-end and adjusted if appropriate.

(e) Leased assets

The Company has entered into leases of motor vehicles and office equipment as disclosed in note 13. Management has determined that all of the risks and rewards of ownership of these motor vehicles and equipment remain with the lessor and has therefore classified the leases as operating leases, and the leased assets are not recognised in the Company's statement of financial position. The Company's commitments at reporting date in regards to operating leases are disclosed in note 13.

(f) Inventories

Inventories are measured at the lower of cost and net realisable value. The cost of inventories includes expenditure incurred in acquiring the inventories and other costs incurred in bringing them to their existing location and condition. Net realisable value is the estimated selling price in the ordinary course of business, less selling expenses.

(g) Impairment

(i) Financial assets (including receivables)

Financial assets are assessed at each reporting date to determine whether there is objective evidence that they are impaired. A financial asset is impaired if objective evidence indicates that a loss event has occurred after the initial recognition of the asset, and that the loss event had a negative effect on the estimated future cash flows of that asset that can be estimated reliably.

Objective evidence that financial assets (including equity securities) are impaired can include default or delinquency by a debtor, restructuring of an amount due to the Company on terms that the Company would not consider otherwise, indications that a debtor or issuer will enter bankruptcy and the disappearance of an active market for a security. In addition, for an investment in an equity security, a significant or prolonged decline in its fair value below its cost is objective evidence of impairment.

The Company considers evidence of impairment for receivables and held-to-maturity investments at both a specific asset and collective level. All individually significant receivables and held-to-maturity investments are assessed for specific impairment. All receivables and held-to-maturity investments found not to be specifically impaired are then collectively assessed for impairment by grouping together similar receivables and held-to-maturity investments with similar risk characteristics.

In assessing collective impairment, the Company uses historical trends of the probability of default, timing of recoveries and the amount of loss incurred, adjusted for management's judgement as to whether current economic and credit conditions are such that the actual losses are likely to be greater or less than suggested by historical trends.

An impairment loss in respect of a financial asset measured at amortised cost is calculated as the difference between its carrying amount and the present value of the estimated future cash flows discounted at the asset's original effective interest rate. Losses are recognised in profit or loss and reflected in an allowance account against receivables. When a subsequent event causes the amount of impairment loss to decrease, the decrease in impairment loss is reversed through profit or loss.

Impairment losses on available-for-sale investment securities are recognised by transferring the cumulative loss that has been recognised in other comprehensive income, and presented to the fair value reserve in equity, to profit or loss. The cumulative loss that is removed from other comprehensive income and recognised in profit or loss is the difference between the acquisition cost, net of any principal repayment and amortisation, and the current fair value, less any impairment loss previously recognised in profit or loss.

If, in a subsequent period, the fair value of an impaired available-for-sale debt security increases and the increase can be related objectively to an event occurring after the impairment loss was recognised in profit or loss, then the impairment loss is reversed, with the amount of the reversal recognised in profit or loss. However, any subsequent recovery in the fair value of an impaired available-for-sale equity security is recognised in other comprehensive income.

(ii) Non-financial assets

The carrying amounts of the Company's non-financial assets are reviewed at each reporting date to determine whether there is any indication of impairment. If any such indication exists, then the asset's recoverable amount is estimated.

The recoverable amount of an asset is the greater of its value in use and its fair value less costs to sell. In assessing value in use, the estimated future cash flows are discounted to their present value using a pre-tax discount rate that reflects current market assessments of the time value of money and the risks specific to the asset.

An impairment loss is recognised if the carrying amount of an asset exceeds its estimated recoverable amount. Impairment losses are recognised in profit or loss. Impairment losses recognised in prior periods are assessed at each reporting date for any indications that the loss has decreased or no longer exists. An impairment loss is reversed if there has been a change in the estimates used to determine the recoverable amount.

An impairment loss is reversed only to the extent that would have been determined, net of depreciation or amortisation, if no impairment loss had been recognised.

(h) Employee benefits

(i) Defined contribution plans

A defined contribution plan is a post-employment benefit plan under which an entity pays fixed contributions into a separate entity and will have no legal or constructive obligation to pay further amounts. Obligations for contributions to defined contribution plans are recognised as an employee benefit expense in profit or loss in the periods during which services are rendered by employees. Prepaid contributions are recognised as an asset to the extent that a cash refund or reduction in future payments is available.

Contributions to a defined contribution plan that are due more than 12 months after the end of the period in which the employees render the service are discounted to their present value.

(ii) Other long-term employee benefits

The Company's net obligation in respect of long-term employee benefits is the amount of future benefit that employees have earned in return for their service in the current and prior periods plus related on-costs. The liability is measured such that it is not materially different from the estimate determined by discounting using market yields at the reporting date on corporate bonds with terms to maturity and currencies that match, as closely as possible, the estimated future cash outflows.

(iii) Termination benefits

Termination benefits are recognised as an expense when the Company is demonstrably committed, without realistic probability of withdrawal, to a formal detailed plan to either terminate employment before the normal retirement date, or to provide termination benefits as a result of an offer made to encourage voluntary redundancy. Termination benefits for voluntary redundancies are recognised as an expense if the Company has made an offer of voluntary redundancy, it is probable that the offer will be accepted, and the number of acceptances can be estimated reliably. If benefits are payable more than 12 months after the reporting period, then they are discounted to their present value.

(iv) Short-term benefits

Short-term employee benefit obligations are measured on an undiscounted basis and are expensed as the related service is provided.

A liability is recognised for the amount expected to be paid under short-term bonus plans if the Company has a present legal or constructive obligation to pay this amount as a result of past service provided by the employee and the obligation can be measured reliably. Such liabilities represent the best estimate of the amounts required to settle the obligation at the end of the reporting

(i) Revenue

(i) Goods sold

Revenue from the sale of goods in the course of ordinary activities is measured at the fair value of the consideration received or receivable, net of any applicable discounts or rebates. Revenue is recognised when persuasive evidence exists, usually in the form of an executed sales agreement, that the significant risks and rewards of ownership have been transferred to the buyer, recovery of the consideration is probable, the associated costs and possible return of goods can be estimated reliably, there is no continuing management involvement with the goods, and the amount of revenue can be measured reliably.

(ii) Services

Revenue from services rendered is recognised in profit or loss in proportion to the stage of completion of the transaction at the reporting date. The stage of completion is assessed by reference to an estimation of the work performed.

(iii) Grants

The company receives a number of grants in the course of its operations. Once the company has been notified of the successful outcome of a grant application, the terms and conditions of each grant are reviewed to determine whether the funds relate to a reciprocal grant (i.e. payment for services rendered), in which case it is accounted for under AASB 118 *Revenue*, or a non-reciprocal grant, in which case it is accounted for under AASB 1004 *Contributions*.

(j) Finance income

Finance income comprises interest income and dividends. Interest income is recognised as it accrues in profit or loss using the effective interest rate method. Dividends from listed entities are recognised when received.

(k) Lease payments

Payments made under operating leases are recognised in profit or loss on a straight-line basis over the term of the lease.

Determining whether an arrangement contains a lease

At inception of an arrangement, the Company determines whether such an arrangement is or contains a lease. A specific asset is the subject of a lease if fulfilment of the arrangement is dependent upon the use of that specified asset. An arrangement conveys the right to use the asset if the arrangement conveys to the Company the right to control the use of the underlying asset. At inception or upon reassessment of the arrangement, the Company separates payments and other consideration required by such an arrangement into those for the lease and those for other elements on the basis of their relative fair values.

(l) Goods and services tax

Revenue, expenses and assets are recognised net of the amount of goods and services tax (GST), except where the amount of GST incurred is not recoverable from the taxation authority. In these circumstances, the GST is recognised as part of the cost of acquisition of the asset or as part of the expense.

Receivables and payables are stated with the amount of GST included. The net amount of GST recoverable from, or payable to, the ATO is included as a current asset or current liability in the statement of financial position.

Cash flows are included in the statement of cash flows on a gross basis. The GST components of the cash flows arising from investing and financing activities which are recoverable from, or payable to, the ATO are classified as operating cash flows.

2. Other income

	2016	2015
Net gain/(loss) on sale of property, plant and equipment	(2,996)	15
Reimbursement of State taxes	34,202	2,335,995
	31,206	2,336,010

3. Personnel expenses

	2016	2015
Wages and salaries	8,418,583	7,813,518
Other associated personnel expenses	414,072	350,416
Contributions to defined contribution plans	791,122	733,477
	9,623,777	8,897,411

4. Cash and cash equivalents

	2016	2015
Cash on hand	193	500
Bank deposits at-call	3,714,495	4,498,917
Cash and cash equivalents in the statement of cash flows	3,714,688	4,499,417

5. Other investments

	2016	2015
Current		
Held-to-maturity investments	3,725,000	8,773,958
Non-current		
Available-for-sale financial assets, comprising listed investments at fair value in:		
Interest rate securities	5,405,052	–
Equity securities	805,636	–
	6,210,688	–

During the year the Board of Directors approved an investment policy which resulted in the appointment of Ord Minnett as the Company's external investment manager, and the endorsement of a conservative investment strategy developed and implemented by Ord Minnett which includes the investment classes listed above, in order to address risks associated with concentration of investments within a single class of assets.

Held-to-maturity investments consist of term deposits with interest rates between 2.75 and 3.05 percent (2015: between 2.92 and 3.61 percent) and mature within 6 months of balance date (2015: within 6 months of balance date).

All available-for-sale investments are quoted on the Australian Securities Exchange. Interest rate securities include corporate bonds, subordinated notes and convertible and reset preference securities.

Trade receivables are shown net of impairment losses amounting to $5,694 (2015: $0) at reporting date. This allowance account is used to record impairment losses until the Company is satisfied that no recovery of the amount owing is possible; at that point the amounts are considered irrecoverable and are written off against the financial asset directly.

The movement in the allowance for impairment in respect of trade receivables during the year was as follows:

	2016	2015
Balance at 1 July	–	–
Impairment charge for the year	5,694	482
Written off during the year	–	(482)
Balance at 30 June	5,694	–

6. Trade and other receivables

	2016	2015
Trade receivables due from those other than related parties	745,727	1,424,498
Trade receivables due from related parties	3,717	11,558
Other receivables	801,594	775,882
	1,551,038	2,211,938

7. Inventories

	2016	2015
Course materials on hand – wine	91,902	78,193
Course materials in transit – wine	–	2,978
	91,902	81,171

8. Property, plant and equipment

	Plant and machinery	Office furniture and IT	Laboratory equipment	Capital WIP	Total
Cost					
Balance at 1 July 2015	368,272	1,086,156	9,382,006	104,048	10,940,482
Additions	103,261	289,646	228,648	420,594	1,042,149
Transfers	–	–	–	(16,025)	(16,025)
Disposals	(7,268)	(156,541)	(263,000)	–	(426,809)
Balance at 30 June 2016	464,265	1,219,261	9,347,654	508,618	11,539,798
Depreciation and impairment losses					
Balance at 1 July 2015	263,602	851,784	7,572,512	–	8,687,898
Depreciation charge for the year	34,512	141,952	629,842	–	806,306
Disposals	(7,183)	(152,266)	(263,000)	–	(422,449)
Balance at 30 June 2016	290,931	841,470	7,939,354	–	9,071,755
Carrying amounts					
at 1 July 2015	104,670	234,372	1,809,494	104,048	2,252,584
at 30 June 2016	173,334	377,791	1,408,300	508,618	2,468,043

9. Interest in WIC building

The Company has a 50-year nominal occupancy right to approximately 53% of the space in the Wine Innovation Cluster (WIC) Central building owned by the University of Adelaide. The other occupants are currently the University of Adelaide and Australian Grain Technologies. The term of occupancy is reviewable after 30 years based on the remaining economic life of the building. The value assigned to the AWRI's interest in the building is net of amounts contributed by Wine Australia (WA).

The building cost will be amortised over a period of 30 years from the date of practical completion (26 November 2008).

Cost	
Balance at 1 July 2015	6,100,140
Balance at 30 June 2016	6,100,140
Amortisation and impairment losses	
Balance at 1 July 2015	1,340,851
Amortisation charge for the year	203,338
Balance at 30 June 2016	1,544,189
Carrying amounts	
at 1 July 2015	4,759,289
at 30 June 2016	4,555,951

10. Payables and accruals

	2016	2015
Current		
Trade payables due to those other than related parties	194,345	636,842
Trade payables due to related parties	–	–
Income received in advance	1,565,217	1,532,774
PAYG and GST	469,084	244,914
Non-trade payables and accrued expenses	2,268,500	1,983,299
	4,497,146	4,397,829

11. Project funds not expended

Any unexpended WA funding is reimbursable to WA, except where WA agrees that amounts can be retained by the AWRI for purposes approved by WA, at which point such amounts are considered to be committed towards that purpose. Project underspends recorded in the year ended 30 June 2016 may be reduced or eliminated by overspends recorded within those projects in prior years – where applicable, the unexpended funds detailed below have been reduced by such amounts.

The unexpended investment agreement funds for the current year totalled $23,443 (2015: $102,996). The unexpended funds from other WA contracts for the current year totalled $347,304 (2015: $47,949).

During the year WA approved the retention by the Company of unspent prior years' funds totalling $65,349 for the purpose of specific capital purchases (2015: $249,511) and $84,115 for other purposes (2015: $108,059). During the year no unspent prior years' funds relating to WA projects were returned to WA (2015: none).

	2016	2015
WA current year's investment agreement funding unexpended	23,443	102,996
WA current year's other contract funding unexpended	347,304	47,949
WA prior years' funding unexpended and uncommitted	1,481	–
	372,228	150,945

12. Provisions

	2016	2015
Current		
Employee entitlements	1,504,693	1,551,460
Non-current		
Employee entitlements	328,452	240,947
Number of employees (full-time equivalents)	96.0	92.1

13. Operating leases

Leases as lessee

Non-cancellable operating lease rentals are payable as follows:

	2016	2015
Within one year	19,961	20,596
One year or later and no later than five years	27,396	17,419
Later than five years	–	–
	47,357	38,015

During the year the Company entered into one new lease for a motor vehicle (running for a period of three years) under an operating lease agreement. This lease provides no option to renew or purchase at the completion of the term.

During the year ended 30 June 2016 an amount of $21,451 was recognised as an expense in respect of operating leases (2015: $21,377).

Leases as lessor

The Company leases out part of its interest in the WIC building (refer note 9) to the Australian Wine Industry Technical Conference Incorporated. Associated lease payments are included within the transactions with related parties disclosed within note 15. The future minimum lease payments under non-cancellable leases are receivable as follows:

	2016	2015
Within one year	8,000	8,000
One year or later and no later than five years	25,333	33,333
Later than five years	–	–
	33,333	41,333

During the year ended 30 June 2016 an amount of $8,082 was recognised as rental income (2015: $7,273).

14. Capital commitments

	2016	2015
Property, plant and equipment		
Contracted but not provided for and payable		
Within one year	19,468	264,367
One year or later and no later than five years	–	120,000
Later than five years	–	–
	19,468	384,367

15. Related parties

Key management personnel compensation
Key management personnel comprises the directors of the Company and other persons having authority and responsibility for planning, directing and controlling the activities of the Company. Key management personnel compensation comprised:

	2016	2015
Total remuneration	1,675,654	1,539,001

During the year non-executive directors became entitled to compensation totalling $82,500 (2015: $90,331). A number of directors voluntarily elected not to receive $53,000 of this entitlement (2015: $62,333), instead redirecting such amounts to support otherwise unfunded activities of the Company relating to individual and group professional development for AWRI staff, undertaken both domestically and internationally.

Key management personnel and director transactions
A number of key management personnel, or their related parties, hold positions in other entities that result in them having control or significant influence over the financial or operating policies of these entities.

A number of these entities transacted with the Company in the reporting period. The terms and conditions of the transactions with key management personnel and their related parties were no more favourable than those available, or which might reasonably be expected to be available, on similar transactions to non-key management personnel related entities on an arm's length basis.

Related parties arising through relationships with key management personnel:

Arrivo Wine
Bathe Wines Pty Ltd
Retallack Viticulture Pty Ltd
Vitibit Pty Ltd

Other related party transactions
During the year the Company provided administrative services and leased office premises to a jointly controlled entity, The Australian Wine Industry Technical Conference Incorporated.

Other related parties:
The Australian Wine Industry Technical Conference Incorporated

Transactions with related parties

	Transactions value for the year ended 30 June		Balance outstanding as at 30 June	
	2016	2015	2016	2015
Services received from related parties	4,681	4,204	–	–
Services provided to related parties	177,502	113,300	3,717	11,558

16. Contingencies

In the opinion of the Directors, there were no material or significant contingent liabilities at 30 June 2016 (2015: none).

17. Subsequent events

There has not arisen in the interval between the end of the financial year and the date of this report any item, transaction or event of a material and unusual nature likely to significantly affect the operations of the Company, the results of those operations, or the state of affairs of the Company, in subsequent financial years.

18. Limited liability

In accordance with the Company's constitution, each member (both during the time he or she is a member and within one year afterwards) is liable to contribute $2 in the event that the Company is wound up. The total amount members would contribute is $22 (2015: $28).

Responsible persons' declaration

The directors of the Australian Wine Research Institute Limited (the Company) declare that, in the directors' opinion:

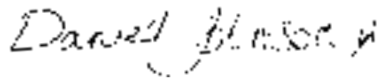
(a) the financial statements, comprising the statement of profit or loss and other comprehensive income, statement of financial position, statement of cash flows, statement of changes in equity, and accompanying notes, are in accordance with the *Australian Charities and Not-for-profits Commission Act 2012* and:

  (i) comply with Australian Accounting Standards – Reduced Disclosure Requirements and the *Australian Charities and Not-for-profits Commission Regulation 2013*; and
  (ii) give a true and fair view of the entity's financial position as at 30 June 2016 and of its performance for the year ended on that date; and

(b) there are reasonable grounds to believe that the Company will be able to pay all of its debts, as and when they become due and payable.

Signed in accordance with subsection 60.15(2) of the *Australian Charities and Not-for-profits Commission Regulation 2013*.

Louisa E. Rose
Chair



Daniel L. Johnson
Managing Director

Dated at Urrbrae on this the 20th day of September 2016.

Independent auditor's report to the members of the Australian Wine Research Institute Limited

Report on the financial report

We have audited the accompanying financial report of the Australian Wine Research Institute Limited, which comprises the statement of financial position as at 30 June 2016, the statement of profit or loss and other comprehensive income, statement of changes in equity and statement of cash flows for the year then ended, notes comprising a summary of significant accounting policies and other explanatory information, and the responsible entities declaration.

Responsible entities' responsibility for the financial report

The responsible entities of the registered entity are responsible for the preparation of the financial report that gives a true and fair view in accordance with Australian Accounting Standards – Reduced Disclosure Regime and the *Australian Charities and Not-for-profits Commission Act 2012* and for such internal control as the responsible entities determine is necessary to enable the preparation of the financial report that gives a true and fair view and is free from material misstatement, whether due to fraud or error.

Auditor's responsibility

Our responsibility is to express an opinion on the financial report based on our audit. We conducted our audit in accordance with Australian Auditing Standards. Those standards require that we comply with relevant ethical requirements relating to audit engagements and plan and perform the audit to obtain reasonable assurance about whether the financial report is free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial report. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial report, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the responsible entities' preparation of the financial report that gives a true and fair view in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the registered entity's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by the responsible entities, as well as evaluating the overall presentation of the financial report.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion

In our opinion the financial report of the Australian Wine Research Institute Limited has been prepared in accordance with Division 60 of the *Australian Charities and Not-for-profits Commission Act 2012*, including:

(a) giving a true and fair view of the registered entity's financial position as at 30 June 2016 and of its financial performance and cash flows for the year ended on that date; and

(b) complying with Australian Accounting Standards and Division 60 of the *Australian Charities and Not-for-profits Commission Regulation 2013*.

BDO Audit (SA) Pty Ltd

Paul Gosnold
Director

Adelaide, 23 September 2016

MEMORIAL FUNDS

Consisting of (and collectively the "Trusts"):
The John Fornachon Memorial Library Endowment Fund
The Thomas Walter Hardy Memorial Trust Fund
The H. R. Haselgrove Memorial Trust Fund
The Stephen Hickinbotham Memorial Research Trust

STATEMENT BY DIRECTORS OF THE TRUSTEE COMPANY

The Australian Wine Research Institute Limited (the "Trustee") acts as unrewarded trustee for the above listed Trusts. As detailed in note 2 to these financial statements, the Trusts are not reporting entities because, in the Trustee's opinion, it is unlikely that users exist who are unable to command the preparation of reports tailored so as to satisfy, specifically, all of their information needs. This is a special purpose financial report that has been prepared to meet the reporting obligations of the Trustee.

In the opinion of the directors of the Australian Wine Research Institute Limited (the Trustee):

(a) (i) the Statements of profit or loss and other comprehensive income give a true and fair view of each Trust's profit or loss for the year ended 30 June 2016; and

(ii) the Statements of financial position give a true and fair view of each Trust's state of affairs as at 30 June 2016.

(b) at the date of this statement, there are reasonable grounds to believe that the Trusts will be able to pay their debts as and when they fall due.

This statement is made in accordance with a resolution of the directors of the trustee company and is signed for and on behalf of the directors by:

Louisa E. Rose
Chair
Dated at Urrbrae on this the 20th day of September 2016.

NOTES TO THE FINANCIAL STATEMENTS

1. Nature and purpose of the Trusts

(a) The John Fornachon Memorial Library Endowment Fund was established on 30 September 1970, to provide for the establishment and maintenance of the Fornachon Memorial Library, for the promotion of study and general knowledge of the wine industry. The Fund was established by way of public appeal on a memorial to the late John Charles Macleod Fornachon, the Director of Research of the Australian Wine Research Institute Limited from 1955 to 1968.

(b) The Thomas Walter Hardy Memorial Trust Fund was established on 29 June 1993 to assist in the communication of information within the wine industry and associated activities, allied to the wine industry on behalf of the Trust. The Trust was established in memory of the late Thomas Walter Hardy.

(c) The H.R. Haselgrove Memorial Trust Fund was established on 12 December 1979 to provide for the promotion and encouragement of wine research by, or under the direction of, the Australian Wine Research Institute Limited as a memorial to the late Harry Ronald Haselgrove.

(d) The Stephen Hickinbotham Memorial Research Trust was established on 7 October 1986 to provide financial assistance and support in the pursuit of scientific research and associated activities, allied to the wine industry. The Trust was established in memory of the late Stephen John Hickinbotham. The Australian Wine Research Institute Limited assumed responsibility for the Trust on 25 May 1992.

2. Statement of accounting policies

In the opinion of the Trustee, the Trusts are of a type identified in Statement of Accounting Concepts 1 as non-reporting entities. Accordingly, the financial statements constitute 'special purpose financial reports' which have been prepared solely to meet the reporting obligations of the Trustee, and the limited information needs of the Trusts' members.

The financial statements have been prepared in accordance with accounting standards, except as stated below, and other mandatory professional reporting requirements.

The following accounting standards have not been adopted because, in the opinion of the Trustee, the cost of compliance outweighs the benefit of the resultant information:

- AASB 7 Financial Instruments: Disclosures
- AASB 107 Statement of Cash Flows
- AASB 124 Related Party Disclosures
- AASB 132 Financial Instruments: Presentation

The financial statements have been prepared on an accrual basis.

Accounting policies have been consistently applied, with the only significant policy being in relation to investments.

Investments comprise money on deposit, and are recorded at their nominal value. Interest is brought to account as earned, with accrued interest at balance date being included in the Statement of financial position as receivables.

STATEMENTS OF PROFIT OR LOSS AND OTHER COMPREHENSIVE INCOME	The John Fornachon Memorial Library Endowment Fund		The Thomas Walter Hardy Memorial Trust Fund		The H.R. Haselgrove Memorial Trust Fund		The Stephen Hickinbotham Memorial Research Trust	
For the year ended 30 June 2016	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**
Income								
Interest	1,713	2,686	1,278	2,005	1,113	1,746	1,424	2,233
Donations and other income	–	–	–	–	–	–	–	–
Total income	1,713	2,686	1,278	2,005	1,113	1,746	1,424	2,233
Expenses								
Advertising	–	–	–	–	–	–	–	–
Audit fees	–	–	–	–	–	–	–	–
Bank charges	–	–	–	–	–	–	–	–
Technical Review contributions	–	–	–	–	–	–	–	–
Sponsorship	–	–	–	–	–	–	–	–
Total expenses	–	–	–	–	–	–	–	–
Profit/(loss) from ordinary activities	1,713	2,686	1,278	2,005	1,113	1,746	1,424	2,233
Other comprehensive income	–	–	–	–	–	–	–	–
Total comprehensive income for the period	1,713	2,686	1,278	2,005	1,113	1,746	1,424	2,233

STATEMENTS OF FINANCIAL POSITION								
As at 30 June 2016	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**
Assets								
Cash at bank	–	–	–	–	–	–	–	–
Investments	131,823	130,063	98,388	97,076	85,676	84,533	109,589	108,126
Receivables	114	161	86	120	74	104	94	133
Total current assets	131,937	130,224	98,474	97,196	85,750	84,637	109,683	108,259
Investments	–	–	–	–	–	–	–	–
Total non-current assets	–	–	–	–	–	–	–	–
Total assets	131,937	130,224	98,474	97,196	85,750	84,637	109,683	108,259
Liabilities								
Sundry creditors	–	–	–	–	–	–	–	–
Total current liabilities	–	–	–	–	–	–	–	–
Net assets	131,937	130,224	98,474	97,196	85,750	84,637	109,683	108,259
Trust funds								
Settled sum	12,785	12,785	50	50	20,000	20,000	50	50
Founders donation	–	–	25,000	25,000	–	–	–	–
	12,785	12,785	25,050	25,050	20,000	20,000	50	50
Accumulated surplus								
Opening balance	117,439	114,753	72,146	70,141	64,637	62,891	108,209	105,976
Profit/(loss) for the year	1,713	2,686	1,278	2,005	1,113	1,746	1,424	2,233
Closing balance	119,152	117,439	73,424	72,146	65,750	64,637	109,633	108,209
Total trust funds	131,937	130,224	98,474	97,196	85,750	84,637	109,683	108,259

APPENDIX 1

EXTERNAL PRESENTATIONS

Staff	Title of presentation	Presented to and where	Date
A. Mierczynska-Vasilev	Red wine adsorption on functionalised surfaces	Oeno 2015 Symposium, Bordeaux, France	1 Jul 15
G.D. Cowey	Hotter and drier – processing ripe fruit	AWRI roadshow workshop, Langhorne Creek, SA	2 Jul 15
	Bushfires and smoke taint tasting		
	Sustainability and efficiencies in the winery		
P.R. Petrie	Hotter and drier in the vineyard		
	Growing grapes in wet seasons		
M.G. Holdstock	Salinity and sodicity in the vineyard		
	Winemaking in wet seasons		
	Q&A session and case studies		
	Building resilience and sustainability in the grape and wine sector		
	New varieties for a changing climate tasting		
C.S. Stockley	The evolution of 'drinking' guidelines and public health policy	38th World Congress of Vine and Wine, Mainz, Germany	8 Jul 15
K.A. Bindon	Managing phenolic quality in the vineyard	AWRI roadshow seminar, Rutherglen, Vic	14 Jul 15
M.P. Krstic	It's getting hotter – what does this mean for our vineyard management strategies?		
	Is it possible to control bunch rot without fungicides?		
E.N. Wilkes	Copper: the good, the bad and the ugly		
	Get the best out of your winery using 'lean production'		
P.A. Henschke	Managing stuck fermentations		
C.A. Simos	Winemaking management strategies for *Botrytis*		
K.A. Bindon	Managing phenolic quality in the vineyard	AWRI roadshow seminar, Bendigo, Vic	15 Jul 15
	The changing wine style of the ripening grape		
P.A. Henschke	Wild ferments – what are the alternatives?		
	Did you know that DAP can strongly affect the flavour profile and style of wine?		
E.N. Wilkes	Copper: the good, the bad and the ugly		
	Get the best out of your winery using 'lean production'		
M.P. Krstic	Terroir – separating fact from fiction		
	Importance of sampling for quality parameters in the vineyard		
	Terroir – separating fact from fiction	AWRI roadshow seminar, Avoca, Vic	16 Jul 15
P.A. Henschke	Wild ferments – what are the alternatives?		
	Choose the right yeast to achieve the red wine style you want		
E.N. Wilkes	Wine development in bottle – the role of oxygen		
	Get the best out of your winery using 'lean production'		
E.J. Bartowsky	Using MLF to accentuate wine aroma and flavour		
	Strategies for a successful MLF		
C.A. Simos	Introduction to the Advanced Wine Assessment Course	Advanced Wine Assessment Course (AWAC 37)	20 Jul 15
W.P. Pearson	Flavour, taints, faults and thresholds		

Staff	Title of presentation	Presented to and where	Date
T.E. Siebert	Overview of aroma compound analyses and sensory methods at the AWRI and their application to 'black pepper' and 'stone fruit' aromas in wine	Staff and postgraduate students, Centre for Wine Research at DLR Rheinpfalz University, Neustadt, Germany	21 Jul 15
P.R. Petrie	Climate impacts and business adaptation	ASVO seminar, Mildura, Vic	23 Jul 15
C.A. Simos	Introduction to the Advanced Wine Assessment Course	Advanced Wine Assessment Course (AWAC 38)	27 Jul 15
W.P. Pearson	Flavour, taints, faults and thresholds		
G.D. Cowey	Hotter and drier – processing ripe fruit	AWRI roadshow workshop, Hunter Valley, NSW	28 Jul 15
	Salinity and sodicity in the vineyard		
	Q&A session and case studies		
	New varieties for a changing climate tasting		
M. Essling	Hotter and drier in the vineyard		
	Growing grapes in wet seasons		
	Building resilience and sustainability in the grape and wine sector		
A.D. Coulter	Bushfires and smoke taint tasting		
	Winemaking in wet seasons		
	Sustainability and efficiencies in the winery		
M.L. Longbottom	Entwine Australia – demonstrating environmental performance of Australian vineyards and wineries	Wines of Western Australia Board, Perth, WA	31 Jul 15
		Wine Grape Council of South Australia, Adelaide, SA	7 Aug 15
	Greenhouse gas abatement in viticulture	Opportunities in a new climate workshop, Adelaide Hills, SA	11 Aug 15
	Entwine Australia – new and improved program, carbon calculator and regional benchmarking		
	Climate and the wine industry		
J.L. Hixson	Maximising the potential of grape marc		
M.G. Holdstock	Opportunities for the grape and wine sector		
	The Emissions Reduction Fund – how does it work?		
P.R. Petrie	Why do varieties respond differently to drought and heat stress – and what does this mean for your irrigation management?	AWRI roadshow seminar, McLaren Vale, SA	12 Aug 15
	Terroir – separating fact from fiction		
M. Essling	How can irrigation management strategies be used to manipulate wine quality?		
	How can cultural practices be used to improve fruit set?		
K.A. Bindon	The changing wine style of the ripening grape		
J.R. Bellon	Winemaking with non-conventional and hybrid yeast		
C.D. Curtin	Complex yeast nutrients – how do they fit into your fermentation management strategy?		
T.T.M.T. Tran	Monitoring Brett, what are your options?	AWRI webinar	13 Aug 15
P.R. Petrie	Is it possible to control bunch rot without fungicides?	AWRI roadshow seminar, Canberra, ACT	19 Aug 15
K.A. Bindon	Managing phenolic quality in the vineyard		
R. Gawel	Putting the texture back into white wine – the role of white wine phenolics		
	Solids ferments: effect of juice clarity and clarification method on the drivers of white wine texture		
P.A. Henschke	Did you know that DAP can strongly affect the flavour profile and style of wine?		
M. Essling	Entwine Australia – new and improved program, carbon calculator and regional benchmarking	Opportunities in a new climate workshop, Mornington Peninsula, Vic	20 Aug 15
	Greenhouse gas abatement in viticulture		
	Opportunities for the grape and wine sector		

Staff	Title of presentation	Presented to and where	Date
G.D. Cowey	Climate and the wine industry	Opportunities in a new climate workshop, Mornington Peninsula, Vic	20 Aug 15
	The emissions reduction fund – how does it work?		
A.D. Coulter	Taints and faults	Lallemand National Conference, Glenelg, SA	
P.R. Petrie	Vine balance – how does it affect yield and quality?	AWRI roadshow seminar, Orange, NSW	
	Why do we need new clones?		
K.A. Bindon	Managing phenolic quality in the vineyard		
	Solids ferments: effect of juice clarity and clarification method on the drivers of white wine texture		
P.A. Henschke	Wild ferments – what are the alternatives?		
P.R. Petrie	Why do varieties respond differently to drought and heat stress – and what does this mean for your irrigation management?	AWRI roadshow seminar, Mudgee, NSW	21 Aug 15
	Vine balance – how does it affect yield and quality?		
K.A. Bindon	Solids ferments: effect of juice clarity and clarification method on drivers of wine texture		
E.N. Wilkes	Get the best out of your winery using 'lean production'		
M.L. Longbottom	It's getting hotter – what does this mean for our vineyard management strategies?	AWRI roadshow seminar, Clare Valley, SA	25 Aug 15
	Entwine Australia – new and improved program, carbon calculator and regional benchmarking		
T.E. Siebert	Pepper and spice in Shiraz: what influences rotundone levels in wines?		
R. Gawel	Solids ferments: effect of juice clarity and clarification method on the drivers of white wine texture		
M.Z. Bekker	Copper in winemaking: the good, the bad and the ugly		
S.A. Schmidt	Managing stuck fermentations		
I.L. Francis	Determining the influence of sensory and non-sensory wine attributes on purchase intent: linking discrete choice and informed sensory testing	Pangborn 2015 Sensory Science Symposium, Gothenburg, Sweden	26 Aug 15
D.L. Johnson	Finding a better way	Winery Engineers Association National Conference, Tanunda, SA	27 Aug 15
M.G. Holdstock	Wine flavours, faults and taints		
S. Nordestgaard	Historical and future developments in grape pressing		
M.P. Day	The use and effects of oxygen during early stages of winemaking – research and industrial practice		
T.J. Abbott	Update on developments in environmental accounting for wineries		
A.D. Coulter	Smoke taint	SAWIA 2015 Bushfire workshop, Barossa Valley, SA	
M.L. Longbottom	Entwine Australia – new and improved program, carbon calculator and regional benchmarking	Opportunities in a new climate workshop, Langhorne Creek, SA	
	Greenhouse gas abatement in viticulture		
M. Essling	Climate and the wine industry		
G.D. Cowey	The Emissions Reduction Fund – how does it work?		
	Opportunities for the grape and wine sector		
K.C. Hirlam	Maximising the potential of grape marc		
P.W. Godden	Presentation and tasting of wines with links to AWRI research projects	SA Science Council, AWRI, Adelaide, SA	28 Aug 15
M.L. Longbottom	Entwine Australia – new and improved program, carbon calculator and regional benchmarking	Opportunities in a new climate workshop, Launceston, Tas	1 Sep 15
	Climate and the wine industry		
	Greenhouse gas abatement in viticulture		

Staff	Title of presentation	Presented to and where	Date
M.G. Holdstock	The Emissions Reduction Fund – how does it work?	Opportunities in a new climate workshop, Launceston, Tas	1 Sep 15
	Opportunities for the grape and wine sector		
J.R. Bellon	Breeding new life into the ancient art of winemaking	University of South Australia, Adelaide, SA	
	The AWRI		
M.L. Longbottom	Entwine Australia – demonstrating environmental performance of Australian vineyards and wineries	Winemakers' Federation of Australia, Adelaide, SA	2 Sep 15
S. Nordestgaard	History of the wine press	Members of the Australian Institute of Food Science and Technology, Engineers Australia, Institution of Chemical Engineers, Royal Australian Chemical Institute, Adelaide, SA	3 Sep 15
P.A. Smith	What are the relationships between grape chemicals?	AWRI webinar	
C.A. Simos	Overview of smoke taint	Australia Fire and Emergency Service Authorities Council, Lenswood, SA	4 Sep 15
C.D. Curtin	Comparative genomics and transcriptomics of *Brettanomyces*	Department of Applied Microbiology, Lund University, Sweden	
M.L. Longbottom	Entwine Australia – demonstrating environmental performance of Australian vineyards and wineries	Wine Grape Growers Australia, Adelaide, SA	6 Sep 15
		Clare Region Winegrape Growers Association, Clare Valley, SA	7 Sep 15
C.D. Curtin	Wine research down under	Microwine EU Consortium, Copenhagen, Denmark	8 Sep 15
A.D. Coulter	Smoke taint	SAWIA 2015 Bushfire workshop, McLaren Vale, SA	
P.R. Petrie	Vine balance – how does it affect yield and quality?	AWRI roadshow seminar, Barossa Valley, SA	
	Why do bunches get hot – and what does this mean for wine quality?		
M. Essling	Does soil and vine nutrient status affect wine quality?		
	How can irrigation management strategies be used to manipulate wine quality?		
J.M. McRae	The changing wine style of the ripening grape		
T.E. Siebert	Pepper and spice in Shiraz: what influences rotundone levels in wines?		
M.L. Longbottom	Entwine Australia – demonstrating environmental performance of Australian vineyards and wineries		
P.R. Petrie	Climate change in viticulture	Accolade viticulture managers, AWRI, Adelaide, SA	9 Sep 15
C.D. Curtin	The good, the bad, and the ugly: volatile sulfur compound metabolism in *Saccharomyces cerevisiae*	Bioflavour Conference, Frankfurt, Germany	11 Sep 15
	Comparative genomics and transcriptomics of the industrial yeast species *Brettanomyces bruxellensis*	International Symposium on Specialised Yeast, Perugia, Italy	16 Sep 15
P.R. Petrie	Vineyard frost management strategies	AWRI webinar	17 Sep 15
P.W. Godden	Wine flavours, faults and taints	Westpac Group premium wine experience, Barossa Valley, SA	25 Sep 15
	Guided tasting		
C.S. Stockley	Wine and health research and related national and international issues	Future Leaders 2015, Loxton, SA	
C.A. Varela	Practical strategies for reducing alcohol levels in wine – generating wine yeasts that produce reduced levels of ethanol	AWRI webinar	1 Oct 15
T.E. Siebert	Volatile aroma compounds related to 'stone fruit' aroma in Viognier and Chardonnay wines	School of Pharmacy and Medical Science Symposium, UniSA, Adelaide, SA	2 Oct 15
C.A. Simos	Smoke taint: what lies beneath and other AWRI research projects	Anchor Yeast technical forum, South Africa	9 Oct 15
M.L. Longbottom	Entwine Australia	Adelaide Hills Wine Region Executive Committee, SA	12 Oct 15

Staff	Title of presentation	Presented to and where	Date
M. Essling	Entwine Australia – new and improved program, carbon calculator and regional benchmarking	Opportunities in a new climate workshop, Riverland, SA	15 Oct 15
	Climate and the wine industry		
M.G. Holdstock	Opportunities for the grape and wine sector in the Emissions Reduction Fund		
J.L. Hixson	A novel use for grape marc – methane mitigation		
M. Essling	Greenhouse gas emissions abatement in viticulture – results of nitrogen use efficiency trials in vineyards		
I.L. Francis	Predicting allocation of grade from key grape compositional measures	2015 Australian Cabernet Symposium, Penola, SA	
M.L. Longbottom	Entwine Australia – environmental performance of Australian vineyards and wineries	AWRI webinar	
A.D. Coulter	Risk of unconventional gas exploration to wine quality	Natural Resources Committee on Fracking, Adelaide, SA	16 Oct 15
P.O. Williamson	Understanding wine consumers: linking sensory testing, consumer product acceptance and marketing research	Future Leaders visit to the AWRI, Adelaide, SA	20 Oct 15
C.A. Simos	An introduction to the AWRI		
G.D. Cowey	A changing environment	AWRI roadshow workshop, Kangaroo Island, SA	21 Oct 15
	Hotter and drier – processing ripe fruit		
	Bushfires		
	Salinity and sodicity in the vineyard		
M. Essling	Hotter and drier in the vineyard		
	Sustainability and efficiencies in the winery		
	Entwine Australia – new and improved program, carbon calculator and regional benchmarking	Opportunities in a new climate workshop, Kangaroo Island, SA	
G.D. Cowey	Climate and the wine industry		
	The Emissions Reduction Fund – how does it work?		
M. Essling	Greenhouse gas emissions abatement in viticulture – results of nitrogen use efficiency trials in vineyards		
C.D. Curtin	Comparative genomics and transcriptomics of *Brettanomyces*	School of Biology, University of Auckland, NZ	
M.P. Krstic	Oak volatiles 101 and trial results	Oak workshop, Healesville, Vic	22 Oct 15
C.A. Varela	AWRI biosciences wine research	SupAgro INRA, Montpellier, France	23 Oct 15
	Using non-conventional yeast for the production of reduced alcohol wines	4th International Symposium, Oenoviti International Network, Conegliano, Italy	26 Oct 15
M.L. Longbottom	Managing nutrition in a changing climate	Research to practice workshop, Riverland, SA	
	Principles of grapevine nutrition		
	Nutrients and grapevine growth		
	Nutrient analyses for grapevines		
K.A. DeGaris	Key grapevine nutrients		
	Alternative methods of grapevine nutrition		
M.L. Longbottom	Entwine Australia	McLaren Vale Grape Wine and Tourism Association Executive Committee, SA	27 Oct 15
G.D. Cowey	Hotter and drier – processing ripe fruit	AWRI roadshow workshop, Mudgee, NSW	
	Q&A session and case studies		
	Building resilience and sustainability in the grape and wine sector		
	New varieties for a changing climate tasting		
P.R. Petrie	Hotter and drier in the vineyard		
	Growing grapes in wet seasons		

Staff	Title of presentation	Presented to and where	Date
A.D. Coulter	Bushfires and smoke taint tasting	AWRI roadshow workshop, Mudgee, NSW	27 Oct 15
	Winemaking in wet seasons		
	Sustainability and efficiencies in the winery		
G.D. Cowey	Hotter and drier – processing ripe fruit	AWRI roadshow workshop, Orange, NSW	28 Oct 15
	Q&A session and case studies		
	Building resilience and sustainability in the grape and wine sector		
	New varieties for a changing climate tasting		
P.R. Petrie	Hotter and drier in the vineyard		
	Growing grapes in wet seasons		
A.D. Coulter	Bushfires and smoke taint tasting		
	Winemaking in wet seasons		
	Sustainability and efficiencies in the winery		
G.D. Cowey	Hotter and drier – processing ripe fruit	AWRI roadshow workshop, Canberra, ACT	30 Oct 15
	Q&A session and case studies		
	Building resilience and sustainability in the grape and wine sector		
	New varieties for a changing climate tasting		
P.R. Petrie	Hotter and drier in the vineyard		
	Growing grapes in wet seasons		
A.D. Coulter	Bushfires and smoke taint tasting		
	Sustainability and efficiencies in the winery		
	Winemaking in wet seasons		
D.L. Johnson	2015 AWRI annual report	Wine Tasmania Board (by teleconference)	3 Nov 15
M.L. Longbottom	Entwine Australia – new and improved program, carbon calculator and regional benchmarking	Opportunities in a new climate workshop, Padthaway, SA	4 Nov 15
	Climate and the wine industry		
	Greenhouse gas emissions abatement in viticulture – results of nitrogen use efficiency trials in vineyards		
G.D. Cowey	Opportunities for the grape and wine sector in the Emissions Reduction Fund		
	A novel use for grape marc – methane mitigation		
R. Gawel	The murky side of winemaking: solids ferments, wine composition and mouth-feel	AWRI webinar	5 Nov 15
C.A. Simos	Technical quality assurance of Australian wine	APEC regulators visit, AWRI, Adelaide, SA	13 Nov 15
M.J. Herderich	Wine authentication		
C.A. Simos	Introduction to the Advanced Wine Assessment Course	Advanced Wine Assessment Course (AWAC 39)	16 Nov 15
W.P. Pearson	Flavour, taints, faults and thresholds		
P.R. Petrie	Earlier, shorter, hotter? Is it really happening?	ASVO seminar, Adelaide, SA	19 Nov 15
M.G. Holdstock	Vintage 2015 – what we saw, what we learnt		
N. Scrimgeour	Using technology to keep on top of ferments		
K.C. Hirlam	Grape marc: maximising the potential of a winery by-product	Crush 2015, the grape and wine science symposium, Adelaide, SA	20 Nov 15
A. Mierczynska-Vasilev	Effects of surface functionalisation on the adsorption of red wine		
K.A. Bindon	The secret life of wine macromolecules		
R. Gawel	Murky winemaking: how juice solids affect the macro-molecular composition and mouthfeel of white wine		
P.O. Williamson	Chinese consumer preferences of Australian, Chinese and French red wines assessed both blind and informed		

Staff	Title of presentation	Presented to and where	Date
P.O. Williamson	Introduction to wine sensory evaluation	VALO exclusive at Chester's, McLaren Vale, SA	21 Nov 15
T.J. Abbott	The Australian wine industry's environmental assurance program: towards streamlined individual LCAs and a national model	AgriFoodLCA Conference, Melbourne, Vic	23 Nov 15
A.D. Coulter	Smoke taint, cold stability and copper	International Masters of Wine, National Wine Centre, Adelaide, SA	24 Nov 16
P.R. Petrie	Delayed pruning to help manage vintage logistics	AWRI roadshow seminar, Griffith, NSW	26 Nov 15
	Sampling for maturity and fruit grading		
R. Gawel	Phenolics and the interactive effects of pH, acidity and alcohol on bitterness and mouth-feel of white wine		
	Solids ferments: effect of juice clarity and clarification method on the drivers of white wine texture		
M. Essling	Integrated strategies for managing *Botrytis*		
	Why do varieties respond differently to drought and heat stress?		
E.N. Wilkes	Cold stability, hitting a moving target		
	Get the best out of your winery using 'lean production'		
C.A. Simos	Practical management of 'Brett' in the winery		
	Interactive session		
P.J. Chambers	Genetically modified foods: the mythology and science	Treasury Wine Estates technical conference, Magill, SA	
A.D. Coulter	Lingering smoky flavours: measurement and sensory aspects of smoke taint		
W.P. Pearson	Defining green flavour in Cabernet Sauvignon		27 Nov 15
M.P. Krstic	Wine sector R&D needs	Goulburn Valley Food R&D roundtable, Maroopna, Vic	2 Dec 15
C.A. Varela	Systems biology: a new approach to industrial yeast strain development	Yeast Products and Discovery Conference, Adelaide, SA	
D. Lee	Synthetic biology production of raspberry ketone in wine yeast		
A.G. Cordente	Generation of novel *Saccharomyces cerevisiae* wine yeast mutants and *Saccharomyces* interspecies hybrids that overproduce 'rose' aroma compounds 2-phenylethanol and 2-phenylethyl acetate		3 Dec 15
J.R. Bellon	Breeding new life into the ancient art of winemaking		
R. Zeppel	Variable nitrate assimilation potential amongst *Brettanomyces bruxellensis* isolates		
N. Scrimgeour	Using in-line sensors to monitor sugar levels during fermentation	AWRI webinar	
S.A. Schmidt	Yeast competitive fitness in wine-like fermentation environments	Yeast Products and Discovery Conference, Adelaide, SA	4 Dec 15
C.D. Curtin	Comparative genomics of the industrial yeast species *Brettanomyces bruxellensis*		
A.R. Borneman	Metagenomic analysis of wild wine fermentations		
M.J. Herderich	Towards a scientific interpretation of the terroir concept: plasticity of the grape berry metabolome	Australia-Italy Grape and Wine Symposium, Adelaide, SA	7 Dec 15
C.A. Simos	Smoke taint Q&A	AWRI roadshow seminar – smoke taint, Frankland River, WA	8 Dec 15
S. Nordestgaard	Recent advances in destemming and sorting technology	AWRI webinar	
M. Essling	Entwine Australia – new and improved program, carbon calculator and regional benchmarking	Opportunities in a new climate workshop, Mildura, Vic	
	Climate and the wine industry		

Staff	Title of presentation	Presented to and where	Date
J.L. Hixson	Opportunities for the grape and wine sector in the Emissions Reduction Fund	Opportunities in a new climate workshop, Mildura, Vic	8 Dec 15
	A novel use for grape marc – methane mitigation		
M. Essling	Greenhouse gas emissions abatement in viticulture – results of nitrogen use efficiency trials in vineyards		
M.P. Krstic	Smoke taint update – improved risk assessment	Drought, fire and smoke management seminar, Pyrenees, Vic	
M.L. Longbottom	Entwine Australia – new and improved program, carbon calculator and regional benchmarking	Opportunities in a new climate workshop, Barossa Valley, SA	10 Dec 15
	Climate and the wine industry		
	Greenhouse gas emissions abatement in viticulture – results of nitrogen use efficiency trials in vineyards		
M.G. Holdstock	Opportunities for the grape and wine sector in the Emissions Reduction Fund		
K.C. Hirlam	A novel use for grape marc – methane mitigation		
J.M. McRae	Hot news in heat stability!	Interwinery Analysis Group, Hahndorf, SA	
M.J. Herderich	Defining the grape metabolome and its relationship with wine composition through comprehensive HPLC-MS/MS profiling of non-volatile grape and wine compounds	Pacifichem Congress, Honolulu, Hawaii, USA	17 Dec 15
M.L. Longbottom	Entwine Australia – new and improved program, carbon calculator and regional benchmarking	Opportunities in a new climate workshop, Margaret River, WA	13 Jan 16
	Climate and the wine industry		
	Greenhouse gas emissions abatement in viticulture – results of nitrogen use efficiency trials in vineyards		
M.G. Holdstock	Opportunities for the grape and wine sector in the Emissions Reduction Fund		
	A novel use for grape marc – methane mitigation		
M.L. Longbottom	Entwine Australia	Wines of Western Australia technical committee, Perth, WA	14 Jan 16
E.N. Wilkes	Why doesn't 14°Bé give 14% alcohol?	AWRI webinar	21 Jan 16
C.A. Simos	Smoke taint Q&A	AWRI roadshow seminar – smoke taint, Geographe, WA	22 Jan 16
I.L. Francis	Cloves, kerosene or capsicum? The science of wine sensory evaluation	Rotary Club of Mitcham, Mitcham, SA	27 Jan 16
M.L. Longbottom	Entwine Australia – new and improved program, carbon calculator and regional benchmarking	Opportunities in a new climate workshop, Hobart, Tas	28 Jan 16
	Climate and the wine industry		
	Greenhouse gas emissions abatement in viticulture – results of nitrogen use efficiency trials in vineyards		
G.D. Cowey	Opportunities for the grape and wine sector in the Emissions Reduction Fund		
	A novel use for grape marc – methane mitigation		
S. Nordestgaard	Destemming and sorting technology in the vineyard and winery	Limestone Coast Grape and Wine Council berry sensory/sorting workshop, Robe, SA	
A.D. Coulter	Cold stability and CMC	International Masters of Wine, Bordeaux, France	17 Feb 16
	Copper: advantages and disadvantages		
	Smoke taint		
	Cold stability and CMC	International Masters of Wine, Cookham, UK	18 Feb 16
	Copper: advantages and disadvantages		
	Q&A session and case studies		
	Smoke taint		19 Feb 16

Staff	Title of presentation	Presented to and where	Date
P.O. Williamson	Influencing consumer choice: short and medium term effect of country of origin information on wine choice	Ehrenberg-Bass Institute of Marketing, University of South Australia, Adelaide, SA	25 Feb 16
C.A. Simos	Smoke taint Q&A	AWRI roadshow seminar – smoke taint, Launceston, Tas	4 Mar 16
P.O. Williamson, I.L. Francis	The latest advances in wine flavour research	Wine Australia Pan Asia Trade and Media group, AWRI, Adelaide, SA	10 Mar 16
E.N. Wilkes	Impact of closures on wine		
V.T. O'Brien	Luxury through innovation		
D.L. Capone	Determining the role of polyfunctional thiols in Chardonnay wine aroma	251st American Chemical Society National Meeting – Symposium on Flavour Chemistry of Alcoholic Beverages, San Diego, USA	14 Mar 16
M.Z. Bekker	Synergistic effects of copper and pH – winemaking variables that significantly impact reductive aromas in wines		
C.S. Stockley	Potassium carbonate as an additive in winemaking – safety aspects	OIV Food Safety Expert group meeting, Bordeaux, France	12 Apr 16
	PDMS as a processing aid in winemaking – safety aspects		
	Proctase health and safety evaluation		
C.A. Simos, M.P. Krstic	Stuck ferments Q&A	AWRI roadshow seminar, Yarra Valley, Vic	22 Apr 16
M.P. Krstic	Regional demonstration trials and findings	Trunk disease workshop, Mornington Peninsula, Vic	26 Apr 16
		Trunk disease workshop, Milawa, Vic	27 Apr 16
G.D. Cowey	Why is climate important in wine-grape production?	Opportunities in a new climate workshop, Great Western, Vic	28 Apr 16
	Trading carbon – what is the future for the wine industry?		
M. Essling	Entwine Australia – promoting a sustainable grape and wine community		
	How does the environmental performance of the Grampians stack up?		
M.P. Krstic	Regional demonstration trials and findings	Trunk disease workshop, Great Western, Vic	
V.T. O'Brien, G.A.P. Patacq	Design thinking	Design thinking/ideation workshop, Kingston-on-Murray, SA	2 May 16
G.D. Cowey	Why is climate important in wine-grape production?	Opportunities in a new climate workshop, Mount Barker, WA	4 May 16
	Where is all my energy going? Sources and sinks in the vineyard and winery		
	Keeping cool in the winery		
	Trading carbon – what is the future for the wine industry?		
M. Essling	Entwine Australia – promoting a sustainable grape and wine community		
	How does the environmental performance of Mount Barker stack up?		
	Fuel, fertiliser and electricity: the multi-pronged approach in the vineyard		
	Harnessing the sun at the winery		
	Grazing sheep in vineyards – saving fuel and money		
C.S. Stockley	Adverse food reactions, wine and winemaking	Oenoviti International Symposium and General Assembly, Bordeaux, France	10 May 16
N. Scrimgeour	The influence of different closure technologies and oxygen management techniques on wine shelf life	AWRI webinar	12 May 16
M.L. Longbottom	Why is climate important in wine-grape production?	Opportunities in a new climate workshop, McLaren Vale, SA	
	Entwine Australia – promoting a sustainable grape and wine community		
	How does the environmental performance of McLaren Vale stack up?		
	Grazing sheep in vineyards – saving fuel and money		

Staff	Title of presentation	Presented to and where	Date
M.L. Longbottom	Fuel, fertiliser and electricity: the multi-pronged approach in the vineyard	Opportunities in a new climate workshop, McLaren Vale, SA	12 May 16
G.D. Cowey	Where is all my energy going? Sources and sinks in the vineyard and winery		
	Keeping cool in the winery		
	Trading carbon – what is the future for the wine industry?		
	Harnessing the sun at the winery		
P.A. Smith	Opportunities for creating value in wine production: impacts of proteins, polyphenols, polysaccharides, oxygen and sulfur compounds.	Marlborough Wine Research Centre, Blenheim, NZ	16 May 16
		Lincoln University, Nelson, NZ	
M. Essling	Why is climate important in wine-grape production?	Opportunities in a new climate workshop, Orange, NSW	18 May 16
	Practical ways to reduce emissions in the vineyard		
	Entwine Australia – promoting a sustainable grape and wine community		
	How does the environmental performance of Orange stack up?		
T.J. Abbott	What is the world doing? What is Australia doing? What is the future for the wine industry?		
	Trading carbon – what is the future for the wine industry?		
	Practical ways to reduce emissions in the winery		
	Trading carbon – what is the future for the wine industry?	Opportunities in a new climate workshop, Hunter Valley, NSW	19 May 16
	Practical ways to reduce emissions in the winery		
M. Essling	Practical ways to reduce emissions in the vineyard		
	Why is climate important in wine-grape production?		
	Entwine Australia – promoting a sustainable grape and wine community		
	How does the environmental performance of the Hunter Valley stack up?		
E.N. Wilkes	Phenolic measurements using the WineCloud	Enartis, Windsor, California, USA	20 May 16
		Enartis, Paso Robles, California, USA	
M.L. Longbottom	Why is climate important in wine-grape production?	Opportunities in a new climate workshop, Adelaide Hills, SA	
	Practical ways to reduce emissions in the vineyard		
	Entwine Australia – promoting a sustainable grape and wine community		
	How does the environmental performance of the Adelaide Hills stack up?		
M.G. Holdstock	Practical ways to reduce emissions in the winery		
	Trading carbon – what is the future for the wine industry?		
	Smoke taint update		
E.N. Wilkes	Workshop on the practical analysis of SO_2, alcohol, TA and sugar	International Wine Technical Summit, San Lusi Obispo, California, USA	23 May 16
C.A. Simos, P.O. Williamson	How spice character makes Australian Shiraz unique	Vinexpo 2016, Hong Kong	26 May 16
E.N. Wilkes	Brett, accepting the problem is the first step	Invisible Sentinel Seminar, Napa, California, USA	27 May 16
T.J. Abbott	Where is all my energy going? Sources and sinks in the vineyard and winery	Opportunities in a new climate workshop, Clare Valley, SA	
	Trading carbon – what is the future for the wine industry?		
	Harnessing the sun at the winery		
	Opportunities for the grape and wine sector in the Emissions Reduction Fund		

Staff	Title of presentation	Presented to and where	Date
M.L. Longbottom	Why is climate important in wine-grape production?	Opportunities in a new climate workshop, Clare Valley, SA	27 May 16
	Entwine Australia – promoting a sustainable grape and wine community		
	How does the environmental performance of Clare stack up?		
	Grazing sheep in vineyards – saving fuel and money		
	Fuel, fertiliser and electricity: the multi-pronged approach in the vineyard		
W.P. Pearson	Aromas and flavours	Wine Australia sensory evaluation dinner, Sydney, NSW	31 May 16
K.A. DeGaris	How can irrigation management strategies be used to manipulate wine quality?	AWRI roadshow seminar, Coonawarra, SA	
	Why do varieties respond differently to drought and heat stress?		
M.L. Longbottom	Does soil and vine nutrient status affect wine quality?		
	Why do bunches get hot – and what does this mean for wine quality?		
P.A. Smith	What are the relationships between grape chemical composition, grape allocation grade and final wine style?		
R. Gawel	Putting the texture back into white wine – the role of white wine phenolics		
	Phenolics and the interactive effects of pH, acidity and alcohol on bitterness and mouth-feel of white wine		
C.A. Simos	Features of the AWRI website		
M.L. Longbottom	Why is climate important in wine-grape production?	Opportunities in a new climate workshop, Tumbarumba, NSW	2 Jun 16
G.D. Cowey	Trading carbon – what is the future for the wine industry?		
	Practical ways to reduce emissions in the winery		
M. Essling	Entwine Australia – promoting a sustainable grape and wine community		
	How does the environmental performance of the Canberra District stack up?		
	Practical ways to reduce emissions in the vineyard		
G.D. Cowey	Why is climate important in wine-grape production?	Opportunities in a new climate workshop, Canberra, ACT	3 Jun 16
	Trading carbon – what is the future for the wine industry?		
	Practical ways to reduce emissions in the winery		
M. Essling	Entwine Australia – promoting a sustainable grape and wine community		
	How does the environmental performance of the Canberra District stack up?		
	Practical ways to reduce emissions in the vineyard		
P.A. Smith	The changing wine style of the ripening grape	AWRI roadshow seminar, Riverland, SA	8 Jun 16
	What are the relationships between grape chemical composition, grape allocation grade and final wine style?		
S. Nordestgaard	Maximising quality during bulk wine transportation		
M. Essling	Agrochemical update		
	Is it possible to control bunch rot without fungicides?		
E.N. Wilkes	Copper in winemaking, the good and the bad		
P.R. Petrie	Vine balance – how does it affect yield and quality?		
	Great wine from grafted vines		
I.L. Francis	Thinking outside the bottle: insights on how Chinese consumers choose wine		

Staff	Title of presentation	Presented to and where	Date
M.P. Krstic	Do you ignore your vineyard after harvest?	AWRI roadshow seminar, Riverland, SA	8 Jun 16
E.N. Wilkes	Get the best out of your winery using 'lean production'		
S. Nordestgaard	Maximising quality during bulk wine transportation	AWRI roadshow seminar, Irymple, Vic	9 Jun 16
M. Essling	Agrochemical update		
E.N. Wilkes	The truth about sulfur dioxide		
M.P. Krstic	Do you ignore your vineyard after harvest?		
P.A. Smith	What are the relationships between grape chemical composition, grape allocation grade and final wine style?		
E.N. Wilkes	Get the best out of your winery using 'lean production'		
P.J. Chambers	Robot room tour and presentation	Wine Australia USA retail buyers group, Adelaide, SA	
P.A. Smith, A. Mierczynska-Vasilev	Nanoparticle tracking analysis		
P.W. Godden	Screwcaps vs cork		
W.P. Pearson	Sensory perception of faults and positive flavour compounds		
M.P. Krstic	Welcome and setting the Chardonnay scene	Cooler climate Chardonnay symposium, Yarra Valley, Vic	16 Jun 16
	International Chardonnay production and performance		
I.L. Francis	Insights into flavour and aroma compounds in Chardonnay		
M.L. Longbottom	Entwine Australia – promoting a sustainable grape and wine community	Padthaway Grapegrowers Association, Padthaway, SA	17 Jun 16
J.M. McRae	Filtration effects on red wines	Treasury Wine Estates winemakers, Nuriootpa, SA	21 Jun 16
K.A. Bindon	Predicting wine tannin and colour in the vineyard	AWRI roadshow seminar, Murgon, Qld	22 Jun 16
	Managing the risk of protein haze formation in white wines		
M.L. Longbottom	Why do varieties respond differently to drought and heat stress?		
	Why do bunches get hot – and what does this mean for wine quality?		
P.J. Costello	Microbial spoilage of wine: a refresher on how to prevent it		
J.L. Hixson	Phenolics and the interactive effects of pH, acidity and alcohol on bitterness and mouth-feel of white wine		
C.A. Simos	Features of the AWRI website		
M.P. Krstic	Introduction – new vineyard management innovations	Future vineyard management practices workshop, Milawa, Vic	
S. Nordestgaard	Latest grape harvesting and grape sorting technologies		
M. Essling	Latest updates and insights into agrochemical use in viticulture		
M.J. Herderich	Old friends in new bottles: Aroma precursors in grapes and wine and the complexities of wine flavour	11th Wartburg Symposium on Flavor Chemistry and Biology, Eisenach, Germany	
M.L. Longbottom	Vine balance – how does it affect yield and quality?	AWRI roadshow seminar, Stanthorpe, Qld	23 Jun 16
	Does soil and vine nutrient status affect wine quality?		
	Entwine Australia – promoting a sustainable grape and wine community		
K.A. Bindon	Manipulation of Pinot Noir red wine phenolic profiles during winemaking		
P.J. Costello	Microbial spoilage of wine: a refresher on how to prevent it		
	Strategies for a successful MLF		
J.L. Hixson	Putting the texture back into white wine – the role of white wine phenolics		
C.A. Simos	Features of the AWRI website		
E.N. Wilkes	Practical analysis of SO_2 and alcohol	Interwinery Analysis Group seminar, Adelaide, SA	
	SO_2, what are we really measuring?		24 Jun 16

Staff	Title of presentation	Presented to and where	Date
R. Gawel	Opportunities for creating value in wine production: impacts of proteins, polyphenols, polysaccharides, oxygen and sulfur compounds	'Gold Standard' California Wine Laboratory Technical Group, Napa, California, USA	24 Jun 16
G.D. Cowey	Q&A session and case studies	AWRI roadshow workshop, Rutherglen, Vic	28 Jun 16
	New varieties for a changing climate tasting		
	Hotter and drier – processing ripe fruit		
	Salinity, sodicity and salty wine		
A.D. Coulter	Bushfires and smoke taint tasting		
	Winemaking in wet seasons		
P.R. Petrie	Hotter and drier in the vineyard		
	Growing grapes in wet seasons		
	Building resilience and sustainability in the grape and wine sector		
A.D. Coulter, G.D. Cowey	Stuck fermentation		
M. Essling	Entwine Australia – promoting a sustainable grape and wine community	Sustainable Australia Winegrowing launch, Adelaide Hills, SA	
V.T. O'Brien, G.A.P. Patacq	Building emotive appeal in wine offerings	Barossa Grape and Wine Association, Barossa Valley, SA	
R. Gawel	White juice solids: effects on phenolics, polysaccharides, and mouth-feel of white wine	American Society for Enology and Viticulture 67th National Conference, Monterey, California, USA	29 Jun 16
P.R. Petrie	Hotter and drier in the vineyard	AWRI roadshow workshop, Goulburn Valley, Vic	
	Growing grapes in wet seasons		
	Building resilience and sustainability in the grape and wine sector		
A.D. Coulter	Winemaking in wet seasons		
	Bushfires and smoke taint tasting		
G.D. Cowey	Salinity, sodicity and salty wine		
	Hotter and drier – processing ripe fruit		
	New varieties for a changing climate tasting		
A.D. Coulter, G.D. Cowey	Stuck fermentation		
P.A. Smith	Defining the mechanisms and impact of winemaking treatments on tannin and polysaccharides in red wine: recent progress in creating diverse styles	Macrowine Conference, Nyon, Switzerland	30 Jun 16
M.J. Herderich	Grape metabolites, aroma precursors and the complexities of wine flavour		

APPENDIX 2

EVENTS ORGANISED BY AWRI STAFF

Staff	Title of event	Held	Date
G.D. Cowey, V.F. Phillips, P.R. Petrie, M.G. Holdstock, M.L. Longbottom	AWRI roadshow workshop – Adapting to difficult vintages	Langhorne Creek, SA	2 Jul 15
C.A. Simos, V.F. Phillips, M.P. Krstic, K.A. Bindon, E.N. Wilkes, P.A. Henschke	AWRI roadshow seminar	Rutherglen, Vic	14 Jul 15
		Bendigo, Vic	15 Jul 15
C.A. Simos, V.F. Phillips, M.P. Krstic, P.A. Henschke, E.N. Wilkes, E.J. Bartowsky		Avoca, Vic	16 Jul 15
F. Blefari, V.F. Phillips, M.G. Holdstock, G.D. Cowey, C.A. Simos, M.F. Calabrese, A.M. Barker, W.P. Pearson	Advanced Wine Assessment Course (AWAC 37)	AWRI, Adelaide, SA	20-23 Jul 15
	Advanced Wine Assessment Course (AWAC 38)		27-30 Jul 15
G.D. Cowey, V.F. Phillips, M. Essling, A.D. Coulter, M.L. Longbottom	AWRI roadshow workshop – Adapting to difficult vintages	Hunter Valley, NSW	28 Jul 15
F. Blefari, V.F. Phillips, M.G. Holdstock, G.D. Cowey, C.A. Simos, M.F. Calabrese, A.M. Barker	Wine show judging – an insider's view of panel tastings #1	AWRI, Adelaide, SA	31 Jul 15
M.L. Longbottom, V.F. Phillips, M.G. Holdstock, J.L. Hixson	Opportunities in a new climate workshop	Adelaide Hills, SA	11 Aug 15
C.A. Simos, V.F. Phillips, G.D. Cowey, P.R. Petrie, M. Essling, K.A. Bindon, J.R. Bellon, C.D. Curtin	AWRI roadshow seminar	McLaren Vale, SA	12 Aug 15
C.A. Simos, V.F. Phillips, P.R. Petrie, K.A. Bindon, R. Gawel, P.A. Henschke		Canberra, ACT	19 Aug 15
C.A. Simos, V.F. Phillips, P.R. Petrie, K.A. Bindon, P.A. Henschke		Orange, NSW	20 Aug 15
V.F. Phillips, M. Essling, G.D. Cowey	Opportunities in a new climate workshop	Mornington Peninsula, Vic	
C.A. Simos, V.F. Phillips, P.R. Petrie, K.A. Bindon, E.N. Wilkes	AWRI roadshow seminar	Mudgee, NSW	21 Aug 15
C.A. Simos, V.F. Phillips, M.L. Longbottom, T.E. Siebert, G.D. Cowey, R. Gawel, M.Z. Bekker		Clare Valley, SA	25 Aug 15
M.L. Longbottom, V.F. Phillips, M. Essling, G.D. Cowey, K.C. Hirlam	Opportunities in a new climate workshop	Langhorne Creek, SA	27 Aug 15
M.L. Longbottom, V.F. Phillips, M.G. Holdstock		Launceston, Tas	1 Sep 15
C.A. Simos, V.F. Phillips, P.R. Petrie, M. Essling, J.M. McRae, T.E. Siebert, M.L. Longbottom	AWRI roadshow seminar	Barossa Valley, SA	8 Sep 15
F. Blefari, P.W. Godden, M.F. Calabrese	Westpac Group premium wine experience		25 Sep 15
M.L. Longbottom, V.F. Phillips, M. Essling, M.G. Holdstock, J.L. Hixson	Opportunities in a new climate workshop	Riverland, SA	15 Oct 15
M.L. Longbottom, V.F. Phillips, M. Essling, G.D. Cowey		Kangaroo Island, SA	21 Oct 15
M.F. Calabrese, G.D. Cowey, M. Essling	AWRI roadshow workshop – Adapting to difficult vintages		
M.P. Krstic	Oak workshop	Yarra Valley, Vic	22 Oct 15

Staff	Title of event	Held	Date
M.L. Longbottom, K.A. DeGaris	Research to practice – Grapevine nutrition in a changing environment	Riverland, SA	26 Oct 15
V.F. Phillips, G.D. Cowey, P.R. Petrie, A.D. Coulter	AWRI roadshow workshop – Adapting to difficult vintages	Mudgee, NSW	27 Oct 15
		Orange, NSW	28 Oct 15
M.P. Krstic	Optimising management of vineyard soils workshop	Yarra Valley, Vic	
V.F. Phillips, G.D. Cowey, P.R. Petrie, A.D. Coulter	AWRI roadshow workshop – Adapting to difficult vintages	Canberra, ACT	30 Oct 15
M.L. Longbottom, G.D. Cowey, M.F. Calabrese	Opportunities in a new climate workshop	Padthaway, SA	4 Nov 15
M.G. Holdstock, W.P. Pearson	Aroma Bar – Vino Paradiso	Sydney, NSW	6-8 Nov 15
M.G. Holdstock, A.M. Barker	Aroma Bar – APEC visitors	AWRI, Adelaide, SA	13 Nov 15
C.A. Simos, F. Blefari, M.G. Holdstock, G.D. Cowey. V.F. Phillips, W.P. Pearson	Advanced Wine Assessment Course (AWAC 39)		16-19 Nov 15
C.A. Simos, F. Blefari, M.G. Holdstock, G.D. Cowey. V.F. Phillips, W.P. Pearson	Wine show judging - an insider's view of panel tastings #2		20 Nov 15
V.T. O'Brien, P.W. Godden, P.O. Williamson, A.L. Freeman, V.F. Phillips, W.P. Pearson, G.A.P. Patacq	VALO exclusive at Chester's	McLaren Vale, SA	21 Nov 15
F. Blefari, M.G. Holdstock, M.F. Calabrese	Deloitte premium wine experience	Barossa Valley, SA	24 Nov 15
V.F. Phillips, P.R. Petrie, C.A. Simos, R. Gawel, M. Essling, E.N. Wilkes	AWRI roadshow seminar	Griffith, NSW	26 Nov 15
V.F. Phillips, M. Essling, J.L. Hixson	Opportunities in a new climate workshop	Mildura, Vic	8 Dec 15
C.A. Simos	AWRI roadshow seminar – smoke taint	Frankland River, WA	
M.P. Krstic	Drought, fire and smoke management seminar	Pyrenees, Vic	
V.F. Phillips, M.L. Longbottom, M.G. Holdstock, K.C. Hirlam	Opportunities in a new climate workshop	Barossa Valley, SA	10 Dec 15
M.P. Krstic	Wine Victoria and Department of Environment, Land, Water and Planning Fire Management Forum	Melbourne, Vic	15 Dec 15
	Phylloxera field day	Yarra Valley, Vic	7 Jan 16
M.L. Longbottom, M.G. Holdstock	Opportunities in a new climate workshop	Margaret River, WA	13 Jan 16
C.A. Simos	AWRI roadshow seminar – smoke taint	Geographe, WA	22 Jan 16
M.L. Longbottom, G.D. Cowey	Opportunities in a new climate workshop	Hobart, Tas	28 Jan 16
C.A. Simos	AWRI roadshow seminar – smoke taint	Launceston, Tas	4 Mar 16
P.O. Williamson, I.L. Francis, E.N. Wilkes, V.T. O'Brien	Wine Australia Pan Asia Trade and Media group	AWRI, Adelaide, SA	10 Mar 16
C.A. Simos, M.P. Krstic	AWRI roadshow seminar – stuck ferments	Yarra Valley, Vic	22 Apr 16
M.P. Krstic	Trunk disease workshop	Moorooduc, Vic	26 Apr 16
		Milawa, Vic	27 Apr 16
M.L. Longbottom, V.F. Phillips, G.D. Cowey, M. Essling	Opportunities in a new climate workshop	Great Western, Vic	28 April 16
V.T. O'Brien, G.A.P. Patacq	Design thinking/ideation workshop	Kingston-on-Murray, SA	2 May 16
M.L. Longbottom, V.F. Phillips, G.D. Cowey, M. Essling	Opportunities in a new climate workshop	Mount Barker, WA	4 May 16
M.P. Krstic, V.F. Phillips	Chardonnay and Shiraz clonal tasting event	Great Western, Vic	10 May 16
M.L. Longbottom, V.F. Phillips, G.D. Cowey	Opportunities in a new climate workshop	McLaren Vale, SA	12 May 16
M.L. Longbottom, V.F. Phillips, M. Essling, T.J. Abbott		Orange, NSW	18 May 16
		Hunter Valley, NSW	19 May 16
V.F. Phillips, M.L. Longbottom, M.G. Holdstock		Adelaide Hills, SA	20 May 16

Staff	Title of event	Held	Date
P.O. Williamson	Aroma bar – Vinexpo 2016	Hong Kong	24 May 16
V.F. Phillips, M.L. Longbottom, M.G. Holdstock, J.L. Hixson, M. Essling	Opportunities in a new climate workshop	Clare Valley, SA	27 May 16
V.F. Phillips, C.A. Simos, K.A. DeGaris, M.L. Longbottom, P.A. Smith, R. Gawel	AWRI roadshow seminar	Coonawarra, SA	31 May 16
V.F. Phillips, M.L. Longbottom, G.D. Cowey, M. Essling	Opportunities in a new climate workshop	Tumbarumba, NSW	2 Jun 16
		Canberra, ACT	3 Jun 16
F. Blefari, M.G. Holdstock	Barossa wine assessment training	Barossa Valley, SA	7-8 Jun 16
V.F. Phillips, M.P. Krstic, C.A. Simos, P.A. Smith, S. Nordestgaard, M. Essling, E.N. Wilkes, P.R. Petrie, I.L. Francis, M.L. Longbottom	AWRI roadshow seminar	Riverland, SA	8 Jun 16
M.F. Calabrese, P.J. Chambers, P.A. Smith, A. Mierczynska-Vasilev, P.W. Godden, W.P. Pearson	Wine Australia USA retail buyers group visit	AWRI, Adelaide, SA	9 Jun 16
V.F. Phillips, M.P. Krstic, C.A. Simos, P.R. Petrie, S. Nordestgaard, M. Essling, E.N. Wilkes, P.A. Smith	AWRI roadshow seminar	Irymple, Vic	
M.P. Krstic, I.L. Francis	Cooler climate Chardonnay symposium	Yarra Valley, Vic	16 Jun 16
M.P. Krstic, S. Nordestgaard, M. Essling	Future vineyard management workshop	Milawa, Vic	22 Jun 16
V.F. Phillips, C.A. Simos, M.L. Longbottom, K.A. Bindon, P.J. Costello, J.L. Hixson	AWRI roadshow seminar	Murgon, Qld	
V.F. Phillips, C.A. Simos, M.L. Longbottom, K.A. Bindon, P.J. Costello, J.L. Hixson		Stanthorpe, Qld	23 Jun 16
V.F. Phillips, G.D. Cowey, P.R. Petrie, A.D. Coulter	AWRI roadshow workshop – Adapting to difficult vintages	Rutherglen, Vic	28 Jun 16
		Goulburn Valley, Vic	29 Jun 16

APPENDIX 3
POSTERS

Staff	Title of poster	Presented at	Date
N.D.R. Lloyd, J.C. Hack, M.R. Solomon, N. Scrimgeour, W.U. Cynkar, M.J. Herderich, E.N. Wilkes	Characterising the effects of storage temperature on wine using non-targeted metabolomics	11th International Conference of the Metabolomics Society, San Francisco, California, USA	29 Jun-2 Jul 15
M.P. Day, M.Z. Viviers, J.M. McRae, K.A. Bindon, S. Kassara, E.N. Wilkes, P.A. Smith	Effect of early oxygen exposure during red winemaking on the production of volatile sulfur compounds, colour and tannins	In Vino Analytica Scientia, Trento, Italy	14-17 Jul 15
M.P. Day, S.A. Schmidt, M.Z. Viviers, D.L. Capone, J.C. Hack, T.M. Parker, P.A. Smith, E.N. Wilkes	Effects of passive oxygenation during white winemaking		
N.D.R. Lloyd, V. Hysenaj, M.R. Solomon, M. Parker, J.C. Hack, D. Perenzoni[1], F. Mattivi[1], C.S. Stockley, M.J. Herderich	Comprehensive profiling of non-volatile grape and wine metabolites: the grape metabolome and its relationship with wine composition		
D.L. Capone, A.M. Barker, P.O. Williamson, W.P. Pearson, A. Agius, I.L. Francis	Relating consumer acceptance, sensory attributes and chemical composition of Chardonnay wines with tropical fruit flavour	Pangborn 2015 Sensory Science Symposium, Gothenburg, Sweden	26-27 Aug 15
J.M. McRae, S.A. Schmidt, N. Warnock[2], P. Anderson[2], P.A. Smith	Proteases: a new frontier in preventing haziness in white wines	ComBio 2015, Melbourne, Vic	27 Sep-1 Oct 15
T.E. Siebert, N. Zibi[3], S.R. Barter, I.L. Francis, M.J. Herderich	Does sunlight exposure affect the pepperiness of Australian cool climate Shiraz?	9th International Cool Climate Wine Symposium, Brighton, UK	26-28 May 16
J.M. McRae, A. Mierczynska-Vasilev, A. Soden[4], M.P. Day, P.A. Smith	Impact of industrial-scale serial filtration on macromolecules in red wines	Macrowine 2016, Nyon, Switzerland	26-30 Jun 16

Affiliations: [1]Fondazione Edmund Mach, Research and Innovation Centre, Food Quality and Nutrition Department, San Michele all'Adige, Italy, [2]Flinders University, [3]Friedrich-Alexander University Erlangen-Nürnberg, Erlangen, Germany, [4]Treasury Wine Estates

APPENDIX 4

TEACHING RESPONSIBILITIES (LECTURES) OF AWRI STAFF

Institution	Subject number	Subject name	No of lectures	Staff member
University of Adelaide	3520WT/7520WT	Advances in wine science	3	E.J. Bartowsky
	3046WT/7046WT	Fermentation technology	2	I.L. Francis
	3005WT	Grape industry practice, policy and communication	1	
			2	C.S. Stockley
			1	P.A. Smith
	7520WT	Advances in wine science	1	C.A. Simos
	7047WT/3047WT	Winemaking at vintage	1	M.P. Day, P.A. Smith
	3007WT/7010WT	Stabilisation and clarification	1	J.M. McRae
			3	A.D. Coulter
	3500WT	Biotechnology in the food and wine industries	4	S.A. Schmidt
		Grape industry practice, policy and communication III	1	N.D.R. Lloyd
	2500WT	Animal and plant biochemistry II	1	C.A. Varela
University of Melbourne	UNIB10009	Food for a healthy planet	1	C.S. Stockley

APPENDIX 5

STUDENT SUPERVISION RESPONSIBILITIES OF AWRI STAFF

Student	Supervisors	Source of funds
PhD		
Jenny Bellon	P.J. Chambers, A.R. Borneman, C.M. Ford[1]	Wine Australia
Liang Chen	D.L. Capone and D.W. Jeffery[1]	China Scholarship Council and Wine Australia
Lisa Hartmann	A.R. Borneman, P.J. Chambers	University of Adelaide and Wine Australia
Sijing Li	K.A. Bindon, K.L. Wilkinson[1]	Australian Research Council Industrial Transformation Training Centre, University of Adelaide
Mango Parker	I.L. Francis, M.J. Herderich, C.A. Black, M. De Barros Lopes[2]	Wine Australia
Olaf Schelezki	P.A. Smith, D.W. Jeffery[1]	Australian Research Council Industrial Transformation Training Centre, University of Adelaide
Tracey Siebert	I.L. Francis, M.J. Herderich, M. De Barros Lopes[2]	Wine Australia
Federico Tondini	V. Jiranek[1], M.J. Herderich	Australian Research Council Industrial Transformation Training Centre, University of Adelaide
Patricia Williamson	I.L. Francis, S. Mueller-Loose[2,3], L. Lockshin[2]	Wine Australia
Ryan Zeppel	A.R. Borneman, C.D. Curtin, J. Kelly[1]	University of Adelaide and Wine Australia
Pangzhen Zhang	K.S. Howell[4], E.W.R. Barlow[4], S. Fuentes[4], M.P. Krstic, M.J. Herderich	University of Melbourne
Masters		
Yu Hou	D.L. Capone, D.W. Jeffery[1]	University of Adelaide

Affiliations: [1]University of Adelaide, [2]University of South Australia, [3]Hochschule Geisenheim, Germany, [4]University of Melbourne

APPENDIX 6

MEDIA INTERVIEWS

Date	Staff member	Discussed	Media
8 Jul 15	M.J. Herderich	Wine research in Australia	*CCTV*, China
13 Jul 15		Wine science	Science in the studio, *ABC639*
10 Aug 15	A.R. Borneman	Wine genomics	Graeme O'Neill, Freelance science writer
18 Aug 15	S. Nordestgaard	Researcher profile	Nick Carne, *Wine Australia RD&E@work*
20 Aug 15	C.A. Simos	Smoke taint	Michael Cavanagh, *ABC Rural*, Canberra
25 Aug 15		The AWRI and climate change issues	Isabella Pittaway, *ABC North and West SA*, Port Pirie
	P.R. Petrie	Climate change and viticulture	
	N. Scrimgeour	Process sensors	Nick Carne, *Wine Australia RD&E News*
3 Sep 15	T.E. Siebert	Mt Langi Ghiran Shiraz wines and their pepper character	David Swan, *The Australian*
15 Sep 15	N. Scrimgeour	Process sensors	Isabella Pittaway, *ABC North and West SA*, Port Pirie
8 Oct 15	M.P. Krstic	Victorian node extension activities	Nick Carne, *Wine Australia RD&E news*
15 Oct 15	D.L. Johnson	Entrepreneurship and commercialisation	*Science Next Collaborative* website
21 Oct 15	P.W. Godden	Aspergillopepsin regulatory approvals	Nick Carne, *Wine Australia RD&E@work*
22 Oct 15	A. Mierczynska-Vasilev	Researcher profile	
23 Oct 15	P.J. Chambers	Cultivating yeast in the modern day	Yvonne Bang, *Nautilus* magazine
2 Nov 15	D.L. Johnson	AWITC and AWITE	Nathan Gogoll, *Australian & New Zealand Grapegrower & Winemaker*
3 Nov 15	M.L. Downie	eBook collection	Nick Carne, *Wine Australia RD&E news*
11 Nov 15	P.R. Petrie	Earlier flowering and earlier harvest	Tim Noonan, *Channel 7*
19 Nov 15	P.O. Williamson	China's taste for Australian red wine	Rachael Hakim, *Research Edge* (UniSA newsletter)
3 Dec 15	M.J. Herderich	Rotundone formation	Nick Carne, *Wine Australia RD&E news*
7 Dec 15	E.N. Wilkes	Grape marc research	Laurissa Smith, *ABC Rural* Wagga Wagga
8 Dec 15	E.J. Bartowsky	Researcher profile	Nick Carne, *Wine Australia RD&E@work*
14 Dec 15	M.P. Krstic	Smoke taint support	Nick Carne, *Wine Australia RD&E news*
19 Jan 16	C.S. Stockley	Adverse reactions from wine	Giusi Mainardi, *OICCE Times*
27 Jan 16	E.J. Bartowsky	Top 10 tips for MLF	Nick Carne, *Wine Australia RD&E News*
28 Jan 16	M.L. Longbottom	Entwine and climate in Tasmania	Sally Dakis, *ABC Rural,* Tasmania
	G.D. Cowey	Grape marc	
9 Feb 16	C.A. Simos	How to be a wine expert	Max Allen, *The Australian*
15 Feb 16	M.P. Krstic	Climate change and viticulture	Calla Wahlquist, *The Guardian Australia*
19 Feb 16	M.L. Longbottom		Lucinda Jose, *ABC Rural,* Geraldton
22 Feb 16	M.P. Day. P.A. Smith, S.A. Schmidt	An update on oxygen in winemaking	Nick Carne, *Wine Australia RD&E@Work*
2 Mar 16	P.W. Godden, E.M.C. Robinson	Overview of the AWRI	Harvey Steiman, MaryAnn Worobiec, *Wine Spectator*
	E.N. Wilkes	Commercial Services overview	
	M.J. Herderich	Research overview	
	V.T. O'Brien	Luxury through innovation	
	C.D. Curtin	Linking research to wine in the glass – yeast that produces rose aroma	

Date	Staff member	Discussed	Media
2 Mar 16	M.P. Day	Linking research to wine in the glass – oxygen exposure during winemaking	Harvey Steiman, MaryAnn Worobiec, *Wine Spectator*
	D.L. Capone	Linking research to wine in the glass – non-grape sources of flavour	
	I.L. Francis	Linking research to wine in the glass – in-mouth flavour release	
	C.A. Simos	Linking research to wine in the glass – smoke taint	
		Industry support programs overview	
3 Mar 16		Smoke taint	Andrew Collins, *ABC WA*
8 Mar 16	V.T. O'Brien	Innovating to create wine product premiums	Science in the studio, *ABC 639*
15 Mar 16	C.S. Stockley	The role of sulfur dioxide in wine allergies and intolerances	Miranda Herron, *Choice* magazine
	A.R. Borneman	Wine yeast genomes	Cristy Gelling, Genetics Society of America
21 Mar 16	S. Nordestgaard	Bulk wine transport project	Nick Carne, *Wine Australia RD&E News*
30 Mar 16	C.S. Stockley	Effect of a change in legal blood alcohol concentration from 0.05 to 0.02	Tony Love, *The Advertiser*
19 Apr 16	A.R. Borneman	Implications of yeast genome work on future yeast breeding	Nick Carne, *Wine Australia RD&E@Work*
2 May 16	G.D. Cowey	Researcher profile	
5-6 May 16	A.R. Borneman, S. Dillon	Shipwreck yeast	Jonica Newby, *ABC Catalyst*
6 May 16	P.W. Godden	'Native grapes'	Max Allen, *The Australian*
	A.R. Borneman	Spontaneous ferments and metagenomics	
13 May 16	G.D. Cowey	Climate and the Australian grape and wine sector	Jack James, student journalist, Queensland University of Technology
6 Jun 16	M.P. Day	Authenticity	Nick Carne, *Wine Australia RD&E News*
8 Jun 16	M.P. Krstic	Post-harvest vineyard care	Tom Nancarrow, *ABC Radio,* Riverland, SA
15 Jun 16	A.R. Borneman	Shipwreck yeast	Sonya Feldhoff, *ABC 891 Afternoons*
			Paul Henley, *BBC Newshour*
16 Jun 16			Ariel Bogle, *Mashable.com*
	C.A. Simos	Lower alcohol wines	Claire Nichols, *ABC Radio National*
30 Jun 16	S.A. Schmidt	Gluatathione project	Nick Carne, *Wine Australia RD&E News*

APPENDIX 7

PAPERS PUBLISHED BY AWRI STAFF RECORDED DURING 2015/2016

1725 Nordestgaard, S. Developments in destemming and sorting technology. Part two: Harvester-mounted destemmers and sorters. *Aust. N.Z. Grapegrower Winemaker* (618): 27-29; 2015.

1726 Petrie, P. Ask the AWRI: Bunch stem necrosis. *Aust. N.Z. Grapegrower Winemaker* (618): p. 36; 2015.

1727 Sparrow, A.M., Dambergs, R.G., Bindon, K.A., Smith, P.A., Close, D.C. Interaction of grape skin, seed, and pulp on tannin and anthocyanin extraction in Pinot noir wines. *Am. J. Enol. Vitic.* 66(4): 472-481; 2015.

1728 Coulter, A., Cowey, G., Petrie, P., Essling, M., Holdstock, M., Stockley, C., Simos, C., Johnson, D. Vintage 2015 – observations from the AWRI helpdesk. *Wine Vitic. J. 30*(4): 38-40; 2015.

1729 Longbottom, M. Compressed, crushed and crowned. *Wine Vitic. J. 30*(4): p. 10; 2015.

1730 Dry, P. Cortese. *Wine Vitic. J. 30*(4): p. 60; 2015.

1731 Cordente, A.G., Capone, D.L., Curtin, C.D. Unravelling glutathione conjugate catabolism in *Saccharomyces cerevisiae:* the role of glutathione/dipeptide transporters and vacuolar function in the release of volatile sulfur compounds 3-mercaptohexan-1-ol and 4-mercapto-4-methylpentan-2-one. *Appl. Microbiol. Biotechnol.* 99(22): 9709-9722; 2015.

1732 Anesi, A., Stocchero, M., Dal Santo, S., Commisso, M., Zenoni, S., Ceoldo, S., Tornielli G.B., Siebert, T.E., Herderich, M., Pezzotti, M. Guzzo, F. Towards a scientific interpretation of the *terroir* concept: plasticity of the grape berry metabolome. *BMC Plant Biology* 15(191): 1-17; 2015.

1733 Zhang, P., Howell, K., Krstic, M., Herderich, M., Barlow, E.W.R., Fuentes, S. Environmental factors and seasonality affect the concentration rotundone in *Vitis vinifera* L. cv. Shiraz wine. *PLoS ONE* 10(7): 64-71; 2015.

1734 Nordestgaard, S. The history of wine presses. Part 1: Batch presses. *Aust. N.Z. Grapegrower Winemaker* (619): 64-71; 2015.

1735 Stockley, C. Ask the AWRI: Wine consumption and heart health. *Aust. N.Z. Grapegrower Winemaker* (619): p. 72; 2015.

1736 Capone, D.L., Sefton, M.A., Jeffery, D.W., Francis, I.L. Terroir or terpenoid transformation: the origin of 1,8-cineole (eucalyptol) in wine. Hofmann, T.; Krautwurst, D.; Schieberle, P. (eds.) *Proceedings of the 10th Wartburg Symposium on Flavor Chemistry and Biology*, Eisenach, Germany, 16-19 April, 2013. Freising, Germany: Deutsche Forschungsanstalt für Lebensmittelchemie: 130-136; 2014.

1737 Smith, P. Assessment of relationships between grape chemical composition and grape allocation grade for Cabernet Sauvignon, Shiraz and Chardonnay. *Aust. N.Z. Grapegrower Winemaker* (620): 30-32; 2015.

1738 Hill, M., Cowey, G. The adoption of innovations by Australian grapegrowers and winemakers. *Aust. N.Z. Grapegrower Winemaker* (620): 70-72; 2015.

1739 Nordestgaard, S. The history of wine presses: Part 2: Continuous presses… and what next? *Aust. N.Z. Grapegrower Winemaker* (620): 73, 75-76, 78-79; 2015.

1740 Cowey, G. Ask the AWRI: DIY haze and deposit identification. *Aust. N.Z. Grapegrower Winemaker* (620): p. 87; 2015.

1741 Francis, I.L., Williamson, P.O. Application of consumer sensory science in wine research. *Aust. J. Grape Wine Res.* 21(S1): 554-567; 2015.

1742 Stockley, C.S., Johnson, D.L. Adverse food reactions from consuming wine. *Aust. J. Grape Wine Res.* 21(S1): 568-581; 2015.

1743 Longbottom, M. ASVO Mildura seminar – was it the best yet? *Wine Vitic. J. 30*(5): p. 15; 2015.

1744 Reschke, S., Tran, T., Bekker, M., Wilkes, E., Johnson, D. Using copper more effectively in winemaking. *Wine Vitic. J. 30*(5): 35-37, 39; 2015.

1745 Powell, K., Krstic, M. Rootstock tolerance and resistance to different genetic strains of phylloxera. *Wine Vitic. J.* 30(5): 48-51; 2015.

1746 Dry, P. Lagrein. *Wine Vitic. J. 30*(5): p. 61; 2015.

1747 Giaccio, J., Curtin, C.D., Sefton, M.A., Taylor, D.K. Relationship between menthiafolic acid and wine lactone in wine. *J. Agric. Food Chem.* 63(37): 8241–8246; 2015.

1748 Bachhuka, A., Christo, S.J., Cavallaro, A., Diener, K.R., Mierczynska, A., Smith, L.E., Marian, R., Manavis, J., Hayball, J.D., Vasilev, K. Hybrid core/shell microparticles and their use for understanding biological processes. *J. Colloid Interface Sci.* 457: 9-17; 2015.

1749 Clark, A.C., Wilkes, E.N., Scollary, G.R. Chemistry of copper in white wine: a review. *Aust. J. Grape Wine Res.* 21(3): 339-350.; 2015.

1750 Sternes, P.R., Moyle, R.L. Deep sequencing reveals divergent expression patterns within the small RNA transcriptomes of cultured and vegetative tissues of sugarcane. *Plant Mol. Biol. Rep.* 33(4): 931-951; 2015.

1751 Moyle, R.L., Sternes, P.R., Birch, R.G. Incorporating target sequences of developmentally regulated small RNAs into transgenes to enhance tissue specificity of expression in plants. *Plant Mol. Biol. Rep.* 33(3): 505-511; 2015.

1752 Stockley, C.S. The relationships between alcohol, wine and cardiovascular diseases – A review. *Nutr. Aging* 3 (2-4): 55-88; 2015.

1753 Ward, S.C., Petrie, P.R., Johnson, T.E., Boss, P.K., Bastian, S.E.P. Unripe berries and petioles in *Vitis vinifera* cv. Cabernet Sauvignon fermentations affect sensory and chemical profiles. *Am. J. Enol. Vitic.* 66(4): 435-443; 2015.

1754 Hixson, J.L., Bindon, K.A., Smith, P.A. Evaluation of direct phloroglucinolysis and colorimetric depolymerization assays and their applicability for determining condensed tannins in grape marc. *J. Agric. Food Chem.* 63(45): 9954–9962; 2015.

1755 Krstic, M.R., Johnson, D.L., Herderich, M.J. Review of smoke taint in wine: smoke-derived volatile phenols and their glycosidic metabolites in grapes and vines as biomarkers for smoke exposure and their role in the sensory perception of smoke taint. *Aust. J. Grape Wine Res.* 21(S1): 537-553; 2015.

1756 Smith, P.A., McRae, J.M., Bindon, K.A. Impact of winemaking practices on the concentration and composition of tannins in red wine. *Aust. J. Grape Wine Res.* 21(S1): 601-614; 2015.

1757 Chambers, P.J., Borneman, A.R., Varela, C., Cordente, A.G., Bellon, J.R., Tran, T.M.T., Henschke, P.A., Curtin, C.D. Ongoing domestication of wine yeast: past, present and future. *Aust. J. Grape Wine Res.* 21(S1): 642-650; 2015.

1758 Bekker, M.Z., Day, M.P., Holt, H., Wilkes, E., Smith, P.A. Effect of oxygen exposure during fermentation on volatile sulfur compounds in Shiraz wine and a comparison of strategies for remediation of reductive character. *Aust. J. Grape Wine Res.* 22(1): 24-35; 2016.

1759 Bartowsky, E.J., Costello, P.J., Chambers, P.J. Emerging trends in the application of malolactic fermentation. *Aust. J. Grape Wine Res.* 21(S1): 663-669; 2015.

1760 Higginson, E.G., Lloyd, N.D.R., Kravchuk, O., Ford, C.M., Thomas, M.R. A high-throughput UHPLC MS/MS method for evaluation of tartaric and malic acid concentration in individual grapevine berries. *Aust. J. Grape Wine Res.* 22(1): 16-23; 2016.

1761 Longbottom, M. Ask the AWRI: Nitrous oxide and viticulture. *Aust. N.Z. Grapegrower Winemaker* (621): 42-43; 2015.

1762 Scrimgeour, N. Ferment sensor technologies put through their paces. *Aust. N.Z. Grapegrower Winemaker* (621): 68, 70, 72-74; 2015.

1763 Coulter, A. Ask the AWRI: Spoilage due to lactic acid bacteria. *Aust. N.Z. Grapegrower Winemaker* (622): 76-77; 2015.

1764 Coulter, A.D., Holdstock, M.G., Cowey, G.D., Simos, C.A., Smith, P.A., Wilkes, E.N. Potassium bitartrate crystallisation in wine and its inhibition. *Aust. J. Grape Wine Res.* 21(S1): 627-641; 2015.

1765 Mierczynska-Vasilev, A., Smith, P.A. Current state of knowledge and challenges in wine clarification. *Aust. J. Grape Wine Res.* 21(S1): 615-626; 2015.

1766 Curtin, C., Varela, C., Borneman, A. Harnessing improved understanding of *Brettanomyces bruxellensis* biology to mitigate the risk of wine spoilage. *Aust. J. Grape Wine Res.* 21(S1): 680-692; 2015.

1767 Schmidt, S.A., Henschke, P.A. Production, reactivation and nutrient requirements of active dried yeast in winemaking: theory and practice. *Aust. J. Grape Wine Res.* 21(S1): 651-662; 2015.

1768 Godden, P., Wilkes, E., Johnson, D. Trends in the composition of Australian wine 1984-2014. *Aust. J. Grape Wine Res.* 21(S1): 741-753; 2015.

1769 Varela, C., Dry, P.R., Kutyna, D.R., Francis, I.L., Henschke, P.A., Curtin, C.D., Chambers, P.J. Strategies for reducing alcohol concentration in wine. *Aust. J. Grape Wine Res.* 21(S1): 670-679; 2015.

1770 Longbottom, M.L., Petrie, P.R. Role of vineyard practices in generating and mitigating greenhouse gas emissions. *Aust. J. Grape Wine Res.* 21(S1): 522-536; 2015.

1771 Herderich, M., Barter, S., Black, C.A., Bramley, R., Capone, D., Dry, P., Siebert, T., Zhang, P. Terroir effects on grape and wine aroma compounds. Ebeler, S.B., Sacks, G., Vidal, S., Winterhalter, P. (eds.) *Advances in wine research*. Washington, D.C.: American Chemical Society: 131–146; 2015. (ACS Symposium series; 1203).

1772 Longbottom, M. A successful seminar and awards night. *Wine Vitic. J.* 30(6): p. 10; 2015.

1773 Gawel, R., Day, M., Schulkin, A., Smith, P. Murky winemaking: How juice solids affect the macromolecular composition and mouthfeel of white wine. *Wine Vitic. J.* 30(6): 18-22; 2015.

1774 Smith, P., Schulkin, A., Kassara, S., Barter, S., Solomon, M., Cynkar, W., Capone, D., Francis, L., Bindon, K., Johnson, D. Applying the latest understanding of grape composition. *Wine Vitic. J.* 30(6): 33-36, 38; 2015.

1775 Dry, P. Friulano. *Wine Vitic. J.* 30(6): p. 54; 2015.

1776 Essling, M. Ask the AWRI: Skipping vineyard sprays in dry years. *Aust. N.Z. Grapegrower Winemaker* (623): p. 38; 2015.

1777 Johnson, D. 2015 Report: Implementation and execution. *Aust. N.Z. Grapegrower Winemaker* (623): 67-70; 2015.

1778 Lloyd, N., Johnson, D.L., Herderich, M.J. Metabolomics approaches for resolving and harnessing chemical diversity in grapes, yeast and wine. *Aust. J. Grape Wine Res.* 21(S1): 723-740; 2015.

1779 Johnson, D.L., Rose, L.E. Foreword to the special edition of the *Australian Journal of Grape and Wine Research* celebrating the 60th anniversary of The Australian Wine Research Institute. *Aust. J. Grape Wine Res.* 21(S1): p. 521; 2015.

1780 Black, C.A., Parker, M., Siebert, T.E., Capone, D.L., Francis, I.L. Terpenoids and their role in wine flavour: recent advances. *Aust. J. Grape Wine Res.* 21(S1): 582-600; 2015.

1781 Day, M.P., Schmidt, S.A., Smith, P.A., Wilkes, E.N. Use and impact of oxygen during winemaking. *Aust. J. Grape Wine Res.* 21(S1): 693-704; 2015.

1782 Smith, M.E., Bekker, M.Z., Smith, P.A., Wilkes, E.N. Sources of volatile sulfur compounds in wine. *Aust. J. Grape Wine Res.* 21(S1): 705-712; 2015.

1783 Scrimgeour, N., Nordestgaard, S., Lloyd, N.D.R., Wilkes, E.N. Exploring the effect of elevated storage temperature on wine composition. *Aust. J. Grape Wine Res.* 21(S1): 713-722; 2015.

1784 Dry, P. Marzemino. *Wine Vitic. J.* 28(4): p. 63; 2013.

1785 Bindon, K.A., Carew, A.L., Mierczynska-Vasilev, A., Kassara, S., Kerslake, F., Smith, P.A. Characterization of macromolecular complexes in red wine: composition, molecular mass distribution and particle size. *Food Chem*. 199: 838-846; 2016.

1786 Sparrow, A.M., Holt, H.E., Pearson, W., Dambergs, R.G., Close, D.C. Accentuated cut edges (ACE): effects of skin fragmentation on the composition and sensory attributes of Pinot noir wines. *Am. J. Enol. Vitic*. 67(2): 169-178; 2016

1787 Holdstock, M. Ask the AWRI: All things analysis. *Aust. N.Z. Grapegrower Winemaker* (624): 52-53; 2016.

1788 Wilkes, E. Baume to alcohol: It's only an approximation. *Aust. N.Z. Grapegrower Winemaker* (624): 59-61; 2016.

1789 Nordestgaard, S. SIMEI 2015 – Wine, olive oil and decanters. *Aust. N.Z. Grapegrower Winemaker* (624): 66-68; 2016.

1790 Geffroy, O., Yobrégat, O., Dufourcq, T., Siebert, T., Serrano, E. Certified clone and powdery mildew impact rotundone in red wine from *Vitis vinifera* L. cv. Duras N. *J. Int. Sci. Vigne Vin* 49(4): 231-240; 2015.

1791 Longbottom, M. ASVO announces new board line-up and Fellow, bolsters industry collaboration. *Wine Vitic. J.* 31(1): p. 10; 2016.

1792 Abbott, T., Longbottom, M., Wilkes, E., Johnson, D. Assessing the environmental credentials of Australian wine. *Wine Vitic. J.* 31(1): 35-37; 2016.

1793 Dry, P. Graciano. *Wine Vitic. J.* 31(1): p. 57; 2016.

1794 Gawel, R., Schulkin, A., Day, M., Barker, A., Smith, P.A. Interactions between phenolics, alcohol and acidity in determining the mouthfeel and bitterness of white wine. *Wine Vitic. J.* 31(1): 30-34; 2016.

1795 Kilmister, R., Unwin, D., Treeby, M., Edwards, E., Krstic, M. Effect of elevated CO_2 and temperature on phenology, carbohydrates, yield and grape composition – preliminary results. *Wine Vitic. J.* 31(1): 38-40, 42; 2016.

1796 Borneman, A.R., Forgan, A.H., Kolouchova, R., Fraser, J.A., Schmidt, S.A. Whole genome comparison reveals high levels of inbreeding and strain redundancy across the spectrum of commercial wine strains of *Saccharomyces cerevisiae*. *G3* 6(4): 957-971; 2016.

1797 Lockshin, L., Corsi, A.M., Cohen, J., Lee, R., Williamson, P. West versus East: measuring the development of Chinese wine preferences. *Food Qual. Pref.* DOI: 10.1016/j.foodqual.2016.02.014; 2016.

1798 Wang, J., Capone, D.L., Wilkinson, K., Jeffery, D.W. Rosé wine volatile composition and the preferences of Chinese wine professionals. *Food Chem.* 202: 507-517; 2016.

1799 McRae, J.M., Bindon, K.A., Hixson, J.L., Smith, P.A. Wine tannin structure and extraction: Review of current research. Combs, C.A. (ed.) *Tannins: Biochemistry, food sources and nutritional properties*. New York, USA: Nova Science Publishers: 85-120; 2016.

1800 Stockley, C.S. A review of the relationship between wine consumption and type 2 diabetes mellitus. *J. Nutr. Therapeut.* 4(4): 124-134; 2015.

1801 Cavallaro, A., Mierczynska, A., Barton, M., Majewski, P., Vasilev, K. Influence of immobilized quaternary ammonium group surface density on antimicrobial efficacy and cytotoxicity. *Biofouling* 32(1): 13-24; 2016.

1802 Petrie, P. Ask the AWRI: Measuring canopy size. *Aust. N.Z. Grapegrower Winemaker* (625): 36-37; 2016.

1803 Zhang, P., Fuentes, S., Siebert, T., Krstic, M., Herderich, M., Barlow, E.W.R., Howell, K. Terpene evolution during the development of *Vitis vinifera* L. cv. Shiraz grapes. *Food Chem.* 204: 463-474; 2016.

1804 Stockley, C.S. Wine consumption, cognitive function and dementias – A relationship? *Nutr. Aging* 3(2-4): 125-127; 2015.

1805 Stockley, C.S. Role of wine components in inflammation and chronic diseases. Moreno-Arribas, M.V., Sualdea, B.B. (eds.) *Wine safety, consumer preference and human health*. Cham, Switzerland: Springer: 241-258; 2016.

1806 Crauwels, S., Van Assche, A., de Jonge, R., Borneman, A.R., Verreth, C., Troels, P., De Samblanx, G., Marchal, K., Van de Peer, Y., Willems, K.A., Verstreppen, K.J., Curtin, C.D., Lievens, B. Comparative phenomics and targeted use of genomics reveals variation in carbon and nitrogen assimilation among different *Brettanomyces bruxellensis* strains. *Appl. Microbiol. Biotechnol*. 99: 9123-9134; 2015.

1807 Williamson, P.O., Lockshin, L., Francis, I.L., Loose, S.M. Influencing consumer choice: short and medium term effect of country of origin information on wine choice. *Food Qual. Pref.* 51: 89-99; 2016.

1808 Nordestgaard, S., Abbott, T. Winery lees: minimising volumes and recovering better quality juice and wine. *Aust. N.Z. Grapegrower Winemaker* (626): 62-64; 2016.

1809 Cowey, G. Ask the AWRI: Predicting alcohol levels. *Aust. N.Z. Grapegrower Winemaker* (626): p. 68; 2016.

1810 Johnson, D. Teasing [OUT] terroir. *WBM* (March/April): 56-57; 2016.

1811 Ristic, R., Fudge, A.L., Pinchbeck, K.A., de Bei, R., Fuentes, S., Hayasaka, Y., Tyerman, S.D., Wilkinson, K.L. Impact of grapevine exposure to smoke on vine physiology and the composition and sensory properties of wine. *Theor. Exp. Plant Physiol.* 28(1): 67-83; 2016.

1813 Bekker, M.Z., Mierczynska-Vasilev, A., Smith, P.A., Wilkes, E.N. The effects of pH and copper on the formation of volatile sulfur compounds in Chardonnay and Shiraz wines post-bottling. *Food Chem.* 207: 148-156; 2016.

1814 Mierczynski, P., Vasilev, K., Mierczynska, A., Maniukiewicz, W., Szynkowska, M.I., Maniecki, T.P. Bimetallic Au-Cu, Au-Ni catalysts supported on MWCNTs for oxy-steam reforming of methanol. *Appl. Catal. B Environ.* 185: 281-294; 2016.

1815 Lee, D., Lloyd, N.D.R., Pretorius, I.S., Borneman, A.R. Heterologous production of raspberry ketone in the wine yeast *Saccharomyces cerevisiae* via pathway engineering and synthetic enzyme fusion. *Microb. Cell Fact.* 15(49): 1-7; 2016.

1816 Taylor, A., Barlow, N., Day, M.P., Hill, S., Patriarca, M., White, M. Atomic spectrometry update: review of advances in the analysis of clinical and biological material, foods and beverages. *J. Anal. At. Spectrom.* 31(3): 554-595; 2016.

1817 Curtin, C., Cordente, T. What's old is new again: yeast mutant screens in the era of pooled segregant analysis by genome sequencing. *Microb. Cell* 3(4): 1-2; 2016.

1818 Varela, C., Sengler, F., Solomon, M., Curtin, C. Volatile flavour profile of reduced alcohol wines fermented with the non-conventional yeast species *Metschnikowia pulcherrima* and *Saccharomyces uvarum*. *Food Chem*. 209: 57-64; 2016.

1819 Moran, M., Petrie, P., Sadras, V. Sensory attributes of Barossa Shiraz 2015 in response to warming and pruning date. *Aust. N.Z. Grapegrower Winemaker* (627): 50-51; 2016.

1820 Stockley, C. Ask the AWRI: Health and nutrition labelling. *Aust. N.Z. Grapegrower Winemaker* (627): p. 66; 2016.

1821 Waterhouse, A.L., Lamuela-Raventós, R.M., Quifer-Rada, P., Stockley, C.S. Wine. Shahidi, F., Alasalvar, C. (eds.) *Handbook of functional beverages and human health*. Boca Raton, FL: CRC Press Taylor & Francis Group LLC: 739-755; 2016.

1822 Petrie, P., Sadras, V. Quantifying the advancement and compression of vintage. *Aust. N.Z. Grapegrower Winemaker* (628): 40-41; 2016.

1823 Essling, M. Ask the AWRI: Grazing sheep in vineyards. *Aust. N.Z. Grapegrower Winemaker* (628): 46-47; 2016.

1824 Wilkes, E., Day, M., Herderich, M., Johnson, D. In vino veritas – investigating technologies to fight wine fraud. *Wine Vitic. J.* 31(2): 36-38; 2016.

1825 Boban, M., Stockley, C., Teissedre, P.-L., Restani, P., Fradera, U., Stein-Hammer C., Ruf, J. Drinking pattern of wine and effects on human health: why should we drink moderately and with meals? *Food Funct.* 7(7): 2937-2942; 2016.

1826 Geffroy, O., Siebert, T., Herderich, M., Mille, B., Serrano, E. On-vine grape drying combined with irrigation allows to produce red wines with enhanced phenolic and rotundone concentrations. *Sci. Hortic.* 207: 208-217; 2016.

1827 Wilkes, E., Warner, L. Sugar analysis – too many choices? *Wine Vitic. J.* 31(3): 68-72; 2016.

1828 Borneman, A., Chambers, P., Schmidt, S., Forgan, A., Kolouchova, R., Herderich, M., Johnson, D. Wine yeast: where are they from and where are we taking them? *Wine Vitic. J.* 31(3): 47-49; 2016.

1829 Godden, P. Documenting 30 years of technological change in the Australian wine industry. *Wine Vitic. J.* 31(3): 11-16; 2016.

1830 Dry, P. Montepulciano. *Wine Vitic. J.* 31(3): p. 61; 2016.

1831 Longbottom, M. Excitement ahead of the Australian Wine Industry Technical Conference. *Wine Vitic. J.* 31(3): p. 11; 2016.

1832 Dry, P. Assyrtiko. *Wine Vitic. J.* 31(2): p. 55; 2016.

1833 Sternes, P.R., Borneman, A.R. Consensus pan-genome assembly of the specialised wine bacterium *Oenococcus oeni*. *BMC Genom.* 17(308): 1-15; 2016.

1834 Johnson, D. See you in July. *Aust. N.Z. Grapegrower Winemaker* (629): p. 20; 2016.

1835 Coulter, A. Ask the AWRI: KHT deposits and cold stability. *Aust. N.Z. Grapegrower Winemaker* (629): p. 76; 2016.

1836 Nordestgaard, S. Five-yearly AWRI Technical Survey to track changes in practices. *Aust. N.Z. Grapegrower Winemaker* (629): p. 81; 2016.

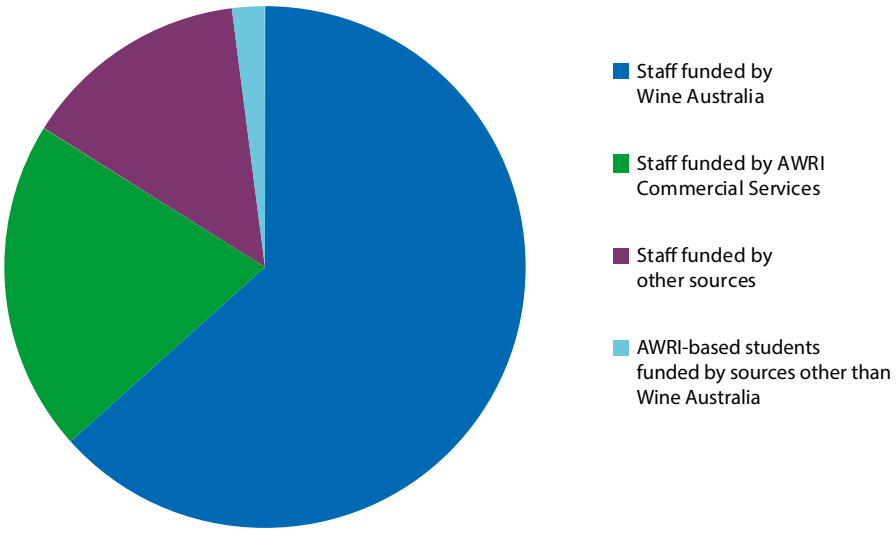
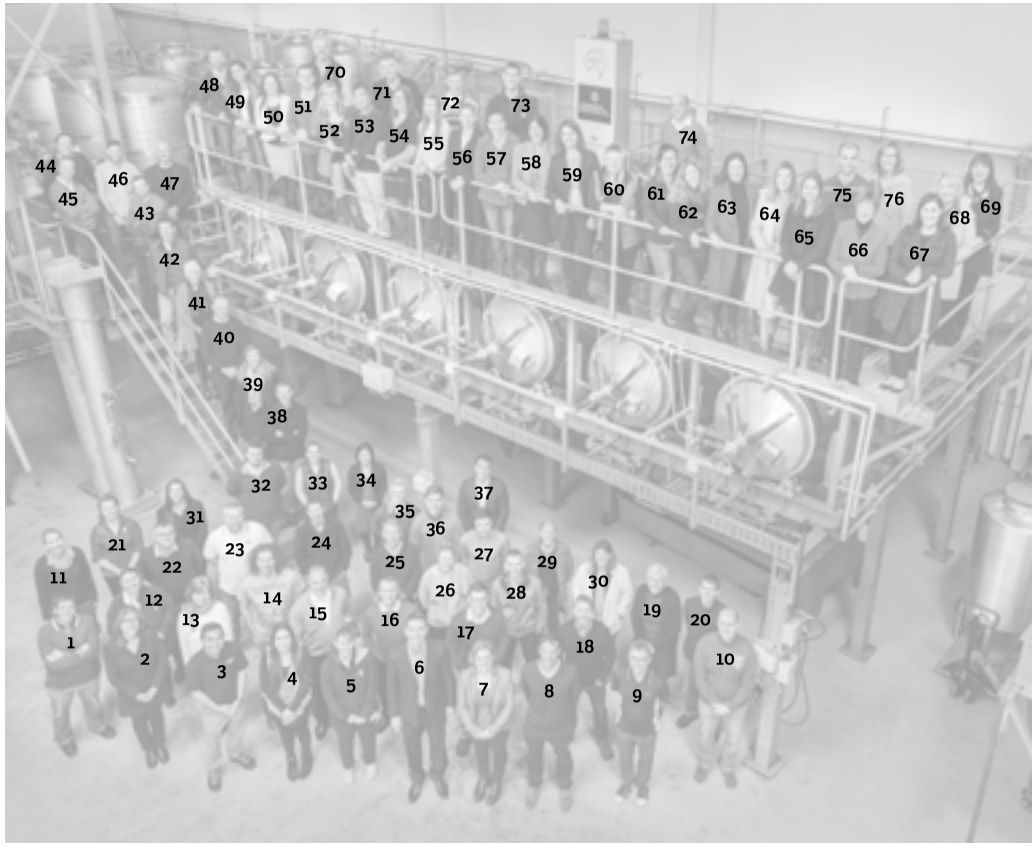


Figure 17. Funding of AWRI staff and students, excluding visiting researchers

STAFF OF THE AUSTRALIAN WINE RESEARCH INSTITUTE

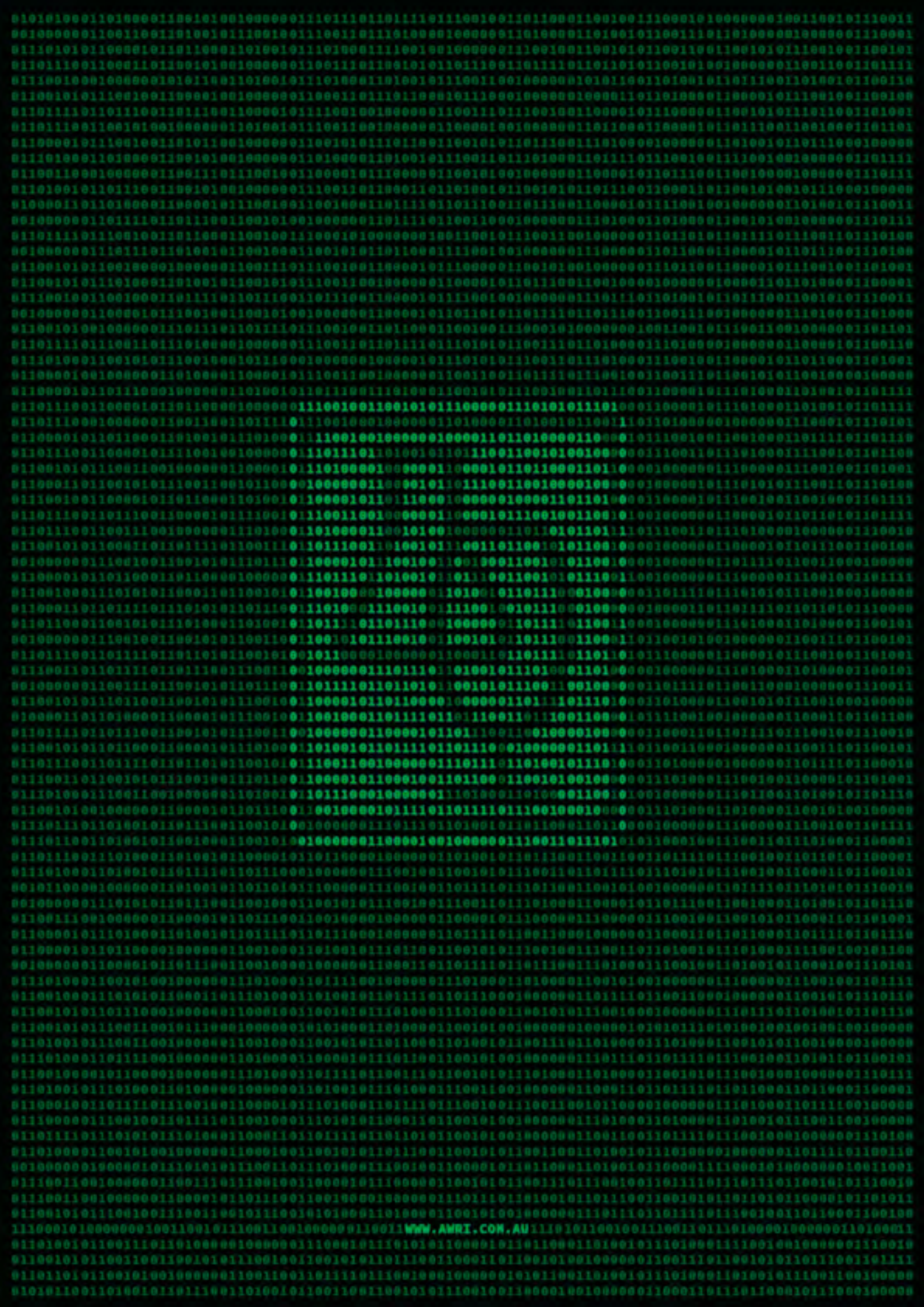
1 John Gledhill
2 Gayle Baldock
3 Jorge Comahig
4 Tenae Miller
5 Elyce Batchelor
6 Dan Johnson
7 Mardi Longbottom
8 Michael Downie
9 Richard Gawel
10 Darek Kutyna
11 Ella Robinson
12 Heather Tosen
13 Wies Cynkar
14 Alex Schulkin
15 Markus Herderich
16 Adrian Coulter
17 Paul Smith
18 Simon Schmidt
19 Anne Lord
20 Tim Reilly
21 Kerry Pinchbeck
22 Leigh Francis
23 Bryan Newell
24 Randell Taylor
25 Peter Godden
26 Alice Barker
27 Ryan Zeppel
28 Neil Scrimgeour
29 Robyn Gleeson
30 Pauline Jorgensen
31 Shiralee Dodd
32 Michael Roach
33 Caroline Bartel
34 Linda Bevin
35 Peter Costello
36 Kieran Hirlam
37 Gregoire Patacq
38 Tadro Abbott
39 Marlize Bekker
40 Eric Wilkes
41 Annette Freeman
42 Geoff Cowey
43 Matt Holdstock
44 Simon Nordestgaard
45 Chris Day
46 Marco Schoeman
47 Mark Braybrook
48 Marcel Essling
49 Vilma Hysenaj
50 Natoiya Lloyd
51 Matthew Wheal
52 Charlotte Jordans
53 Yoji Hayasaka
54 Lisa Hartmann
55 Laura Bey
56 Jacqui McRae
57 Kate Cuijvers
58 Deborah Thornton-Wakeford
59 Joana Fernandes
60 Brigitte Lynch
61 Esther Kristianto
62 Marta Avramova
63 Keren Bindon
64 Agnieszka Mierczynska-Vasilev
65 Patricia Williamson
66 Creina Stockley
67 Francesca Blefari
68 Maria Calabrese
69 Dimitra Capone
70 Angus Forgan
71 Paul Petrie
72 Alfons Cuijvers
73 Josh Hixson
74 Con Simos
75 Toni Garcia Cordente
76 Tracey Siebert

Absent
Melissa Aitchison
Sarah Ballantine
Sheridan Barter
Kate Beames
Jenny Bellon
Anthony Borneman
Catherine Borneman
Paul Chambers
Martin Day
Kerry DeGaris
Simon Dillon
Peter Dry
Andrea Francis
Paul Henschke
Adam Holland
Leanne Hoxey
Stephen Johnson
Jelena Jovanovic
Stella Kassara
Radka Kolouchova
Mark Krstic
Jillian Lee
Jane McCarthy
Vince O'Brien
Jennifer O'Mahony
Mango Parker
Wes Pearson
Virginia Phillips
Amy Rinaldo
June Robinson
Mark Smith
Mark Solomon
Pamela Solomon
Fang Tang
Cristian Varela
Kylee Watson



Translation of the binary code featured on the front and back covers

The world's first high quality reference genome for *Vitis vinifera* cv. Chardonnay grapevine is a landmark event in the history of grape and wine science. Chardonnay is one of the world's most widely planted grape varieties and Chardonnay wines are among the world's most sought after. Australia has forged an international reputation for high quality Chardonnay wine styles at all prices, and Australian Chardonnays are among the most recognised and rewarded of all wines produced in our country. Completion of the reference genome, comparisons with the genomes of several other Chardonnay clones and correlation of genomes with observable traits in the vine and/or the wine will provide a substantial information resource, improve our understanding and appreciation of clonal diversity, and contribute to the production of even better wines. The AWRI is delighted to have worked, together with its collaborators, to produce this outcome for the benefit of Australia's grapegrowers and winemakers.


WWW.AWRI.COM.AU