Annual Report 2018
The Australian Wine
Research Institute

Board members

Ms L.E. Rose,
BAppSc (Oen), 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

Mr B. Bryant,
BSc (Oen)
Elected a member under Clause 25.2 (c) of the Constitution (until 30 June 2018)

Ms W. Cameron,
BAppSc (Biochem and Microbiol), MSc, BAppSc (Wine Sci), MW, GradDip (Ed), GradCert (Bus)
Elected a member under Clause 25.2 (c) of the Constitution (from 1 January 2018)

Dr J.S. Harvey,
BSc (Hons), PhD, MBA, GAICD
Elected a member under Clause 25.2 (c) of the Constitution

Mr K.R. Horton,
BAppSc (Wine Sci)
Elected a member under Clause 25.2 (c) of the Constitution (until 31 December 2017)

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 I.M. Jones,
BSc, MSc
Elected a member under Clause 25.2 (c) of the Constitution (from 1 January 2018)

Prof. K.D. Kirk,
BSc (Hons), PhD, DPhil
Elected a member under Clause 25.2 (b) of the Constitution

Dr S.C. McNab,
BAgSc (Hons), PhD
Elected a member under Clause 25.2 (c) of the Constitution (until 31 December 2017)

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

Mr M.R. Watson,
BEc, MBA, CA, RITP, MAICD
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

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

- Excellence
- Integrity
- Passion

Behaviours

Behaviours in support of 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.

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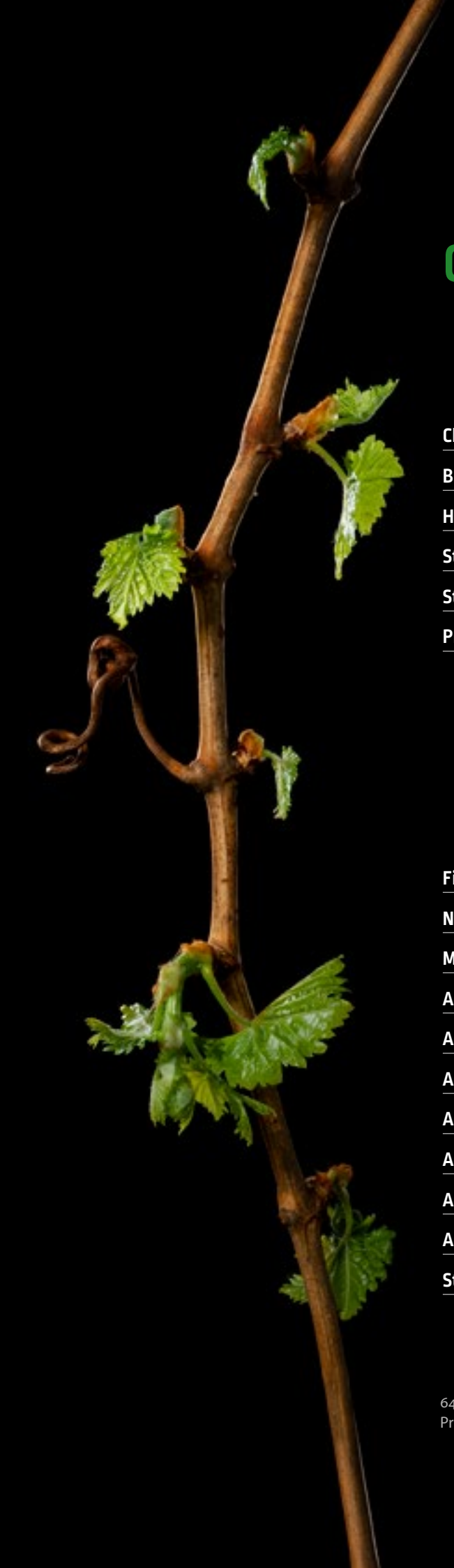


Contents

64th Annual Report – 30 June 2018
Presented to the Australian grape and wine community

Chair and Managing Director's report


Louisa Rose

This has been a positive year for the Australian grape and wine community. Prices paid for wine-grapes have been increasing and Australian wine exports growing. The world's wine buyers and consumers are becoming more aware of what Australia's wines have to offer. Innovation across the value chain is a key part of this story – from improved understanding of planting material or efficiencies in wine production right through to new ways to showcase Australian wines in major markets. These positive developments provide our industry with some important opportunities. Now is the time to think about the decisions that will help maintain sustainability and prosperity in the long term – decisions to support the mechanisms that have underpinned the current successes and that will help us to adapt to the increasing rate of global change.

The Australian wine industry cannot isolate itself from global movements in agriculture and technology. As with other sectors, disruption is inevitable and can happen incredibly quickly. It is important for us to stay aware of developments in areas such as artificial intelligence, automation and the changing nature of the human workforce, so that we are not caught out or left behind and instead can benefit from the changes that are coming.

The AWRI strives to take a long-term view when planning future activities. Industry needs to transcend governmental or classical RDE funding cycles. The need to plan for the future is now supported by the eight-year timeframe of the current RDE plan and the associated long-term funding agreement signed with Wine Australia. The longer horizon adopted provides flexibility for the AWRI to deliver meaningful outcomes for industry in the short term while providing scope for some 'slow burn' projects to be supported – the latter may have the greatest impact in the long run.

Major events, such as the Australian Wine Industry Technical Conference, provide opportunities for members of our industry to come together to discuss important issues, to gain insights from outside perspectives and to make sure the big picture isn't lost among the busy day-to-day priorities. The AWRI, with its partner ASVO, has made significant progress on planning for the 17th AWITC, which will be held in Adelaide in July 2019. A new partnership has been signed with the Wine Industry Suppliers Association and Fair Events to deliver the trade exhibition under the WineTech banner. This complements the previous partnerships with the Winemakers' Federation of Australia Outlook Conference and McWilliam's Maurice O'Shea Award dinner, which all come together to make the AWITC a 'must-attend' event for the grape and wine community. Some new themes will be explored at the 17th AWITC, including the importance of diversity to our continuing success, the growing field of AgTech and the future of winemaking technologies.

AWRI Directions

At the AWRI, this has been the first year of a new AWRI RDE plan and investment agreement with Wine Australia. Good progress has been made across the suite of new projects, with project highlights summarised later in this document. To complement the RDE plan, in 2017/2018 the AWRI developed a new set of business and operational initiatives, *AWRI Directions*, to guide its activities from 2018 to 2020. These initiatives are clustered under four key themes:

1. World-class people and culture
2. Expand the funding base and economic flexibility of the AWRI
3. Improve infrastructure, systems and processes
4. Build/retain relationships, strategic capabilities, services and partnerships.

AWRI Directions has been developed to ensure that the AWRI's governance, systems, infrastructure and service offering all continue to reflect best practice and remain up to date with changes occurring in the wine industry, research and business.

Increasing efficiency

The AWRI continually monitors its overall efficiency and its associated ability to deliver value for levy payers. Analysis of staffing statistics from the past five years shows a continuing increase in the proportion of AWRI staff working in scientific and industry service roles. While there is a natural limit to the gains to be realised by seeking efficiency in administrative support roles without compromising RDE outcomes, this general direction assists the available industry levies to work as hard as possible.

Sustainability

This year has seen major steps forward in the area of sustainability, a topic linked to many elements of grape and wine production

(many with a technical focus) and an area of interest in some markets and consumer segments. For the past 18 months a national steering committee with members including representatives of the AWRI has been working to improve the way sustainability programs are delivered to the Australian grape and wine sector. In August last year the steering committee commissioned an independent review of the current global sustainability landscape.

The review sought to understand the global drivers for sustainability and international demand for demonstration of sustainability credentials. It also explored questions of what an Australian grape and wine sector sustainability program should look like, any barriers to adoption of such a program and, importantly, how Australian wine's sustainability credentials should be communicated to the market. The recommendations of the review can be summarised in three key points:

1. The Australian wine sector should proceed with implementation of a single national sustainability program (NSP) based on the existing Sustainable Australia Winegrowing and Entwine resources, supported by robust verification services.

2. The NSP should be established under formal joint ownership of all the national industry bodies.

3. Sustainability should be integrated into all global marketing activity undertaken by the Australian wine sector.

The report recommendations have been included in a business plan which is expected to be implemented in the next 12 months.

While environmental matters capture most of the attention when considering sustainability efforts in Australian grapegrowing and winemaking, the social and financial elements cannot be forgotten. Indeed, the 'social licence' of alcohol, including wine, is under international scrutiny, with associated impacts on regulatory and taxation policies.

New viticultural services and expertise

In January the AWRI assumed responsibility for the virus testing and elimination services previously provided by the University of Adelaide. This is an area of increasing importance to our industry and complements the wide range of services provided by the AWRI to both grapegrowers and winemakers.

New viticultural positions were created during the year to ensure that the viticultural component of the AWRI's projects receives sufficient attention, reflecting the importance of working seamlessly from grape to wine to achieve and extend the most useful and relevant research outcomes.

To meet the demands of industry the AWRI has also gained access to new expertise in entomology. This has been achieved via an agreement with Sugar Research Australia that allows phylloxera expert Dr Kevin Powell to provide support to the AWRI and the wine industry in areas relating to insect pests. It also assures that expertise will be available in the event of a biosecurity emergency.

Commercial Services

AWRI Commercial Services had another record-breaking year in terms of services provided, with the laboratories processing more than 25,000 samples for the first time, an increase of more than 6% from the previous year. This increase was delivered in a year which also saw the launch of a range of new services, including grapevine virus testing and analysis of beer and spirits, which involves microbiological tests, basic beer compositional analysis, water testing and hops analysis. This diversification

Dan Johnson

reflects the involvement of many winemaking regions and wine producers in new areas such as craft brewing and production of spirits.

Involvement in Wine Australia's in-market events

During the year, AWRI staff were involved with Wine Australia events held in Australia, South Korea, Japan, Hong Kong, UK, USA, Germany and Austria. Contributions included presentations, masterclasses and interactive sensory experiences. A major highlight of the year was the development of the 'Aroma wall' in partnership with renowned glass artist Nick Mount, which was launched at Vinexpo in Hong Kong. Nick produced an interactive display of hand-blown glass vessels, each of which was filled with wine spiked with an aroma with links to research at the AWRI and Australian wine. The concept was very popular with attendees and was seen as an innovative and creative way of introducing a new audience to Australian wine. It is expected that the 'Aroma wall' will feature at other Wine Australia events in the coming year.

Further innovation in sensory assessment was demonstrated at Wine Australia-hosted events in New York and Hong Kong. AWRI scientists and collaborators showcased a new sensory method, known as Pivot© Profile, with an audience of wine trade participants, and gained important data on the sensory differences among Australian Shiraz wines, benchmarked against international styles. The data from these tastings will be related to data provided by a group of international sommeliers and Australian winemakers obtained earlier in the project. Results will be used to gain insights into how Shiraz sensory profiles relate to regions and sites, and ultimately the site-specific influences on these characteristics.

Technical trends

As with previous years, the nature of the industry's technical support needs over the past 12 months was reflected in the volume, timing and topics of the enquiries answered by the AWRI helpdesk team, and the associated extension activities of the AWRI as a whole. The enquiries received were strongly influenced by climatic conditions during the growing season and over vintage.

The 2017/2018 vintage was generally trouble-free in the vineyard; however, some localised challenges resulted in queries to the AWRI helpdesk. The first was a major frost which affected the south-east of South Australia and the west of Victoria in late spring. The timing of the frost was particularly damaging because it occurred when the shoots on the vines were long and inflorescences well developed. A frost at this phenological stage can cause major yield reductions, with no opportunity for secondary buds to burst and replace the lost fruit. Affected growers needed to manage a variable canopy throughout the season, and even if some of the crop survived the frost there was a risk it could be contaminated with unripe secondary bunches. In addition, hail affected some vineyards around Canberra in January 2018. Advice was provided on how to assess the hail damage, so that decisions could be made on managing the fruit through to harvest.

While the conditions in most regions were not favourable to disease, parts of the Yarra Valley experienced very high downy mildew pressure through to December. Persistent rainfall made it difficult to apply sprays and for the sprays to stay on the vines long enough to be effective. Disease symptoms were found on leaves in these areas and yields were affected where inflorescences were infected at a few sites. Fortunately, dryer conditions in January and February meant that fruit ripened well in most places without further issues.

A dry and hot summer in some regions saw fire ban seasons extended and risks of bushfires (and therefore smoke events) increase. Fires were experienced in parts of NSW, Victoria, Tasmania and WA. A bushfire on the edge of one NSW wine region occurred just a few weeks before harvest, when grapes are at high risk of becoming affected by smoke. Another region in NSW experienced smoke drift from a distant fire during the same period. Rapid technical support was provided in the form of face-to-face Q&A sessions in the affected regions. Smoke events affect major wine-producing countries across the world, and the AWRI's expertise is often sought by those who encounter challenges with smoke-affected fruit and wine.

A number of queries were received about pH and acid additions, with some winemakers reporting that the pH of their wines did not shift to the degree they expected (or even in the direction they expected) post-fermentation. Investigations into these ferments found that potassium levels were high, and in some cases almost double the 'typical' level. In areas where dry conditions were combined with low fruit crops and high vigour, it appears that potassium uptake from the soil led to higher than usual concentrations of potassium in the fruit, which the affected the pH/acidity balance of wines. Winemakers were advised to add acid at the juice stage to reduce pH as soon as possible and to monitor pH and titratable acidity during fermentation, as a pH/acid imbalance after fermentation can be very difficult to rectify.

A large proportion of this year's viticulture queries related to sustainability and environmental management. Of the remaining queries, agrochemicals continued to be a priority topic for growers. Questions about the use of iprodione were relatively common as growers and wineries sought clarification on regulatory changes occurring in the EU. The AWRI issued an agrochemical update about iprodione, no longer recommending it for use on fruit destined for export wine to the EU and referring growers to consult the 'Dog book' for alternative control options. The helpdesk also received a higher than average number of calls about leaf damage from suspected herbicide drift. This prompted an *eBulletin* about reporting spray drift, with growers and winemakers encouraged to contact the helpdesk for advice about residue testing.

Of the pest and disease issues reported to the helpdesk, fungal diseases dominated, but it was the detection of Queensland fruit fly in Tasmania that was one of the more unusual issues encountered. To assist growers and winemakers, helpdesk staff liaised with biosecurity stakeholders to work through the transport and processing issues required to deal with this pest, which had not previously been detected in Tasmania.

Regulatory-related queries received by the helpdesk covered the broad areas of allergens, general food safety/toxicology, heavy metal content of grapes and wine, and legality of compounds, practices and processes.

Looking forward (and back!)

As we look forward into 2018/2019, the focus will be on continuing to deliver the targets in the AWRI's RDE plan, while commencing the new business and operational initiatives in *AWRI Directions*. Other likely developments on the horizon include:

- Publication of the AWRI's research on the Chardonnay genome – a major achievement in the field of grapevine genomics, with practical impacts for industry in terms of understanding Chardonnay clones
- New projects on the links between business resilience and sustainability (funded through the Food Agility CRC), indole in sparkling wines and wine packaged in cans
- A new National Sustainability Program, to be managed by the AWRI on behalf of the major industry bodies
- New Australian Government funding to support analytical infrastructure at the AWRI, through Metabolomics Australia.

In November 2018, the AWRI will mark 10 years in its 'new' building and the 10-year anniversary of the establishment of the Wine Innovation Cluster – a key vehicle for collaboration in grape and wine research on the Waite campus. We acknowledge the vision and hard work of those involved in the development of both WIC and the Wine Innovation Central building – big ideas from which we are still seeing the benefits. Another milestone to be marked in May 2019 will be 20 years since the bottling of the AWRI's landmark closure trial – a trial that is still cited and discussed today.

The AWRI Board is warmly thanked for its commitment and contributions during the year, with particular thanks to three concluding Directors, Dr Stuart McNab, Kim Horton and Ben Bryant, all of whom made valuable contributions during their time on the Board. The Board welcomed new Directors Wendy Cameron and Iain Jones from 1 January 2018 and we appreciate their commitment to the AWRI since their commencement.

As always, the AWRI management team and staff are gratefully acknowledged for their continuing hard work, enthusiasm, dedication and service to our industry.

Louisa Rose

Dr Dan Johnson

Board notes

Chair
Ms L.E. Rose

Audit committee
Mr M.R. Watson (Chair)
Mr T. J. Bekkers
Dr J.S. Harvey

Personnel committee
Ms L.E. Rose (Chair)
Mr B. Bryant
Prof. K.D. Kirk

Meetings

Ordinary General Meeting
The 63rd Ordinary (Annual) General Meeting was held on 28 November 2017.

Extraordinary General Meeting
There were no Extraordinary General Meetings held.

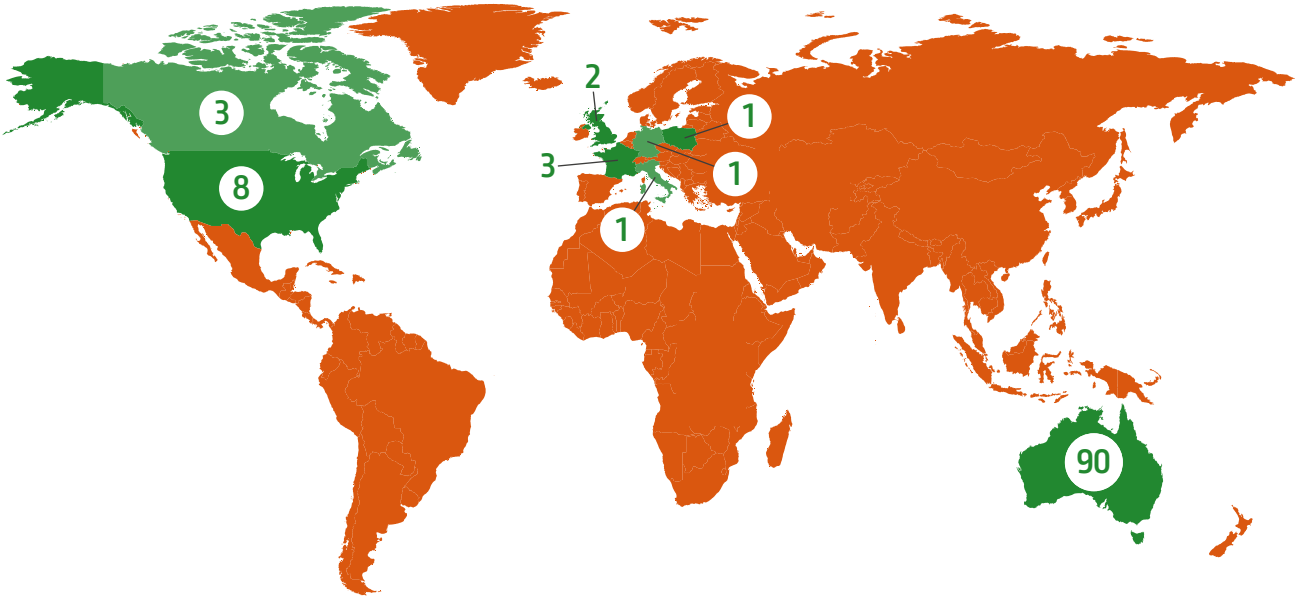
Board
The Board of the AWRI met on the following dates: 19 September 2017, 28 November 2017, 27 February 2018 and 29 May 2018.

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 and Bioplatforms Australia, along with a large number of confidential commercial clients.

Appreciation

The activities at the AWRI benefit from collaborations with individuals and organisations from the following countries: Australia, Canada, France, Germany, Italy, Poland, UK and USA. The assistance and cooperation from partners across the globe are gratefully acknowledged.



L to R: Iain Jones, Dan Johnson, Wendy Cameron, Kiaran Kirk, Louisa Rose, Ben Bryant, Liz Riley, John Harvey, Mark Watson, Toby Bekkers

Highlights of the year

General

Implementation of new investment agreement

The AWRI and Wine Australia signed a new agreement covering research, development and extension activities at the AWRI from 2017 to 2025. This long-term partnership reflects a high level of strategic alignment between the two organisations. During the first year of the agreement's operation, governance arrangements were updated including a new Management Committee, intellectual property register and reporting mechanisms.

Approved Research Institute status

An application was made to the Australian Tax Office (ATO) for the AWRI to be recognised as an Approved Research Institute (ARI) and receive Deductible Gift Recipient status. Central to this application were amendments to the AWRI's constitution to include, among other aspects, the establishment and operation of a Research Fund and a Research Committee, as required of ARIs. The ATO recently approved this application, backdating the ARI status to July 2000.

Renewed employment agreement

The AWRI's internal Employment Agreement, which covers all AWRI staff, was renewed during the year. A total of 91% of staff participated in the voting process, of whom 98% approved the agreement, which came into effect in June 2018.

Release of beer made with 'shipwreck yeast'

A beer was produced using the yeast isolated from beer bottles salvaged from the wreck of the *Sydney Cove,* under a partnership between the AWRI, Queen Victoria Museum and Art Gallery (QVMAG), Launceston and Lion Nathan. The beer, known as 'The Wreck – Preservation Ale', was released to the public at several events in May 2018 and attracted worldwide media interest, with a global reach estimated at more than 220 million.

Customers, consumers and markets

International ring test program

The APEC Wine Regulatory Forum ring test program, managed by the AWRI, involves 18 accredited laboratories from across the Asia-Pacific Economic community that conduct wine regulatory analysis. The program provides an opportunity for participants to compare results on a regular basis, with the aim of improving agreement among the laboratories. Since 2015 there has been a significant improvement in the alignment among participating laboratories for analytes such as total sulfur dioxide, sugars and alcohol. Since Australian wines are often subjected to in-market analysis, this improvement increases the confidence of Australian companies exporting wines to those countries. The program has been such a success that there has been overwhelming support for its continuation past the end of the funding window for the APEC Wine Regulatory Forum.

Aroma wall

An interactive display of hand-blown glass vessels, known as the 'Aroma wall', was presented as part of Wine Australia's presence at Vinexpo in Hong Kong. Each vessel contained wine spiked with an aroma linked to research at the AWRI and Australian wine. The concept was very popular and was seen as an innovative and creative way of introducing a new audience to Australian wine.

'Dog book' improvements

Significant changes were made to the agrochemicals 'Dog book' to improve navigation, reduce the risk of growers using products that are not approved by wineries and minimise the use of herbicides in the 30 days before harvest. Project staff reviewed data for the registration of three new active constituents to assess their suitability for use in wine production and establish appropriate withholding periods for export wine. New information was also assessed to determine appropriate withholding periods for two established active constituents when they are used only once per season.

Regulatory updates

The AWRI's databases *Analytical requirements for the export of Australian wines* and *Permitted additives and processing aids for winemaking and wine importing countries* were updated to include analytical requirements for 45 countries and information on permitted additives and processing aids in 29 countries.

Extension, adoption and education

Helpdesk support

The AWRI helpdesk responded to 1,751 enquiries, conducted 213 winemaking investigations and analysed more than 950 samples. Key areas where queries were received included smoke taint, pH/acid balance, frost and hail damage, downy mildew, agrochemicals, sustainability and environmental management.

Winemaking treatment workshops

Twenty-one Shiraz or Pinot Noir winemaking treatment workshops were staged during the year. The concept of custom-producing a series of wines that reflects Australian winemaking practices has attracted considerable industry interest. This format provides an opportunity to illustrate different treatments made to a single batch of grapes from a single vineyard and what happens to a wine stylistically when you change one variable at a time.

Wine Australia Regional Program

The AWRI assisted in coordinating the design and delivery of extension and adoption activities within the program's 11 regions. The annual regional partners meeting was held in the Yarra Valley in July 2017, with updates from the regional partners and discussions on biosecurity and social science research on extension.

ShowRunner

The AWRI's wine show management system, ShowRunner, was used by 22 shows in 2017/2018. The National Wine Show of Australia has committed to use ShowRunner in November 2018 – the first capital city wine show to adopt the system.

Communications review

A review of the AWRI's communications was conducted, with assistance from an external communications consultant. Almost 400 stakeholders responded to a survey about the AWRI's communications, with overall feedback being very positive. Electronic communications (including *eNews*, *eBulletins* and the AWRI website) and *AWRI Technical Review* were among the most popular of the AWRI's communication platforms.

Library services

The John Fornachon Memorial Library's collection grew by more than 10% during the year and now includes almost 100,000 items.
In 2017/2018 the library responded to 1,100 reference enquiries; delivered 2,213 journal articles; conducted 64 specialist literature searches; and expanded its eBook collection to 143 titles. Migration of the current library management system to a new platform is nearing completion.

Webinars

Sixteen webinars were presented to a total of 626 attendees – almost double the previous year's number of attendees. In addition, webinar recordings were viewed more than 3,500 times on the AWRI's YouTube channel. Webinars covered a wide spectrum of topics including heat stability, spray application, frost management and remediation of volatile sulfur compounds.

In-person interactions

During the year AWRI staff gave 260 external presentations, coordinated 75 events, authored 4 posters, conducted 39 media interviews, presented 21 lectures to university students and supervised or co-supervised 24 students.

Publications

In 2017/2018 AWRI staff authored 86 peer-reviewed and non-peer-reviewed papers for scientific journals and industry publications.

Stakeholder communications

Six AWRI reports and six columns on alternative varieties were published in the *Wine and Viticulture Journal*. Eleven '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 21 *eBulletins* issued through the year. Updates of AWRI activities were provided in six issues of *eNews*, emailed directly to producers.

Social media engagement

The AWRI's Twitter following grew by 200 during 2017/2018 to 3,515. The AWRI's Facebook presence also grew by more than 250 likes to reach 1,006. The AWRI's YouTube channel includes webinar recordings and other AWRI video content. Since its launch, the channel has attracted more than 20,000 views and 347 subscribers.

Performance, products and processes

'Green' flavours in Shiraz wine

Earlier studies showed that inclusion of stalks in a Shiraz fermentation can result in elevated concentration of methoxypyrazines – compounds that give a 'green' herbaceous character to wine. Following this work, isobutylmethoxypyrazine was found at elevated concentration in the rachis (stalk) of Shiraz bunches from vines that had previously been shown to produce 'green' wines. Grape berries were found to contain negligible levels of pyrazines.

Varietal thiols in red wines

A surprisingly high concentration of the 'grapefruit'/'tropical fruit' thiol 3-mercaptohexanol was found in commercially available red wines, above the reported sensory threshold for all wines, with a particularly high level observed in Pinot Noir wines. This compound is known to be important to the flavour of Sauvignon Blanc and other white varieties; however, much less is known about its role in red wines.

Clonal differences in Viognier flavour

Large differences among Viognier clones were found in the juice concentration of monoterpenes involved in 'apricot' flavour. Two clones showed similar monoterpene concentration profiles throughout ripening but both of the other clones were substantially lower in monoterpene concentration. Winemaking studies will be undertaken to investigate how these berry compositional differences relate to wine composition and sensory properties.

New sensory method

The rapid method called Pivot© Profile has been found to be a robust, reliable and valid means of characterising the sensory properties of a set of wines. The method has been successfully applied in a study of Shiraz regional characteristics, with panels including international sommeliers, Australian winemakers and the AWRI's trained descriptive analysis panel.

Flavour from grape marc

Phenol-free glycosides isolated from white grape marc, a waste product in the winemaking process, had a major effect on 'fruity' flavour of white wines while not adding any bitterness. This result points to the potential of phenol-free glycosides to enhance flavour. Levels of terpene glycosides, free terpenes and the potent compound β-damascenone were all boosted in the wines.

Effect of CO_2 in still wines

The effects of CO_2 levels on mouth-feel in table wines were quantified. Sub-spritz concentrations were found to have a significant impact on the taste and mouth-feel of both red and white wines.

Publication of new heat test

A highlight of the previous annual report was the development of an updated heat test for protein stability which could consistently and reliably be completed within a five-hour turnaround time (two hours' heating at 80°C and three hours' cooling at 20°C). This year, guidelines for the new heat test were publicised via a peer-reviewed publication, an article in *AWRI Technical Review* and an AWRI webinar. The updated heat test will be included in the next edition of *Chemical Analysis of Grapes and Wine: Techniques and Concepts,* the Australian wine industry's key reference book for wine laboratory methods.

Juice pasteurisation to remove protein

Pasteurisation of grape juice for one minute at 75°C has been previously shown to reduce the concentration of haze-forming proteins in white wines without adverse effects on sensory profiles. The effects of longer juice heating times on protein concentrations, heat stability and sensory profiles of wines have now been assessed. Laboratory-scale trials demonstrated that juice pasteurisation for up to two minutes effectively heat stabilised wines containing high concentrations of proteins. These trials were followed with industry-scale trials using a prototype pasteurisation unit. Semillon and Sauvignon Blanc juices were heated at 75°C for one or two minutes before fermentation. The two-minute pasteurisation removed most of the protein in juice. These results demonstrate that pasteurisation may be a viable alternative to bentonite for protein stabilisation of wines.

Regeneration of magnetic nanoparticles

Previous work showed that magnetic nanoparticles with coatings designed to bind specifically with heat-unstable wine proteins were effective in removing protein from wine. This year, it was demonstrated that such particles could be regenerated after adsorption of wine protein, with the particles exhibiting high stability and good reusability within six successive adsorption–desorption processes. The results suggest potential for the application and reuse of magnetic nanoparticles as an alternative to bentonite for protein removal from wines, reducing waste and potentially enabling recovery of useful materials.

Colour stability in red wines

Experiments were conducted to explore the role of tannin composition and size on the formation and stability of polymeric pigments. Losses of wine colour through precipitation of large pigmented tannins mediated by acetaldehyde were observed, suggesting that the management of both tannin size and acetaldehyde concentration is needed for colour stability. Acetaldehyde is generally considered to be beneficial to wine colour due to its enhancement of tannin-anthocyanin linkages; however, this study has shown that under certain circumstances it may lead to colour loss.

Diversity of commercial wine additives

A survey of commercial oenotannin and mannoprotein products showed a marked diversity of composition, as well as potential deviation from the advertised impact in wine. Bench trials with different products are recommended for winemakers to be able to make informed decisions about the fitness for purpose of commercial supplements.

Effects of aeration during fermentation

Malolactic fermentation conducted simultaneously with alcoholic fermentation was not affected by aeration of ferments during standard red winemaking, providing confidence for winemakers to use these techniques together. In additional experiments, aeration during fermentation was found to induce structural changes in tannin that influence its interactions with other molecules, showing potential for an impact on astringency.

Aeration of non-*Saccharomyces* ferments to reduce alcohol

When ferments conducted by some non-*Saccharomyces* yeast species are exposed to oxygen, the yeast's metabolism of sugar can be directed toward endpoints other than ethanol, something that does not happen with *Saccharomyces cerevisiae*. In a collaboration with Università Politecnica delle Marche, Italy, several non-*Saccharomyces* strains were evaluated under a range of aeration conditions. Ethanol reductions of between 0.8% and 1.8% v/v (depending on the degree of aeration) were observed without significant production of acetic acid. This is one example of how altered production practices may be used to lower alcohol concentration in wine.

Sensory effects of glutathione

Glutathione is a naturally occurring antioxidant present in grapes that plays an important role during winemaking. Additions of glutathione were made to Chardonnay and Riesling juices and wines to assess its sensory effects. Overall, glutathione additions to both Riesling and Chardonnay had a detrimental effect on wine style, with control wines rated higher in fruit-related attributes and glutathione-treated wines rated higher in 'dank'/'drain' and 'capsicum' attributes.

Winemaking trials of 'floral' yeasts

New variants of wine yeasts that enhance 'floral' characters in wine have undergone pilot-scale winemaking trials. It is hoped that they will expand the range of wines suitable for application of 'floral' character-enhancing yeasts.

Improved stability for wine yeast hybrids

Methods to facilitate the genomic stability of wine yeast hybrids have been developed that will expedite the path to market for newly developed interspecific hybrids.

Overcoming MLF sensitivity to SO_2

Investigations of the malolactic fermentation (MLF) performance of *Oenococcus oeni* strains in model wines and white wines with limiting conditions confirmed the intrinsic sensitivity of *O. oeni* to SO_2. This characteristic can restrict its ability to conduct MLF in wines with moderate to high SO_2 content. Further, investigation of the MLF performance of two commercial malolactic starter cultures highlighted the critical importance of starter culture acclimatisation on the success or failure of MLF induction in difficult wine conditions.

Production of SO_2 by wine yeasts

The ability of 96 different *S. cerevisiae* wine yeasts to produce SO_2 was evaluated in fermentations of Chardonnay juice containing 40 mg/L total SO_2. The yeasts' capacity to produce SO_2 varied dramatically, with most strains contributing only incremental amounts to the total SO_2. However, four strains were found to double the initial SO_2 concentration of the Chardonnay must. In the most extreme case, yeast-derived SO_2 contributed an additional 150 mg/L above initial must concentrations. The use of such yeasts would preclude MLF as a possibility for the wines produced using them.

Insights from grape objective measures

Grape objective measures were identified that were capable of predicting Shiraz fruit parcels which would fail to produce wines in premium quality categories. Grape nitrogen was key to defining both wine quality grade and wine sensory properties, and this points to nitrogen management in the vineyard as critical in maintaining quality in premium Shiraz.

Hyperspectral imaging to detect *Botrytis* in grape berries

Hyperspectral imaging was successfully used to distinguish between *Botrytis*-infected and clean grapes. Analysis of the hyperspectral images of individual berries was also able to discriminate damaged *Botrytis*-infected berries from healthy damaged berries, shrivelled berries from sound berries and berries infected with sour rot from berries infected with *Botrytis*. The hyperspectral imaging could also easily identify matter other than grapes. This result will be applied in experiments at the weighbridge next vintage.

New gene transformation protocol for *Brettanomyces bruxellensis*

A new gene transformation protocol was developed for *Brettanomyces bruxellensis*. Genetic transformation is a foundational technology that enables the comprehensive study of a species and opens up a multitude of molecular biology tools. As part of this development, constructs have been created which enable *Brettanomyces* cells to be labelled with either green- or blue-fluorescent proteins. Cells that express these proteins glow when exposed to certain wavelengths of light and this enables the rapid identification and counting of these cells during fermentation.

SO_2 resistance of industry isolates of *Brettanomyces*

Historical and new industry isolates of *Brettanomyces* yeast were tested to determine if average levels of SO_2 resistance had changed over time. Strains isolated from 2000 to 2004 displayed levels of SO_2 resistance that broadly represented the range of tolerances observed in an earlier study. Strains isolated from 2010 to 2014 did not show a significant difference in their median SO_2 resistance, although there were a small number that displayed higher levels of SO_2 resistance than were seen in the 2000-2004 cohort. Interestingly, the 2016-2017 isolates, sourced from 16 different tank/barrel samples, displayed greater tolerance to SO_2, growing at concentrations significantly higher than those observed from the two previous cohorts. While sample numbers of later isolates are relatively low (and sourced from only two companies) these preliminary data suggest that strains with significantly higher levels of SO_2 resistance are present in the field. While this result will need further investigation through acquisition of additional samples, results from a recent AWRI survey of Australian bottled wine (see highlight overleaf) suggest that the existence of these SO_2-tolerant strains is not yet being reflected in 4-ethylphenol levels in packaged wines. This may mean that the tolerant strains are not widespread, or that *Brettanomyces* issues in wineries are being identified and dealt with effectively to ensure affected wine is not entering the marketplace.

Brigitte Lynch, Jillian Lee, Robyn Gleeson

Updated *Brettanomyces* survey

In the 2000s the AWRI carried out a multi-year survey of *Brettanomyces* in Cabernet Sauvignon wines. The original survey included commercially available Cabernet Sauvignon wines from five regions across Australia, over seven vintages, finishing with the 2005 vintage. The survey isolated and characterised any *Brettanomyces* yeast present in the bottled wine and measured marker compounds including 4-ethylphenol (4EP). This year an update to the survey was conducted, examining 91 wines from the 2015 vintage from the same regions, providing a snapshot of the situation ten years later. The mean concentration of 4EP in the 2015 wines was just 29 µg/L, even lower than levels reported in 2005. The highest 4EP observed was 327 µg/L, which is below the sensory aroma threshold. Approximately 60% of the Australian wines tested contained 'not detectable' levels of 4EP. No viable *Brettanomyces* yeasts were isolated from any of the bottled wines. Results from this survey suggest that the observation of increased SO_2 tolerance of some *Brettanomyces* strains isolated in wineries (discussed in the previous highlight) is not currently translating to elevated 4EP in wines in the marketplace.

Volatile sulfur compound precursors

The liberation of H_2S from dicysteinyl polysulfanes was demonstrated in model wine. Sulfur dioxide rapidly reduced the polysulfanes to liberate H_2S. This sheds further light on a potential source of H_2S formation in wine post-bottling.

Microbiological factors in volatile sulfur compound (VSC) formation

The sulfur-containing amino acid methionine has been identified as a possible precursor for the undesirable VSCs methanethiol (MeSH) and methylthioacetate (MeSAc). High concentrations of methionine in a synthetic grape juice resulted in an increased formation of both MeSH and MeSAc at the end of fermentation. In addition, the formation of these undesirable sulfur compounds depended on the genetic make-up of the yeast used.

Treating smoke-affected wines and juices

A range of activated carbon products were evaluated for their effectiveness in fining smoke-affected red grape juice and red wine. Some were better at removing smoke glycosides than free smoke volatiles; others were more effective in juice than wine. Sensory dilution studies were conducted in Pinot Noir, looking at different dilution rates of a smoke-affected wine with an unaffected wine. For the wine studied, diluting the smoke-affected wine by a factor of four or more reduced the concentrations of smoke glycosides to typical baseline levels. This study highlighted that dilution of smoke-affected wine by an unaffected wine is a feasible option to diminish the sensory impact of smoke taint. However, more work is needed to see if this result is more broadly applicable to different wines with varying levels of smoke taint.

Environment, sustainability and natural capital

Independent global review of sustainability programs

An independent review of Australian wine's place in the global sustainability landscape was commissioned. A key recommendation from the review was that the Australian wine sector should proceed with implementation of a single national sustainability program (NSP) under formal joint ownership of all the national industry bodies. Following the review, a business plan for the proposed NSP was developed and approved by Australian Vignerons and the Winemakers' Federation of Australia. An implementation plan is being produced to take effect in 2018/2019.

Links between environmental performance and business resilience

A pilot study was completed with Entwine members to quantify the links between environmental performance and business resilience. Results suggest that vineyard energy use may be a useful quantitative indicator of overall sustainability, with low energy users more likely to be more sustainable than high energy users. This relationship will be investigated in a project commencing next year which will aim to identify appropriate financial metrics of sustainability.

Good outcomes from must dilution

A winemaking trial compared dilution of high sugar must and early harvest of grapes, as options to reduce final wine alcohol concentration. The results showed that lowering 15.5°Baume must to 13.5°Baume using dilution was more beneficial for both colour and sensory outcomes than earlier harvest, and the mode of dilution used had little impact.

Genomic differences among Chardonnay clones

Genomic evaluation of Chardonnay clones revealed substantial genetic variation among clones. It was possible to detect instances of differential inheritance from the Pinot Noir and Gouais Blanc parents of Chardonnay. Expanded gene families involved in wax biosynthesis were identified, showing how gene expansion has enriched the Chardonnay genome for both redundancy and functionality. Mapping of clonal genetic variation revealed the breadth of variation that has accumulated during the long-term asexual propagation of this woody plant species. The markers identified in this work form a solid framework for the future identification of unknown vegetatively propagated plant clones.

Differences between Australian and European Shiraz clones

As part of a collaboration with SARDI, seven Australian-selected clones of Shiraz and three imported European clones were compared using a whole genome sequencing approach. In the absence of a pre-existing reference genome for Shiraz, one was created, and inter-clonal genetic variation was determined through comparison to this reference. Results showed that the Australian-selected clonal material was genetically distinct from more recently imported Shiraz clones, forming a distinct group, but that genetic diversity within the group of Australian-isolated Shiraz was low.

Defining regional characters of Shiraz

A comprehensive series of sensory studies was completed involving Shiraz wines from six Australian regions. This is arguably the most systematic examination of regional differences yet undertaken, and will provide insight into chemical compositional drivers of the sensory attributes unique to specific regions.

Isotope ratios to distinguish Australian wines

Building on previous work using strontium isotope ratios as markers for wines' place of origin, the combination of isotope ratios of boron, lead, oxygen and strontium was successful in distinguishing Australian wines from non-Australian wines. The discriminating power of these isotope ratios was found to be much greater than that of trace metal composition.

Diversity in wild ferments

Analysis of samples from uninoculated ferments collected across Australia in the 2016 and 2017 vintages showed significant diversity in the species of fungi and yeast present. Whole genome sequencing indicated that uninoculated ferments also harbour significant diversity of *Saccharomyces cerevisiae* yeast strains. Interestingly, it appears that commercial strains do not generally dominate these wild fermentations, even when wineries are performing conventional ferments at the same location.

Factors influencing rotundone formation

In continuing efforts to understand factors influencing the formation of the 'black pepper' compound rotundone in grapes, biosynthesis of the precursor α-guaiene has been identified as a key driver of elevated concentrations of rotundone. Site characteristics appear to be more important than regional or genetic determinants, as similar effects were observed in Shiraz vineyards planted with clonal selections or mass-selected vines.

Biosecurity support

Information and advice were provided to industry regarding two biosecurity issues: Grapevine Pinot Gris virus and brown marmorated stink bug. Contributions were also made to a desktop study on managing phylloxera.

Foundational data and support services

Another analysis record for AWRI Commercial Services

In 2017/2018, the Commercial Services laboratories processed more than 25,000 samples, an increase of more than 6% compared to the previous record year. A total of 172 new customers were added, compared to 148 in the previous year.

Virus testing services

The AWRI now provides grapevine virus testing and elimination services for industry. This is an area of increasing importance, as new viruses are detected and their implications more clearly understood.

Identification, storage and distribution of microbial strains

A total of 489 yeast and bacterial strains were submitted to the AWRI Wine Microorganism Culture Collection (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. The AWMCC additionally holds 7,200 yeasts isolated from Australian ferments as part of the bioprospecting project. During the year, the AWMCC distributed 377 microbial samples from cryogenic stocks.

Smoke taint background database

The AWRI's survey of background levels of smoke taint compounds was finalised and now includes data for 12 varieties obtained from more than 500 grape samples across 23 regions in Australia. The background database is used by the AWRI helpdesk when interpreting smoke taint analysis results.

WIC Winemaking Services

WIC Winemaking Services processed 392 (6-150 kg) ferments during the 2018 vintage, with a further 72 ferments to be conducted outside the vintage period from fruit or juice that was frozen during vintage. Further investments in new stainless steel storage vessels have increased flexibility of the services offered and an upgraded screw capper has improved the consistency of closure application during bottling.

Improved sensory analysis capacity

The addition of a new group of trained sensory panellists and adoption of rapid sensory techniques and innovative data acquisition and analysis methods have increased the efficiency of the AWRI's sensory analysis, allowing greatly increased throughput of projects.

Metabolomics SA

Metabolomics SA successfully completed 91 jobs, with a total of 2,421 samples analysed. The number of analysed samples increased by 30% compared to the previous financial year. Specifically, the number of samples analysed for external clients increased by 41%, which was reflected in a 46% increase in revenue.

Bioinformatics enhancements

New scripts and tools were developed to improve data processing and compound identification. R-based scripts were developed to extract LC-MS and LC-MS/MS spectra of standard compounds analysed.

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Staff

The number of AWRI staff employed in a full-time, part-time and casual capacity as at 30 June 2018 was 127 (96.9 full-time equivalents). When the number of AWRI-based students (both from Australia and overseas) and visiting researchers is added, the total increases to 141. Of these, approximately 61% were funded by Wine Australia in 2017/2018.

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Melanie Brandt, *Hochschule Geisenheim University, Germany*, visiting student (5/2/18-3/4/18)

Laura Canonico, *Università Politecnica delle Marche, Italy*, visiting student (24/10/17-23/12/17)

Anaïs Faucon, *Montpellier SupAgro, France*, visiting student (3/4/17-8/9/17)

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Jessica Lleixa Daga, *Universitat Rovira i Virgili, Spain*, visiting student (6/3/17-28/7/17)

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Bo Teng, *Sichuan University, China* (27/9/16-30/4/18)

Aude Watrelot, *University of California, Davis, USA* (6/3/18-3/5/18)

Staff activities 2017-18

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

Kate Beames is a member of the Australian Wine Industry Technical Conference Planning Committee.

Anthony Borneman is an Affiliate Lecturer at the University of Adelaide.

Bob Dambergs is an Honorary Associate of the University of Tasmania at the Tasmanian Institute of Agriculture, a committee member of the Riverland Wine Industry Development Council, a committee member of the Riverland Winegrape Growers Association and a member of the Riverland Wine Technology Delivery Group.

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 & 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 and Wine Research*; a member of the Editorial Board of the *Journal of the Science of Food and Agriculture*; an Affiliate Associate Professor at the University of Adelaide; and an Adjunct Associate Professor at the University of South Australia.

Peter Godden is an Ex-Officio Councillor of the Royal Agricultural and Horticultural Society of South Australia, and was a Panel Chair at the 2017 Barossa Wine Show.

Paul Henschke is an Associate Editor of the *Australian Journal of Grape and Wine Research*; an Affiliate Professor of the University of Adelaide; and Fellow of the Australian Society for Viticulture and Oenology.

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 Professor, University of Adelaide; a member of the Advisory Board of the *Journal of Agricultural and Food Chemistry* and Journal Advisory Committee of the *Australian Journal of Grape and Wine Research;* a member of the Winemakers' Federation of Australia Wine Industry Technical Advisory Committee; and a delegate and expert for the Organisation Internationale de la Vigne et du Vin.

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

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 Graduate School of Management; and a Director of the National Wine Foundation. He is a member of the International Scientific Board of L'Institut des Sciences de la Vigne et du Vin, Bordeaux, France; the *World of Fine Wine* Editorial Board; the Wine Innovation Cluster Leadership Group; the Waite Strategic Leadership Group; the South Australian Food Innovation Centre partners group; 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 Australian Wine Industry Future Leaders Program; the INSEAD Blue Ocean Strategy program; the IESE Creative Negotiation program; and the Oxford Advanced Management and Leadership Program.

Mark Krstic is a member of the Victorian Government's Wine Ministerial Advisory Committee; member of Hort Innovation's Table Grape Strategic Investment Advisory Panel; member of the National Wine Research and Extension Network; member of the National Viticulture Biosecurity Committee; Associate Editor of *Wine & Viticulture Journal*; Honorary Senior Fellow at the University of Melbourne; member of the Yarra Valley Technical Subcommittee; member of the Mornington Peninsula Vignerons Association Technical Subcommittee; member of the Australian Wine Industry Technical Conference Planning Committee; and a graduate of the Australian Wine Industry Future Leaders Program.

Natoiya Lloyd is a committee member of the SA branch of the Royal Australian Chemical Institute.

Mardi Longbottom is Vice President of the Australian Society of Viticulture and Oenology; member of the Executive Committee of Australian Vignerons; member of the Limestone Coast Grape and Wine Council Technical Subcommittee; 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.

Brigitte Lynch is Secretariat for the Interwinery Analysis Group committee.

Jacqui McRae is a committee member for the SA Chapter of Wine Communicators of Australia; a member of the planning committee for Crush – the grape and wine symposium; a member of the Pint of Science SA 2018 organising committee; and a registered project manager with the Australian Institute for Project Management.

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.

Bryan Newell is a member of the Interwinery Analysis Group committee.

Simon Nordestgaard is Vice President of the Winery Engineering Association.

Wes Pearson is a committee member of the McLaren Vale Districts Group and a graduate of the Australian Wine Industry Future Leaders Program and the Len Evans Tutorial.

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.

Michael Roach is a committee member and webmaster of the Adelaide Protein Group – a special interest group of the Australian Society for Biochemistry and Molecular Biology.

Ella Robinson is a member of the Australian Wine Industry Technical Conference Planning Committee and a committee member for the SA Chapter of Wine Communicators of Australia.

Neil Scrimgeour is the chair of the planning committee for Crush – the grape and wine science symposium.

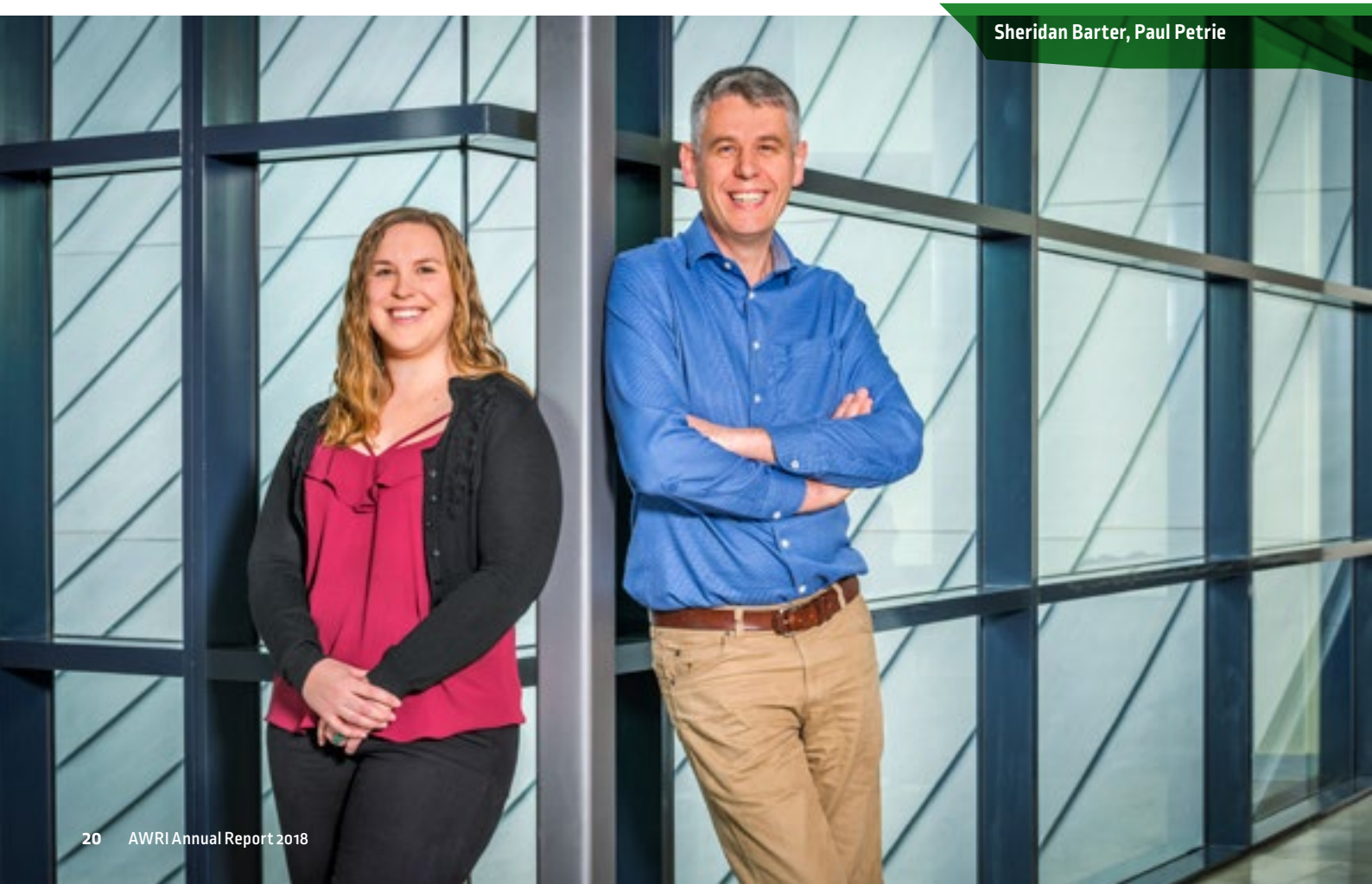
Con Simos is Chair of the National Wine Research and Extension Network; board member of Wine Communicators of Australia; member of the Australian Wine Industry Technical Conference Planning Committee; member of the Wine Strategy Implementation Committee; member of the WA Wine Industry Association R&D 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. She is a delegate and expert for the Organisation Internationale 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,* the *Austin Journal of Cardiovascular Disease and Atherosclerosis,* the *Journal of Nutritional Therapeutics* and the *Journal of Wine Research*, as well as a charter member of the International Scientific Forum on Alcohol Research, a member of the Advisory Board of the Paralelo 40 International Surveillance System on Mediterranean Diet (Spain), a member of the Scientific Board and Scientific Council of Experts of the (European) Wine Information Council, and a member of the European Food Safety Authority Expert Database. Creina is also a member of the Scientific Committee for the WineHealth 2019 International Wine and Health Conference.

Cristian Varela is a member of the Editorial Board of the journals *Applied and Environmental Microbiology, International Journal of Food Microbiology* and *Food Microbiology.*

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

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



Sheridan Barter, Paul Petrie

Progress reports

Customers, consumers 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 and safety impacts of wine consumption; to provide technical guidance on agrochemical use to meet export market requirements; to provide technical support for market promotion activities; to preserve the integrity and quality of Australian wine; and to contribute technical expertise to national and international forums on wine regulation.

Staff

Francesca Blefari, Geoff Cowey, Marcel Essling, Peter Godden, Prof. Markus Herderich, Matt Holdstock, Anne Lord, Virginia Phillips, Con Simos, Dr Creina Stockley, Dr Eric Wilkes.

Collaborators

Accolade Wines (Jonathan Breach); Agrochemicals Reference Group; AgVet Chemical Forum (Janine Clark); Alcohol Beverages Australia (ABA) (Fergus Taylor, Gohar Yazdabaldi); Australian Pesticides and Veterinary Medicines Authority (APVMA) (Jason Lutze, Ken Robinson); Australian Vignerons (AV) (Andrew Weeks); CropLife Australia (Alastair James); Department of Agriculture and Water Resources (DAWR) (Nigel Pinto); DrinkWise Australia (Tess McLachlan, John Scott); E. & J. Gallo Winery, USA (Steve Tallman); ETS Laboratories, USA (Gordon Burns); FIVS (International Federation of Wines and Spirits), France (Dr Greg Hodson, Bennett Caplan); Food Standards Australia New Zealand (FSANZ) (Dr Mark FitzRoy); GrapeLink (Graeme Forsythe); Grapeweb (Mark Riddell, Mark Roberts); Homologa (Janika Schuster); Institute of Masters of Wine, UK (Penny Richards); Organisation Internationale de la Vigne et du Vin (OIV), France (Jean-Marie Aurand, Dr Jean-Claude Ruf); South Australian Research and Development Institute (SARDI) (Barbara Hall); Treasury Wine Estates (Mandy Gerhardy); Winemakers' Federation of Australia (WFA) (Tony Battaglene, Damien Griffante); Wine Australia (Steve Guy, Ali Lockwood, Emma Symington, Hiro Tejima, Rachel Triggs); Wine Institute, USA (Katherine Bedard, Tom LaFaille).

Informing government, producers and consumers about health and safety aspects of wine

Background

The aim of this project is to increase knowledge of the effects of alcohol consumption on human health and society in order to support the development of evidence-based public health policy. This project maintained a capability to credibly engage with government and progress policy development related to wine and alcohol in society from a strong evidence base.

Submissions

Project staff prepared a comprehensive scientific submission on the consultation draft of the *National Alcohol Strategy 2018-2026* for the Australian Government Department of Health. Staff also provided input on request to submissions from other parties, including to the Food Regulation Standing Committee's policy options targeted consultation paper: *Pregnancy warning labels on packaged alcoholic beverages*.

Provision of scientific information

A number of scientific information and briefing papers were prepared. Topics covered included:

- Alcohol consumption during pregnancy in Australia with a focus on Fetal Alcohol Spectrum Disorders (FASD)
- Changes in the numbers of Australian women drinking alcohol during pregnancy from 2009 to 2018
- Relationships between alcohol consumption and all-cause mortality, cardiovascular disease, diabetes and dementia.

Complementary to this, the AWRI's 12 wine and health fact sheets and frequently asked questions were reviewed and updated. In addition, two position papers were published after peer review and another four articles were published in non-peer-reviewed publications (see Appendix 7 for details).

Supporting market access, safety and regulation

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 and assistance for 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 and assistance were provided on a number of market access issues. These included the analysis of allergens in wine and associated labelling in different export markets, the analysis and content of heavy metals in wine and the energy content of wine and energy calculations. The AWRI's databases of *Analytical requirements for the export of Australian wine* and *Permitted additives and processing aids for winemaking and wine importing countries* were updated regularly and now cover 45 and 29 individual countries respectively, in addition to information on regional trading blocs. An application to permit the addition of potassium polyaspartate to wine was also prepared for submission to FSANZ.

The team continued to support efforts to improve market access for Australian wine in the international marketplace through participation in forums including the International Wine Technical Summit, FIVS, World Wine Trade Group Industry Meeting and the APEC Wine Regulatory Forum (WRF), as well as supporting the WFA Wine Industry Technical Advisory Committee. Papers and presentations covered topics including a review of the variability of typical wine components, issues with the use of sugar free extract as a marker for wine adulterations, the need for a standardised method for determining sugar in wine, a guide for best practice measurement of total sulfur dioxide, fit for purpose analysis and authenticity measurement in wine. The project team also continued to lead the development of a database of typical values for wine components to be internationally curated and based at the AWRI.

One of the successful programs managed by the AWRI is the APEC WRF ring test program. This program involves 18 accredited laboratories from across the Asia-Pacific Economic community that conduct wine regulatory analysis. It provides an opportunity for participants to compare analytical results on a regular basis, with the aim of improving the agreement among the laboratories. Run as a subset of the Australian Interwinery Analysis Group program, the initiative has seen a significant improvement in the alignment of results among laboratories in different countries for analytes such as total sulfur dioxide, sugars and alcohol (Figure 1). This improvement has the potential to significantly reduce disputes when wine is tested in international markets for compliance with local regulations, giving Australian exporters greater confidence in their ability to export wines to these countries. The program has been such a success that there has been overwhelming support for its continuation past the end of the funding window for the APEC WRF.

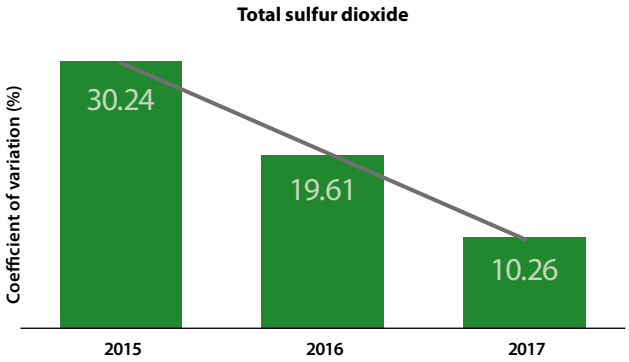


Figure 1. The improvement in the coefficient of variation (a measurement of the differences in results among laboratories) for participants of the APEC WRF ring test program for the measurement of total sulfur dioxide

The project team continued to participate at the OIV as members of the DAWR-led Australian delegation, together with a representative from WFA. 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. Project staff also participated in several electronic working groups. Additional information was prepared and presented to support Australian-initiated draft resolutions and dossiers on dimethylpolysiloxane and protease enzymes, since although these processing aids are permitted in Australia, they not yet permitted for winemaking under OIV regulations.

Enhancing the reputation of Australian wine through market promotion activities

Background

This project supports Wine Australia's market development strategy by providing targeted technical content that is designed to inform and educate the wine trade, media and consumers. An engaging message creates opportunities to promote the innovation dimension of Australian wine. Under this project, the AWRI hosts and delivers presentations to international visitors and presents themed tastings, masterclasses and educational activities at Wine Australia events.

Market promotion activities

Twelve presentations were delivered to a total of 341 participants in Australia, South Korea, Japan, United Kingdom, Germany and Austria. Content was varied, with the most popular topic being 'Australian Shiraz: pepper and provenance'. Tastings featuring wine flavours and faults were also presented. Interactive aroma experiences were provided at the Australian Wine Grand Tastings in South Korea and Japan, using 'sniff strips' to present a range of wine aromas in a display known as the 'Aroma bar'. This concept was then upgraded at Vinexpo in Hong Kong as an interactive display stand of hand-blown glass vessels, known as the 'Aroma wall'. Each vessel contained wine spiked with a different aroma with links to research at the AWRI and Australian wine. The concept was very popular and was seen as an innovative and creative way of introducing a new audience to Australian wine. Brief handouts were also provided to explain each wine aroma on display and how it related to Australian wine.

Collecting and disseminating information on agrochemicals

Background

Governments around the world set limits for the amounts of residues of agrochemicals that are 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. This project aims to assist grape and wine producers to manage agrochemical residue levels in their products. It achieves this 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.

Providing the latest information

The project team reviewed 192 Sanitary and Phytosanitary notifications from the World Trade Organization and 24 gazettes issued by the APVMA. The outcomes of these reviews included changes to MRLs for markets including Japan, the European Union and the USA. The APVMA gazettes highlighted issues including the registration of new active constituents such as pydiflumetofen, a broad spectrum fungicide.

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 publication *Agrochemicals registered for use in Australian viticulture* (commonly known as the 'Dog book'). More than 8,500 copies of the 2018/2019 'Dog book' were produced and distributed in June 2018. Updates were made to the online search portal and the smart phone agrochemical app, and an electronic version of the 'Dog book' was made available through the AWRI website. One significant change this year was the inclusion of a 'Key changes to this edition' page which provides a summary of changes made since the previous edition. In addition, the 'Dog book' now includes a general recommendation for the use of herbicides, to restrict these sprays in the 30 days to harvest. A modification was also made to the way registered products are shown where the recommendation is that growers should contact their grape purchaser prior to use or not use these products if their fruit is uncontracted.

Three new active constituents were registered for wine-grape production: abamectin in combination with chlorantraniliprole; *Bacillus amyloliquefaciens*; and pydiflumetofen. Wine sensory and residue data were reviewed to assess the suitability of these constituents for use in wine production and establish withholding periods for export wine. In addition, new information was assessed to determine withholding periods for the active constituents fenpyrazamine and dimethomorph when they are used once per season. Four *eBulletins* were issued during the year, including a notification in December 2017 that iprodione was no longer recommended for use on grapes destined for export wine, and advice about the risk and reporting of spray drift in March 2018.

Extension, adoption and education

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 and train students, foster industry adoption and bridge gaps between research and practice.

Staff

Gayle Baldock, Linda Bevin, Francesca Blefari, Maria Calabrese, Adrian Coulter, Geoff Cowey, Michael Downie, Dr Katie Dunne (to 29 June 2018), Marcel Essling, Peter Godden, Dr Yoji Hayasaka, Prof. Markus Herderich, Matt Holdstock, Dr Mark Krstic, Dr Mardi Longbottom, Anne Lord, Dr Paul Petrie, Virginia Phillips, Ella Robinson, Con Simos, Dr Creina Stockley.

Collaborators

Barossa Grape & Wine Association (Nicki Robbins); Brown Brothers (Brett McClen); Department of Economic Development, Jobs, Transport and Resources/Agriculture Victoria (DEDJTR/AV) (Dr Sze Flett, Sue McConnell, Assoc. Prof. Ian Porter, Jenny Treeby); Department of Primary Industries NSW (Adrian Englefield, Darren Fahey); Hoddles Creek Estate (Franco D'Anna); Langhorne Creek Wine Region (Lian Jaensch); Limestone Coast Grape and Wine Council (Ulrich Grey-Smith, Dr Kerry DeGaris); Lion Nathan (Alexandra Merry); Mornington Peninsula Vignerons Association (Cheryl Lee, Tyson Lewis); Murray Valley Winegrowers (Mike Stone); NSW Wine Industry Association (Angus Barnes, Liz Riley); *Practical Winery & Vineyard Journal*, USA (Don Neel); Queensland Wine Industry Association (Mike Hayes); Queen Victoria Museum and Art Gallery (QVMAG) (Claire Campbell, Richard Mulvaney, David Thurrowgood); Riverland Wine (Chris Byrne, Chris Bennett); University of Melbourne (Prof. Snow Barlow, Dr Sigfredo Fuentes, Dr Kate Howell, Dr Pangzhen Zhang); *WBM* (Anthony Madigan); Wine Grapes Marketing Board (Brian Simpson); Western Australian Department of Primary Industries and Regional Development (Richard Fennessey); Wine Australia (Hannah Bentley, Belinda Bramley, Nick Carne, Jo Hargreaves, Dr Sharon Harvey, Ali Lockwood, Dr Paul Smith, Dr Liz Waters); Wine Communicators of Australia (Lynda Schenk); Wine Network Consulting (Mark O'Callaghan, Rachel Sutcliffe); Wines of Western Australia (Larry Jorgensen); Wine Tasmania (Paul Smart); Wine Victoria (Angie Bradbury, Damien Sheehan, Rachael Sweeney); Winetitles (Sonya Logan, Hans Mick); Yarra Valley Wine Growers Association (Caroline Evans, Susanne Pyle); Yering Station (Andy Clarke, Darren Rathbone, Brendan Hawker, Willy Lunn).

The staging and conduct of extension programs

Background

The AWRI's extension program aims to facilitate the early awareness of research findings, technology adoption and practice change, all of which contribute to improvements in competitiveness. Activities include the long-standing roadshow seminar program, workshops, webinars, the Research to Practice program, the Advanced Wine Assessment Course and other tasting events. Education activities in areas not covered by levy-payer-funded extension are delivered under a user pays model.

Roadshow seminars and workshops

During the year, 13 roadshow seminars and 31 workshops were held in winemaking regions across Australia (see Appendix 2 for details). Workshop topics included spray application, addressing regional challenges, Shiraz and Pinot Noir winemaking treatments and smoke taint. A total of 1,037 participants attended seminars and workshops during the year.

Webinars

Sixteen webinars were presented to a total of 626 attendees – almost double the previous year's number of attendees. In addition, webinar recordings were viewed more than 3,500 times on the AWRI's YouTube channel. Webinars covered a wide spectrum of topics including heat stability, spray application, frost management and remediation of volatile sulfur compounds. The portfolio of presenters was equally diverse, with just one-quarter of all sessions presented by AWRI staff and the remainder presented by researchers from a range of organisations and industry personnel.

Educational courses and events

Three Advanced Wine Assessment Courses were held at the AWRI during the year, with 16 participants in each course. A one-day wine judging course was held for 16 Institute of Masters of Wine students in November 2017 and a one and a half day abridged course was delivered for the Barossa Grape & Wine Association in May 2018. At each tasting course, participants used the ShowRunner software platform. Two Research to Practice modules, on grapevine nutrition and alternative varieties, were also presented (see Appendix 2).

Support for Wine Communicators of Australia

The AWRI provided technical support and hosting for 13 WCA webinars and continued to enhance and support the WCA website. New functionality added to the website included integration of the online store with the WCA accounting system and set-up of automated follow-up emails. Events were coordinated and managed across three states, including three national wine show lunches and several smaller state-based events.

Communication with stakeholders

Background

Communication with the Australian grape and wine community is an essential aspect of the AWRI's activities, helping to maximise benefits from investments in research, development and extension by promoting awareness and adoption. This project develops new content and manages the delivery of information and knowledge to Australian grape and wine producers in formats designed for easy understanding and practical adoption. Communication outlets include the AWRI website, industry journals, the *AWRI Annual Report*, *AWRI Technical Review*, electronic newsletters and social media. Details of all presentations delivered and articles published by AWRI staff in 2017/2018 are listed in the Appendices.

AWRI website

The AWRI website is a major platform for communicating with grape and wine producers, students, potential employees and the general public. Approximately 122,650 visitors accessed the AWRI website during the year with more than 485,715 page-views. Of the total page-views, 21.8% were viewed using a mobile device or tablet. Updates to content included new fact sheets, summaries of the projects being conducted under the AWRI's 2017-2025 RDE plan, information about biosecurity risks, content marking the 25th anniversary of the Advanced Wine Assessment Course and a large number of previously published columns and articles. The website was also used to communicate with levy payers about the AWRI Board election and to promote events including seminars, workshops, tastings and webinars.

eBulletins and *eNews*

Twenty-one *eBulletins* were delivered to approximately 3,200 subscribers during the year (Table 1).

Table 1. *eBulletins* issued during 2017/2018

Date	Topic	Author
9/08/2017	Grapevine Pinot Gris virus advice	Mardi Longbottom
10/08/2017	AWRI webinars – registration is open now!	Michael Downie
11/08/2017	*Technical Review* August 2017 issue available	Linda Bevin
22/08/2017	AWRI Board election	Shiralee Dodd
3/10/2017	Agrochemical update – October 2017	Marcel Essling
9/10/2017	Four new AWRI webinars – registration is now open!	Michael Downie
9/10/2017	Grapevine Pinot Gris virus update	Mardi Longbottom
6/11/2017	Five new AWRI webinars – registration is now open!	Michael Downie
18/11/2017	*Technical Review* October 2017 issue available	Linda Bevin
20/11/2017	Spring growth and wet conditions	AWRI helpdesk team
8/12/2017	New recommendation for iprodione	Marcel Essling
14/12/2017	Detection of brown marmorated stink bug highlights importance of biosecurity vigilance	Mardi Longbottom
21/12/2017	Downy mildew infections reported following wet weather	AWRI helpdesk team
22/12/2017	Christmas closure	AWRI helpdesk team

Date	Topic	Author
14/02/2018	*Technical Review* February 2018 issue available	Linda Bevin
28/02/2018	More imports of brown marmorated stink bug to Australia	Mardi Longbottom
5/03/2018	Agrochemical update – spray drift	Marcel Essling
24/04/2018	*Technical Review* April 2018 issue available online	Linda Bevin
12/06/2018	*Technical Review* June 2018 issue available online	Linda Bevin
14/06/2018	Grapevine virus testing	Multiple authors
18/06/2018	Agrochemical update June 2018 – new 'Dog book' available	Marcel Essling

The AWRI's electronic newsletter, *eNews*, was distributed bi-monthly to an audience of approximately 3,550 subscribers. This publication provides information about upcoming events, new information resources, research updates and a general snapshot of the AWRI's activities.

Social media

The AWRI's Twitter following grew by 200 during 2017/2018 to 3,515. The AWRI's Facebook presence also grew by more than 250 likes during the year to reach 1,006. The AWRI's YouTube channel includes AWRI webinar recordings and other AWRI video content. Since its launch, the channel has attracted more than 20,000 views and 347 subscribers.

Annual report

For the past 63 years, the AWRI has produced a printed annual report 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 publishes a 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 wide range of other extension and communication activities undertaken by AWRI staff members throughout the year (see Appendices).

Technical Review

The AWRI's bi-monthly publication, *Technical Review,* publishes abstracts of recently published grape and wine science literature and technical articles authored by AWRI staff. *Technical Review* is available to grape and wine producers via the AWRI website or in hard copy. A total of 772 articles featured in the *Technical Review* Current Literature section were requested by and provided to readers during the year. *Technical Review* was nominated for a Wine Communicator Award in the category of best technical/trade publication in 2017.

Editorial support

The AWRI contributes regular articles to *Wine & Viticulture Journal* and *Australian & New Zealand Grapegrower & Winemaker*, while also contributing to other Australian and international industry journals. Details of the articles published are included in Appendix 7.

Media liaison

The AWRI is regularly approached by national and international media for comment on technical issues related to wine. Five media releases were prepared and distributed (Table 2) and 39 requests from the media were handled during the year (Appendix 6). Worldwide media interest was attracted by the commercial production of a beer made using yeast isolated from the shipwreck of the *Sydney Cove* in a partnership between Lion Nathan, QVMAG and the AWRI, with a global reach estimated at more than 220 million.

Table 2. Media releases prepared and distributed during 2017/2018

Announcement	Date distributed
Exploring the colour of wine science	10/08/2017
New investment agreement between Wine Australia and the AWRI to underpin success of Australia's grape and wine sector	4/09/2017
AWRI Board election results announced	13/09/2017
Skilled taster reaps rewards	22/09/2017
New home for grapevine virus testing	30/01/2018

Development of digital extension tools and software

Background

The AWRI currently provides a range of online databases and mobile apps to support Australian grape and wine producers. The uptake of these technologies is high and the demand for technology to improve productivity or promote efficient processes will continue to increase. This project ensures there is a planned and coordinated approach to the development, delivery and maintenance of innovative and collaborative digital tools.

Agrochemical and MRL database platforms

The Agrochemical and MRL databases form the core capability behind the 'Dog book', agrochemical and MRL online search functions and agrochemical mobile apps. Plans to upgrade the databases are completed and development work will commence in 2018/2019. The Australian table grapes sector uses an MRL online search platform developed by the AWRI. Discussions are underway about upgrading the platform and developing a mobile app for table grape producers.

Query investigation system

The query investigation system (QIS) is the AWRI's helpdesk support system. It holds data from more than 20 years of helpdesk queries and investigations. Most of the paperwork used to support the helpdesk is scanned and made accessible via the QIS, enabling the team to find information more efficiently and respond quickly to stakeholder queries. New enhancements are currently being added to the system to support a paperless helpdesk operation.

Extension tools and software source code

The source codes of business-critical extension tools and software have been consolidated and are managed using a web-based repository hosting service under the AWRI's control.

Gayle Baldock, Adrian Coulter

ShowRunner

Background

ShowRunner is an all-in-one wine show management system developed at the AWRI, which covers all aspects of a wine show from online entries to electronic scoring and production of results. The software began as a tailored solution for the Advanced Wine Assessment Course and has been adapted to the processes and practices of the Australian wine show system.

Rapid adoption by Australian wine shows

In 2016/2017, ShowRunner was used by three wine shows; by the end of calendar year 2017, an additional 20 wine shows across Australia had adopted the system. By the end of 2018 it is expected that almost 30 shows will be using the software. Interest has also been received from international wine shows and shows of other beverages. Users, show organisers, exhibitors and judges have all commented on the ease of use of the system, the stability of the platform, its functionality and features. A significant reduction in administration time has also been observed by show committees. A software and support licence agreement has been developed and is being used by all clients from 2018 onwards.

Regional engagement – the AWRI 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, Murray Valley Winegrowers, Wine Australia, DEDJTR/AV and the AWRI. Project activities are overseen by the Victorian Winegrowers Liaison Committee, which agrees on an annual workplan of activities under funding from DEDJTR/AV and Wine Australia's regional program.

Node activities

Key extension activities in 2017/2018 included a sparkling wine symposium, evaluation of a rootstock demonstration trial in Mornington Peninsula, a rootstock symposium, events on managing stuck and sluggish ferments, tastings from the AWRI's Shiraz winemaking trial and sessions on smoke taint. The AWRI completed the requirements of its 2014-2017 collaborative project and finalised key extension resources on biosecurity, climate change, smoke taint and quality management in the vineyard.

AWRI helpdesk

Background

The AWRI's technical helpdesk plays an important role supporting grape-growers and winemakers across Australia. The helpdesk provides rapid, confidential support on topics across winemaking, viticulture, health and regulatory issues, delivered by an experienced multi-disciplinary team.

Helpdesk enquiries

During 2017/2018 1,751 enquiries were received (Table 3), slightly more than last year (1,696). Almost 90% of these were answered within 24 hours of being received.

Table 3. Enquiries received by the AWRI helpdesk in 2017/2018

Topic	Number of enquiries
Winemaking	1,264
Viticulture	402
Regulatory	85
Total	**1,751**

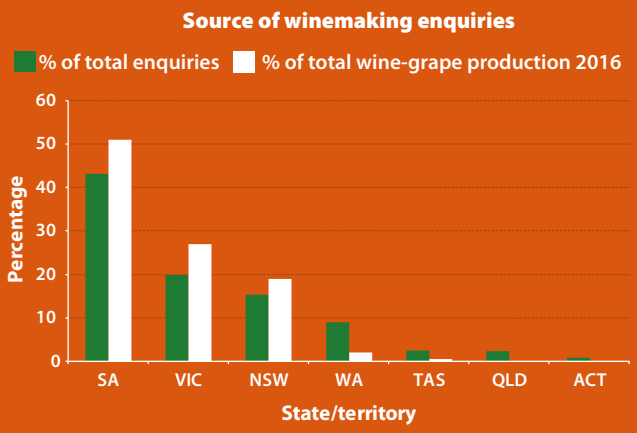


Figure 2. Winemaking enquiries received by the AWRI helpdesk in 2017/2018 by state/territory, compared to wine-grape production in 2016

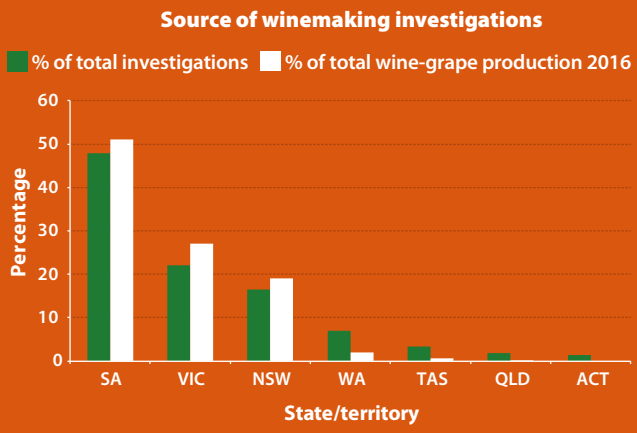


Figure 3. Winemaking investigations undertaken by the AWRI helpdesk in 2017/2018 by state/territory, compared to wine-grape production in 2016

Winemaking enquiries

The majority of the winemaking enquiries received during the year were from wine companies and suppliers actively aligned with the wine industry, with a small number coming from government organisations, students, legal practitioners and journalists. Approximately 17% of winemaking enquiries resulted in investigations, with samples requested and analysis performed to identify the problem and recommend a solution. Figure 2 shows the sources of winemaking enquiries in relation to the proportional volume of wine-grape production for each state/territory.

Viticultural enquiries

During the year, the viticulture team responded to 402 viticulture-related enquiries. The largest proportion of these related to sustainability and included advice on environmental management. Of the remaining queries, agrochemicals continued to be a priority topic for growers. Questions about the use of iprodione were relatively common as growers and wineries sought clarification on the regulatory changes occurring in the EU. The helpdesk also received a higher than average number of calls about leaf damage from suspected herbicide drift. Both of these issues prompted communications to industry via *eBulletins*.

Regulatory enquiries

There were 85 regulatory-related enquiries during 2017/2018. These covered the broad areas of allergens, general food safety/toxicology, heavy metal content of grapes and wine, and legality of compounds, practices and processes.

Winemaking problem-solving investigations

In 2017/2018, the helpdesk team conducted 213 winemaking problem-solving investigations, which is slightly higher than the previous year (208), and consistent with the 10-year average. The number of samples analysed as part of these investigations increased slightly compared to last year (Table 4). A breakdown of the investigations conducted by state/territory is shown in Table 5. State-based usage of the service is similar to previous years, with SA accounting for the highest number of investigations, followed by Victoria, NSW and Western Australia, which generally aligns with the volume of wine-grape production of the different states/territories (Figure 3).

Table 4. Winemaking investigations conducted and samples analysed by the AWRI helpdesk team during the past three years

Type of investigation	2015/2016	2016/2017	2017/2018
Identification of hazes and deposits	55	69	56
Microbiological investigations	29	24	39
Sensory assessments	68	61	60
Taint and contamination problems	61	30	42
Other investigative analyses	27	24	12
Closure-related investigations	7	0	4
Total number of investigations	**247**	**208**	**213**
Total number of samples analysed	**1,291**	**837**	**958**

Table 5. Winemaking investigations conducted during the past three years, broken down by state/territory

State/territory	2015/2016	2016/2017	2017/2018
SA	107	110	102
VIC	57	30	47
NSW	51	45	35
WA	20	12	15
ACT	1	1	3
TAS	11	5	7
QLD	0	5	4
Total	**247**	**208**	**213**

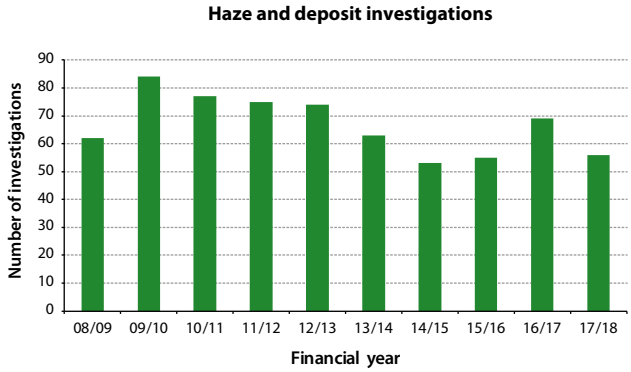


Figure 4. Haze and deposit investigations conducted by the AWRI helpdesk team from 2008/2009 to 2017/2018

The number of haze and deposit investigations conducted by the helpdesk team remained significant (Figure 4), making up more than a quarter of all winemaking investigations conducted during the year. The type and nature of the hazes and deposits varied and ranged from yeast and bacteria to bottling line lubricants and grease. Crystalline deposits were again common, making up approximately one-third of all deposits identified. Potassium hydrogen tartrate was the most commonly isolated crystalline deposit, followed by calcium tartrate. Another common haze or deposit identified was protein from wines that had been insufficiently bentonite fined and were heat unstable.

The number of sensory-related investigations conducted by the AWRI helpdesk continued to be significant, with 60 investigations this year (Figure 5). One-quarter of these concerned the common winemaking faults sulfides and microbial spoilage, while others included poor colour, 'green fruit' characters, acidity issues, smoke taint, oxidation, unwanted eucalypt character, oxidation, indole, leesy characters, bitterness, millipede taint and pinking.

The number of investigations of microbiological issues increased significantly this year, with 39 investigations conducted, compared to 24 the previous year (Figure 6). *Brettanomyces* growth and spoilage was the most common problem, with 20% of the investigations relating to this spoilage yeast. A similar number (18%) of investigations concerned wines that had refermented in bottle causing elevated carbon dioxide and spritz. There were three investigations of mousy wines, and seven investigations where elevated volatile acidity had occurred through bacterial growth.

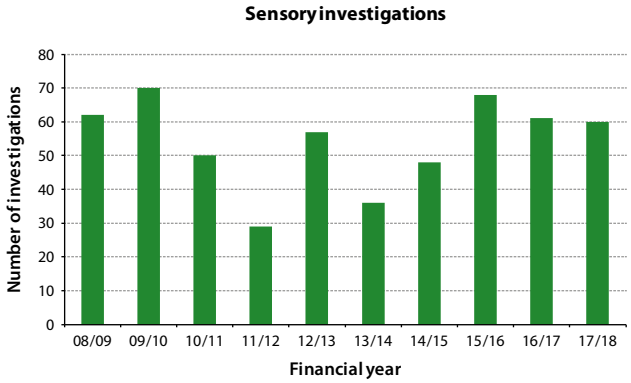


Figure 5. Sensory-related investigations conducted by the AWRI helpdesk team from 2008/2009 to 2017/2018

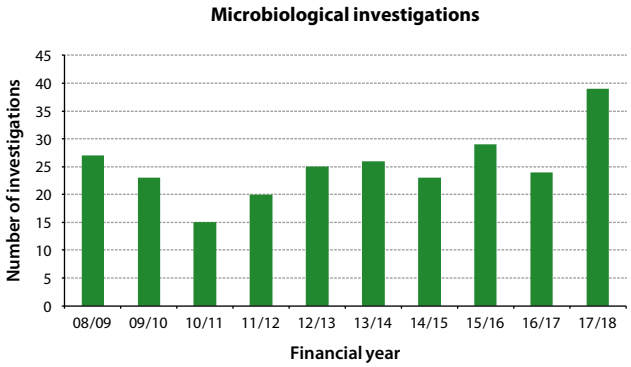


Figure 6. Microbiological investigations conducted by the AWRI helpdesk team from 2008/2009 to 2017/2018

There were approximately 40% more investigations of taints and contaminations this year compared to last year (Figure 7). These included wine affected by 2,6 dichlorophenol-tainted bentonite, millipede taint, musty characters including trichloroanisoles, and contaminations from bottling line lubricants, cleaning chemicals and hydraulic oil.

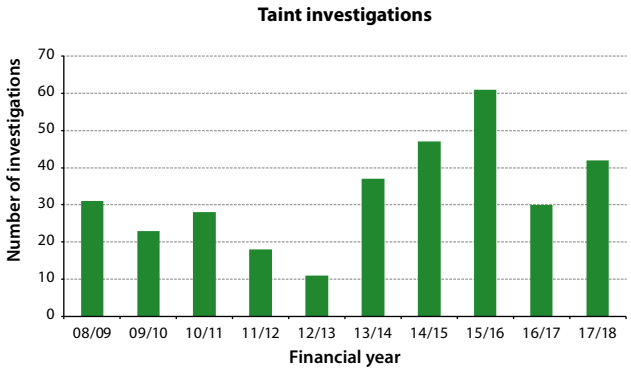


Figure 7. Taint investigations conducted by the AWRI helpdesk team from 2008/2009 to 2017/2018

Library services

Background

The John Fornachon Memorial Library holds the largest knowledge base of grape and wine technical resources in the southern hemisphere, with a collection of almost 100,000 items. 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'.

eBook collection

The library continued to invest in eBooks during 2017/2018, with the collection growing to 143 titles. The library's eBooks are easy to access and can be read across a range of devices or downloaded for offline use.

Staff publications database

The staff publications database, accessible from the AWRI website, received more than 5,430 hits this year with 715 staff publications requested and delivered. The database contains more than 2,000 citations of publications authored by AWRI staff and is updated regularly to ensure the latest publications are available.

Michael Downie, Anne Lord

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 the information they need on common topics including oenology, viticulture, sustainability and wine and health. The website received more than 1,580 hits on information packs and the library delivered more than 539 articles from information packs.

Library reference and information requests

The library responded to 1,100 reference and information requests and delivered 2,213 articles. More than 80% of the requests were completed within one business day and over 85% were received via the AWRI website or other electronic means. Table 6 outlines the types of articles requested and shows a fairly even split between AWRI-authored publications, current literature from *AWRI Technical Review* and the library's reprint collection. Library staff also conducted 64 specialised literature searches in 2017/2018 on topics including winemaking, vineyard management, biosecurity, winery operations and wine and health.

Library management system

A project to migrate the current library management system to a new platform is in progress and nearing completion. Once complete, this system will deliver a modern, fully featured, adaptable and future-proofed library system. Users will see significant improvements in user experience, accessibility and collection discoverability and will be better equipped to search, access and request information via the online library catalogue.

Table 6. Articles supplied from library collections in 2017/2018

Article type	Number of articles supplied
AWRI staff publications	715
Technical Review Current Literature	772
Library reprint collection	726
Total	**2,213**

Regional Program

Background

The AWRI coordinates Wine Australia's Regional Program, which supports the regional extension and adoption of research and development findings in the Australian grape and wine sector. The program provides an important connection between relevant research and development and locally identified grapegrower and winemaker needs. Funding from Wine Australia is provided to 11 Regional Program partners, who develop, deliver and report on activities completed within the Regional Program.

Regional activities

The AWRI assisted in coordinating the design and delivery of extension and adoption activities within the program's 11 regions via input into each region's Annual Operating Plan. The annual regional partners' meeting was held in the Yarra Valley in July 2017, with updates from the 11 regional partners and discussions on biosecurity and social science research on extension. The Regional Program also supported the implementation of Wine Australia's new Incubator Initiative, a program which supports early career researchers spending time in wine regions to conduct research and development activities.

Performance, 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 and objective measures for grape quality and wine style, optimisation of primary and secondary fermentation, assessing new winery processes and equipment, preventing and treating taints and faults and achieving a greater understanding of wine flavour and texture.

Staff

Vicky Amora (from 4 December 2017), Gayle Baldock, Caroline Bartel, Sheridan Barter, Dr Marlize Bekker, Dr Jenny Bellon, Laura Bey, Eleanor Bilogrevic, Dr Keren Bindon, Dr Anthony Borneman, Dr Dimitra Capone (to 7 February 2018), Dr Peter Costello, Adrian Coulter, Kate Cuijvers, Dr Julie Culbert, Dr Bob Dambergs, Dr Martin Day, Simon Dillon, Dr Zung Do (from 25 January 2018), Damian Espinase Nandorfy, Angus Forgan, Dr Leigh Francis, Dr Toni Garcia Cordente, Dr Richard Gawel, Yevgeniya Grebneva, Dr Yoji Hayasaka, Prof. Markus Herderich, Dr Josh Hixson, WenWen Jiang (from 16 October 2017), Charlotte Jordans, Stella Kassara, Radka Kolouchova, Dr Mark Krstic, Allie Kulcsar (from 12 February 2018), Dr Darek Kutyna, Jane McCarthy, Dr Jacqui McRae, Stefanie Melzer (from 5 February to 15 June 2018), Dr Agnieszka Mierczynska-Vasilev, Dr Simon Nordestgaard, Dr Cristobal Onetto (from 26 March 2018), Mango Parker, Wes Pearson, Dr Paul Petrie, Lisa Pisaniello (from 16 January 2018), Dr Simon Schmidt, Alex Schulkin, Dr Tracey Siebert, Dr Paul Smith (to 6 October 2017), Mark Solomon, Dr Cristian Varela, Dr Eric Wilkes, Dr Patricia Williamson.

Students

Fangzhou Chen (University of Adelaide), Lisa Hartmann (University of Adelaide), Eva (Yihe) Sui (University of Adelaide), Lin Sun (University of Adelaide), Ryan Zeppel (University of Adelaide), Wenjing Zhang (University of Adelaide).

Visiting researchers

Dr Bo Teng (Sichuan University, China), Dr Aude Watrelot (University of California, Davis, USA).

Visiting students

Marta Avramova (University of Bordeaux, France), Lauren Barrett (Montpellier SupAgro, France), Laura Canonico (*Università Politecnica delle Marche, Italy),* Melanie Brandt (Hochschule Geisenheim University, Germany), Anaïs Faucon (Montpellier SupAgro, France), Jana Hildebrandt (University of South Australia), Jessica Lleixa Daga (Universitat Rovira i Virgili, Spain), Louisa Schueth (Technical University of Dresden, Germany).

Collaborators

Accolade Wines (Warren Birchmore, Lucy Clements, Alex Sas); Agriculture Victoria (Joanne Bui, Dr Tim Plozza, Pei Zhang); Cape Jaffa Wines (Anna Hooper); Casella Family Brands (Steve Warne, James Wilson); CSIRO (Dr Rob Bramley, Dr Paul Boss, Peter Clingeleffer); Deakin University (Prof. Russell Keast); De Bortoli Wines (Steve Webber); Flinders University (Dr Martin Johnston); Henschke Wines (Prue Henschke); Hochschule Geisenheim University, Germany (Dr Simone Mueller-Loose, Prof. Doris Rauhut, Prof. Manfred Stoll); Institute of General and Ecological Chemistry, Lodz University of Technology, Poland (Dr Waldemar Maniukiewicz, Dr Pawel Mierczynski); John Danilewicz; La Trobe University (Dr Ian Porter); Metabolomics Australia (Dr Luca Nicolotti); Mondelez International (Dr Gal Kreitman); Mt Langi Ghiran (Damien Sheehan); Mt Majura (Dr Frank van de Loo); National Wine and Grape Industry Centre, Charles Sturt University (Prof. Leigh Schmidtke); Oregon State University, USA (Dr Chris Curtin); Pernod Ricard Winemakers (Dr Jean Macintyre, Tim Pelquest-Hunt); Pfeiffer Wines (Jen Pfeiffer); Printhie Wines (Drew Tuckwell); Punt Road Wines (Tim Shand); SARDI (Dr Marcos Bonada, Roger Maywald); Shaw + Smith (Adam Wadewitz); Stonier Wines (Michael Symons); The Lane Vineyard (Michael Schreurs); Treasury Wine Estates (Dr Anthony Robinson, Ian Shepherd, Dr Vanessa Stockdale); Università Politecnica delle Marche, Italy (Dr Laura Canonico, Dr Maurizio Ciani); University of Adelaide (Assoc. Prof. Sue Bastian, Dr Dimitra Capone, Assoc. Prof. Cassandra Collins, Assoc. Prof. Chris Ford, Assoc. Prof. David Jeffery, Dr Sijing Li, Ross Sanders, Assoc. Prof. Kerry Wilkinson); University of Bordeaux Institut des Sciences de la Vigne et du Vin, France (Prof. Philippe Darriet, Dr Panagiotis Stamatopoulos); University of California, Davis, USA (Prof. Andrew Waterhouse, Dr Aude Watrelot); University of South Australia (Dr Alex Cavallaro, Dr Armando Corsi, Dr Miguel de Barros Lopes, Prof. Larry Lockshin, Prof. Peter Majewski, Prof. Krasi Vasilev, Rahul Visalakshan); University of Tasmania, Tasmania Institute of Agriculture (Gail Gnoinski, Dr Fiona Kerslake, Dr Rocco Longo, Dr Angela Merry); VA Filtration (David Wollan, Matthew Hooper); Vasse Felix (Michael Langridge); Western Sydney University (Dr Gabriel Perrone); Wine Australia (Willa Yang); Wine Victoria (Rachael Sweeney); Wines by Geoff Hardy (Geoff Hardy, Shane Harris); Yalumba (Brooke Howell, Louisa Rose).

Identification and control of volatile compounds responsible for important sensory attributes

Background

This project aims to expand the knowledge of key volatile chemical compounds responsible for important sensory attributes in wine. For many winemakers and consumers, these attributes define a wine's fundamental quality and therefore value in relation to its price; they also provide researchers, grapegrowers and winemakers with quality markers and leads for targeting improvements to vineyard management and winemaking practices. To complement and fast track flavour chemistry research and related studies, this project is also assessing alternative, less time-consuming and/or simplified sensory methods for wine characterisation.

Methoxypyrazines in Shiraz: the role of whole bunch fermentations and concentration in stalks

Previous studies showed that the inclusion of stalks in a Shiraz fermentation can result in elevated concentrations of methoxypyrazines, compounds that give a 'green' herbaceous character to wines. These compounds were not previously thought to be important to Shiraz wines. To investigate this further, methoxypyrazines were measured in the rachis (stalk) of Shiraz grape bunches sampled during ripening. Methoxypyrazine concentrations declined post-veraison, but remained relatively high at maturity, and were highest in the rachis from vines that had previously been shown to produce wines with 'green' flavour. Grape berries had negligible levels of pyrazines. To assess the influence of whole bunches in winemaking, an experiment was conducted with Shiraz and Pinot Noir grapes from the 2018 vintage, using different ratios of whole bunches to crushed/destemmed fruit.

Understanding the role of varietal thiols in red varieties

Thiol compounds are known to be important flavour compounds in Sauvignon Blanc and other white varieties, where they contribute 'tropical fruit', 'passionfruit', 'grapefruit' and 'box hedge' characters. Much less is known about the role of these compounds in red wines. A survey was conducted of the concentration of thiols in 105 commercially produced red wines from across Australia. The wines included Shiraz, Cabernet Sauvignon, Grenache, Merlot and Pinot Noir as well as examples of Malbec, Durif, Tempranillo, Mataro and Petit Verdot. For two of the thiols quantified, none of the wines had a detectable concentration. For the compound 3-mercaptohexanol (3-MH), generally described as having a 'grapefruit' aroma, all wines had a concentration higher than the sensory detection threshold measured in model wine, indicating the possible contribution of this compound to red wine flavour. Figure 8 shows a summary of the results for the red wines, and it seems from these data that Pinot Noir wines can have higher concentrations of this compound. While only a small number of Grenache wines were analysed, there was some evidence that the concentration was also higher for this variety, possibly pointing to a possible contribution from 3-MH to the 'red berry' character of Pinot Noir and Grenache wines. There were higher levels in some examples of each variety, and further work will investigate causes for these differences. It is known that 3-MH can be susceptible to oxidation, and the formation of its precursors can be influenced during post-harvest grape handling. Figure 8 also gives an indication of the confidence interval for the median concentration for each variety. For Pinot Noir and Mataro, the confidence intervals are large, reflecting the wide variation in 3-MH concentration found for these varieties. Further work is planned to investigate this result.

One factor known to affect thiol concentration in wines is nitrogen fertilisation, either in the soil or through foliar sprays. A project investigating the effect of foliar application of nitrogen and sulfur on Shiraz and Chardonnay grapevines is underway, with two doses applied. The sprays have been shown to have been taken up by the vines, with increased concentrations of amino acids and subsequently, yeast assimilable nitrogen. Finished wines will be assessed to determine any effects on varietal thiol concentrations and amino acid profiles.

Riesling flavour: TDN and aged character

The compound TDN (1,1,6-trimethyl-1,2-dihydronaphthalene) is important to the flavour of bottle-aged Riesling wines, but can be considered a negative character in young wines. The formation of TDN was studied in 2016, assessing the effects of bunch zone sun exposure and vineyard site temperature in the Barossa and Eden Valleys. Accelerated ageing experiments were also conducted with Riesling wine, investigating both sensory and chemical effects. Results shaped a vineyard study conducted in 2018, looking at modulating light quality at the bunch zone. Wines made from sun-exposed Riesling berries had much higher concentrations of TDN than those made from shaded berries. Wines have also been produced by collaborators in Germany, using winemaking protocols aligned with those in Australia, to assess whether viticultural or winemaking influences might be of greater importance to TDN development in wine during bottle ageing.

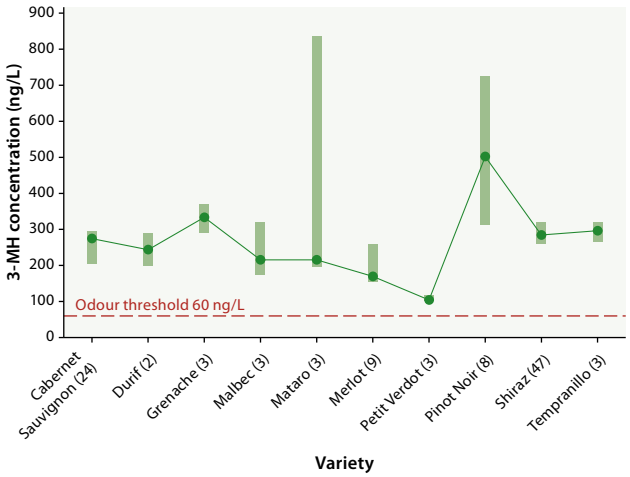


Figure 8. The concentrations of 3-MH in 105 commercially produced Australian red wines, displayed by variety, where the value in brackets is the number of wines analysed. The median value is shown by the circle symbol, while the confidence interval for the median is indicated by the rectangle. The dashed line is the odour detection threshold for 3-MH in model wine; above this concentration it could be expected that the compound could contribute to wine aroma.

'Stone fruit' flavour in white wine

Following earlier work where several terpene compounds were shown to be involved in 'apricot' character in white wines, studies have been carried out to determine the formation of these compounds in grapes of four Viognier clones during ripening. Samples were taken from veraison to after harvest in an Eden Valley vineyard. Two clones showed similar monoterpene concentration profiles throughout ripening but the other two clones were substantially lower in monoterpene concentration. Winemaking studies will be undertaken to investigate how these berry compositional differences relate to wine composition and sensory properties.

'Raisin'/'jammy' flavour in ripe Shiraz

While the propensity of Shiraz grapes to shrivel under periods of high temperatures late in the season is well known, the chemical compounds related to 'overripe', 'raisin' or 'jammy' characters are not established. Work has started to better understand heat-related reactions that occur to produce compounds that may contribute to these sensory attributes. Model systems have been studied, as well as heated grape material. Working with collaborators at SARDI, overripe berries from both sun-exposed and shaded bunches have been subjected to sensory analysis, with ranking tests showing clear differences in 'jammy' flavour among the samples, which will be related to gas chromatography-sniffing experiments to identify compounds involved in the sensory differences.

Mark Solomon, Josh Hixson, Tracey Siebert

Assessment of rapid, alternative sensory methods

The technique known as 'Pivot© Profile' has scope for use in industry as well as research. It is a free description method, where judges use a 'pivot' wine as a reference to assess a set of samples. For each wine, judges note descriptive terms that are more or less intense than the pivot. A simple count of terms allows interpretation of how the wines in the set differ, and a map can be created to easily visualise the results.

In 2017, Wine Australia invited 50 eminent sommeliers to Australia for a series of events. This provided a chance to assess the descriptors used by international wine professionals for Shiraz wines using the Pivot© Profile method. In addition, it was an excellent opportunity to measure the preferences of this group, and learn more about their thoughts on Australian Shiraz. A wide range of ultra-premium Australian Shiraz wines, up to $250 retail price and sourced from multiple regions, were tasted by this group, as well as, in a later session, a group of Australian winemakers.

The two groups of judges who used the Pivot© Profile method (international sommeliers and Australian winemakers) generated highly similar groupings of the wines, showing that the method is robust, and not dependent on judge background. The Pivot© Profile method also related closely to the conventional sensory descriptive analysis method applied at the AWRI, although this method, which involves rating the intensities of defined attributes, gave more detailed and statistically analysable data.

Further sets of wines have been examined using Pivot© Profile, and there have been similar successful results. The great advantage of this method is its rapidity, requiring only one session to complete, compared to descriptive analysis which can require six or more sessions. The main challenge with the method is the data entry and the relatively complex data analysis. Other rapid methods, such as Napping or Rate All That Apply, have also been investigated. Napping (also called projective mapping) involves sorting and grouping wines on a grid, and seems to give a somewhat different insight into sensory differences, emphasising certain attributes at the expense of others. Further work is planned to evaluate Napping in more detail.

Using glycosides and other flavour precursors for improved wine flavour

Background

This project aims to understand the release of flavour compounds in the mouth and their contribution to wine flavour and aftertaste. Previous work at the AWRI showed that flavour compounds bound to sugars (known as glycosides) could be cleaved during tasting, releasing a burst of flavour. The mechanism of release was via in-mouth enzymes, most likely from salivary bacteria; however, the flavour impact of glycosides varied across individuals. Current work aims to investigate grape glycosides as a potential wine additive, investigating their stability during fermentation and wine ageing as well as their sensory impact. The factors underlying individual variability in sensory response to in-mouth release of precursors will also be investigated.

Enhancing flavour precursors in winemaking

Isolating glycoside flavour precursors from grapes is relatively simple, although the conventional method also extracts less desirable phenolic compounds, which contribute bitterness. In a novel approach, phenolic-free glycosides were obtained from a substantial quantity of ripe Gewürztraminer grape skins, using straightforward pilot-scale methods, with the assistance of an engineering company. The phenol-free glycoside concentrate contained large amounts of bound monoterpenes, which are major contributors to 'floral', 'citrus' and 'fruity' flavours, especially in white wines. This material was added to a Chardonnay and a Riesling juice prior to fermentation, and to wine prior to bottling, in a winemaking experiment conducted during 2016 and 2017, with in-depth data analysis recently completed. Phenol-free glycosides were added at single strength (equivalent to the amount already in the juice) or double strength.

Chemical analysis showed that the glycoside material greatly boosted free monoterpenes in the finished Chardonnay and Riesling wines. The important fruit flavour-enhancing compound β-damascenone was also substantially increased by the glycoside addition. Whether the glycoside material was added before or after fermentation made

only a small difference in final monoterpene concentration. There was only a negligible change in phenolic composition and colour due to the glycoside addition, indicating that the glycosides were indeed phenolic-free. Apart from the free volatile compounds, the intact glycosides in the wines were also enhanced, with the concentration of geraniol glycoside increased more than 60-fold. Figure 9 shows chemical and sensory data for some of the Riesling wines studied, with a control wine compared to the same wine with phenol-free glycosides added at single strength to juice and to wine.

Sensory analysis showed that there was a strong increase in 'fruity'/'floral' aroma and flavour attributes due to the glycoside additions, with descriptors such as 'rose', 'citrus' and 'confectionary' used by the panel. Importantly, there was no significant difference in viscosity, acidity, astringency or bitterness caused by the additions, showing that the flavour-active glycosides only affected 'fruity' characters, with no detrimental effect on mouth-feel.

A group of white wine consumers in Sydney also tasted wines from the study and their preferences were recorded. A considerable number of the consumers liked the Riesling with a single addition of glycosides, while those wines with a double addition were not well appreciated, suggesting the flavour effect for these wines was too strong. A group of winemakers also assessed wines from the study and there was agreement that the wines made with added glycosides were greatly different from the controls.

One aspect of interest in this study was whether, for the wines with added glycosides, the release of flavour from glycosides during tasting might have been partly responsible for the observed increases in flavour and aftertaste. Some evidence for this was found by examining the sensory scores for those panellists who were tested as having the ability to perceive flavour from model systems containing added glycosides but no free volatiles. The individuals who could taste flavour from glycosides in the model system rated the wines with glycoside additions as more intense in 'floral' flavour and aftertaste than those who could not detect flavour from the model glycosides.

A study aimed at assessing factors contributing to individual differences in sensory response to glycosides was conducted. The capacity of people to detect the flavour of free volatiles and their glycoside counterparts was assessed with a group of 41 individuals. In addition, the ability of their saliva to complete glycoside hydrolysis was tested. Results showed that more than 80% of people tested had a significant flavour response to at least one of the glycosides tested, with a complex pattern of response to free volatiles and precursors. Data from saliva tests are currently being analysed.

Molecular drivers of wine texture and taste

Background

Wine textures play a key role in the quality of white and red wines. Achieving desirable texture can be challenging, with many components potentially contributing to the overall mouth-feel. Knowledge of the identity and origins of contributing compounds will enable winemakers to better manage the texture of wines during production and optimise positive characters while minimising negative ones.

Factors influencing texture during winemaking

The amount of time juice spends in contact with grape solids can influence the texture of white wines. In the 2017 vintage, Chardonnay and Sauvignon Blanc wines were produced after the juice had been in contact with grape solids for 24, 48 and 72 hours. Methods were optimised to analyse polysaccharides and phenolics in juice and ferment samples to track the changes in composition during winemaking. Wines produced after longer contact time with solids generally showed higher concentrations of polysaccharides, whereas the concentrations of phenolics remained similar regardless of contact time. These results will be compared to sensory analysis outcomes to assess the impact of juice treatment on wine texture.

Dissolved CO_2 was recently found to be a factor influencing the textural properties of white wines. This work was expanded to assess the influence of dissolved CO_2 on red wines. Shiraz and Cabernet Sauvignon wines were prepared with different levels of CO_2, alcohol, tannins and pH to assess the relative influence of each factor. Sensory analysis indicated that sub-spritz concentrations of dissolved CO_2 can have a significant influence on red wine mouth-feel.

Understanding the drivers of bitterness in wine

Sulfonated derivatives of indole have previously been identified as important bitter compounds in wines. Factors influencing the formation of these compounds were investigated with the aim of developing ways

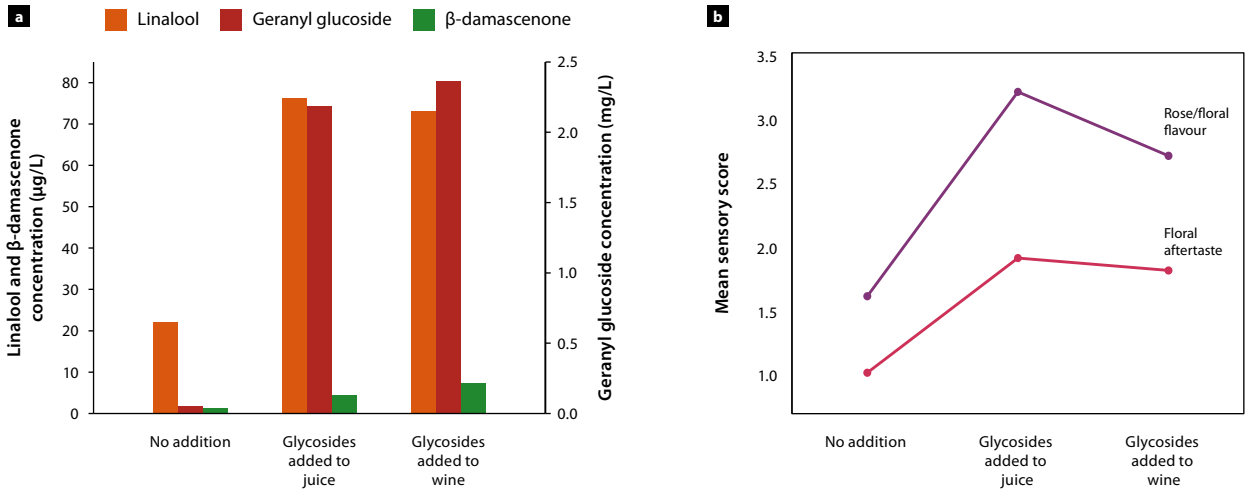


Figure 9. Changes in Riesling a) wine composition and b) sensory attributes due to addition of phenol-free glycosides derived from Gewürztraminer grape skins to juice before fermentation or to wine prior to bottling

of better managing wine bitterness during wine production. Model wine studies involving SO_2 addition to the indole derivative, tryptophol, found that the bitter compound developed more readily at lower pH (3.2) and higher temperatures (22°C). In grape juice, the process of sulfonation was similar to that in model wine but concentrations were lower. Further studies investigated the influence of pH and temperature on the evolution of phenolics and indole derivatives during white and red winemaking. Results indicated that the concentration of indole derivatives increased during fermentation. Future work will confirm whether sulfonation of phenolics occurs after post-ferment additions of SO_2 and subsequent storage.

Sensory analysis using Napping was also conducted on a commercially produced sulfonated indole derivative and a structurally related synthesised compound to assess any sensory effects of the compounds' differing chemical structures. Both compounds were found to have sensory properties similar to those of other known bitter compounds.

Concentrations of bitter compounds in wine may not have a direct relationship with overall wine bitterness due to potential interactions between bitter compounds and other wine components, particularly macromolecules. Methods were developed to assess the interactions between macromolecules and bitter compounds using nanoparticle tracking analysis (NTA). The particle sizes of isolated polysaccharides in contact with sulfonated tryptophol were consistently smaller than those of the isolated polysaccharides alone. This suggested that the polysaccharides were contracting in size upon interacting with the bitter compound, which in turn suggests that wine bitterness may be influenced by the concentration of polysaccharides.

Managing wine extraction, retention, clarity and stability for defined styles and efficient production

Background

This project investigates wine macromolecules such as tannins, polysaccharides and proteins to understand their impact on wine stability, clarity, filterability, sensory properties and style. A key focus area has been to develop tools to better achieve and measure wine protein stability. Tannins, anthocyanins, polysaccharides and their interactions are studied to provide information about the effects of using wine additives, and to improve colour and cold stability. The new knowledge and tools generated provide winemakers with options to address stability, clarity and ultimately production efficiency during winemaking.

Tools to manage wine protein stability faster and better

Protein removal is the primary means used by winemakers to prevent formation of unsightly protein hazes in finished wines. An accurate test to predict the bentonite dose required to prevent instability is a critical step. A highlight of the previous annual report was the development of an updated heat test which could consistently and reliably be completed within a five-hour turnaround time (two hours' heating at 80°C and three hours' cooling at 20°C). This year, guidelines for the new heat test were publicised via a peer-reviewed publication (McRae et al. 2018), an article *in AWRI Technical Review* and an AWRI webinar. Projects investigating pasteurisation and functionalised magnetic nanoparticles as alternatives to bentonite have also continued.

Pasteurisation of grape juice has been previously shown to reduce the concentration of haze-forming proteins in white wines without adverse effects on sensory profiles when conducted for one minute at 75°C. The effects of longer juice heating times on protein concentrations, heat stability and sensory profiles of wines have now been assessed. Laboratory-scale trials demonstrated that juice pasteurisation for up to two minutes effectively heat stabilised wines containing high concentrations of proteins. These trials were followed by industry-scale trials using a prototype pasteurisation unit. Semillon and Sauvignon Blanc juices were heated at 75°C for one or two minutes before undergoing fermentation. The two-minute pasteurisation removed most of the protein in juice. These results demonstrate that pasteurisation may be a viable alternative to bentonite for protein stabilisation of wines.

In recent years, magnetic separation technology has allowed for selective removal of pathogenesis-related proteins using carefully-tuned surface functionalities (Mierczynska-Vasilev et al. 2017). The process uses magnetic nano-beads which encapsulate haze proteins and are subsequently removed by applying an external magnetic force. New experiments examined the influence of different surface coatings, enabling different mechanisms by which proteins are selectively bound to be compared (Figure 10). Plasma coatings rich in amine, carboxyl and oxazoline functional groups were prepared and their efficacy in removing haze-forming proteins was examined using unfined Semillon and Sauvignon Blanc wines. This work will help guide design of new technology for the selective removal of haze proteins from white wines and has contributed to the broad understanding of protein interactions with surfaces.

When considering magnetic nanoparticles for this type of application, another important consideration is their reusability to reduce costs. Since protein adsorption onto magnetic nanoparticle surfaces is a reversible process, their regeneration and reuse is possible. The effectiveness of three different protein cleaning solvents (water, 10% sodium dodecyl sulfate

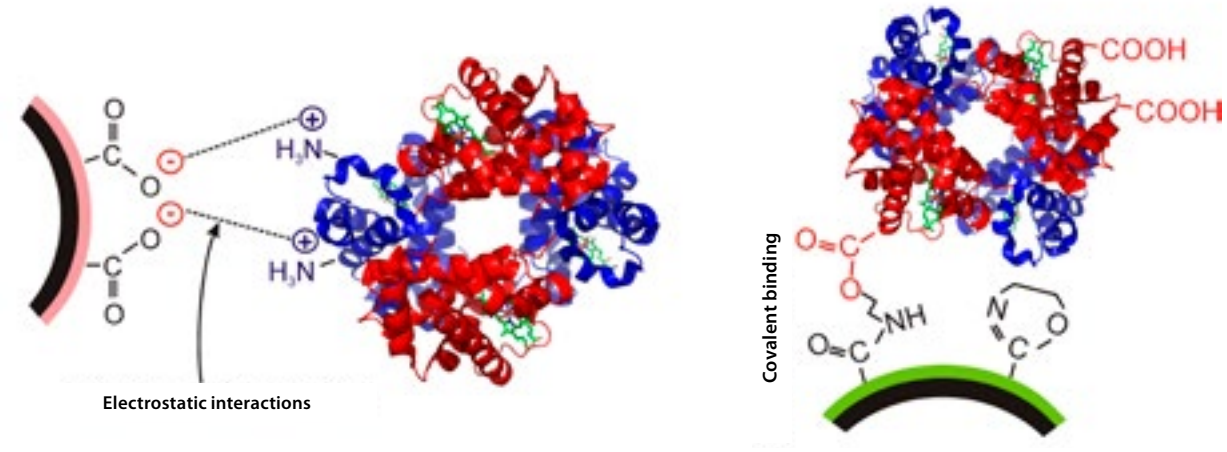


Figure 10. Possible mechanisms for protein adsorption on magnetic nanoparticles

(SDS)/water and acetone/water) were evaluated on bare, pre-washed and acrylic acid plasma coated magnetic nanoparticles. After each wash cycle, the nanoparticles were re-tested in wine, with monitoring of protein, phenolics, organic acids and elemental composition. The acrylic acid plasma coated magnetic nanoparticles exhibited a high stability and good reusability within six successive adsorption–desorption processes (Figure 11). The results suggest the strong potential for the application and reuse of magnetic nanoparticles as an alternative approach to bentonite for protein removal from wines, reducing waste and potentially enabling recovery of useful materials.

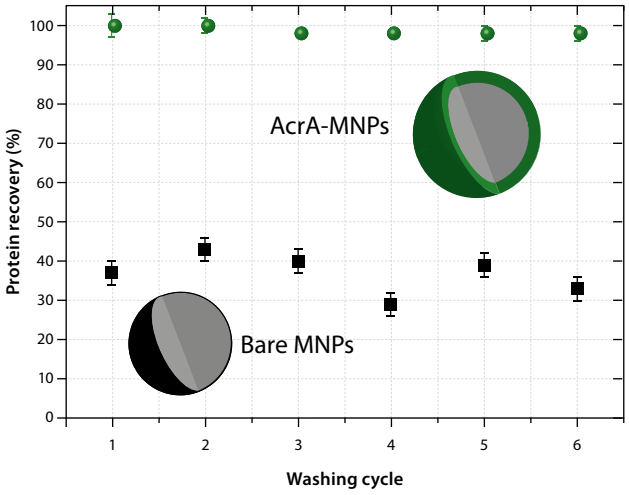


Figure 11. Cleaning efficiency of 10% SDS/water solution for Chardonnay wine treated with bare and acrylic acid plasma coated magnetic nanoparticles (AcrA-MNPs)

Improved understanding of red wine colour stability

Tannins react with anthocyanins to form polymeric pigments during fermentation and ageing, and are thought to contribute to the bulk of stable colour in aged wines. A study aimed to explore the role of tannin composition and size on the formation and stability of polymeric pigments. Tannins of a defined size range were prepared from white Cabernet grape seed (1,250 – 6,000 g/mol) and skins (2,000 – 13,000 g/mol) and were combined with anthocyanin in three different media: wine made from chemically defined must (CDM), wine made from CDM with added acetaldehyde (CDMA) and model wine made up of acidified 15% ethanol (MW). After an ageing period, it was found that the formation of polymeric pigments (and hence wine colour) was quite different among the three media. In model wine (which contained neither natural nor added acetaldehyde) large molecular weight tannins formed greater quantities of polymeric pigment with anthocyanin, and had a more intense colour. In CDM and CDMA wines the reverse trend was observed – losses of polymeric pigment and colour increased as tannin molecular mass increased, and the effect was greater for seed than skin tannins. The loss in colour was found to be primarily due to precipitation of large molecular mass tannins after reaction with anthocyanin. To explain this phenomenon, tannin particle size was compared using nanoparticle tracking (Figure 12). In the model wine, average particle sizes of the tannins ranged from 80 to 140 nm but far larger particle sizes were found in CDM and CDMA wines. This suggested that the principal mechanism for tannin and colour precipitation was the polymer size increase mediated by acetaldehyde, and this might partially explain the lack of large tannins observed in red wine. Acetaldehyde is generally considered to be beneficial to wine colour due to its enhancement of tannin-anthocyanin linkages; however, this study has shown that under certain circumstances it may lead to colour loss.

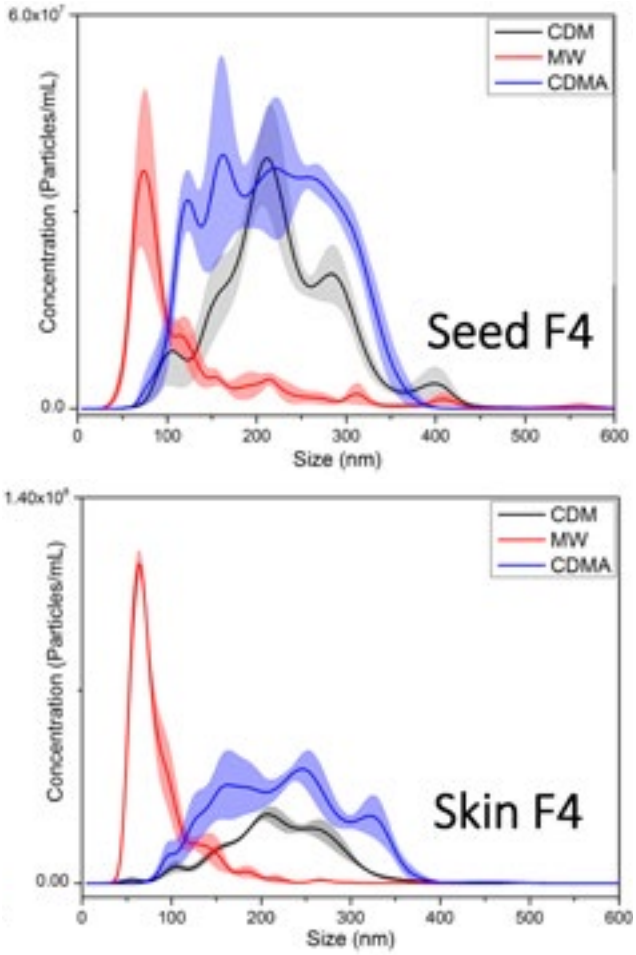


Figure 12. Particle size distribution of large molecular mass (F4) seed and skin tannins combined with anthocyanin in chemically defined wine media (CDM), CDM with acetaldehyde (CDMA) and model wine (MW)

Developing guidelines on the use of tannin and polysaccharide additives in winemaking

Oenotannin and mannoprotein additives can be used to improve wine protein, cold or colour stability and may also be used to modify wine texture. Fourteen grape-based oenotannins and eight mannoproteins from the Australian market were screened, and their composition and molecular size distribution were determined (Li et al. 2018a,b). It was interesting to find that the analysis of the commercial oenotannins did not always agree with the labelled origin of material (i.e. grape skin or seed tannin). It was also found that for certain manufacturers, products marketed for different oenological purposes were found to have similar compositions.

Commercial mannoproteins also had diverse composition, notably in terms of their relative protein content (10 to 50%) and the presence of gum arabic. The protein content of mannoprotein additives may significantly affect wine composition, since these yeast-derived proteins can precipitate tannins, and hence influence texture and colour. To further investigate this possibility, the stability of commercial mannoprotein and gum arabic products in the presence of tannins was investigated. Studies were conducted in model wine solutions at different ethanol concentrations and characterised using NTA. Results showed aggregation of polysaccharide additives and tannin. Mannoprotein formed large, highly light-scattering aggregates, while gum arabic exhibited only weak interactions with tannin. A 3% reduction in alcohol concentration

from 15% v/v to 12% v/v was found to increase aggregate size for mannoprotein, but had no impact on gum arabic. Under the conditions of the study, the polysaccharide additives were found to be stable and did not precipitate or cause tannin loss. However, the results showed that there are differences in colloidal behaviour between polysaccharide products, and further work will aim to determine the alcohol or tannin concentration at which instability, identified by precipitation or turbidity, might occur. Together, the results suggest a range of effects could potentially be achieved by applying different products, and this warrants ongoing study.

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Influencing wine style and efficiency through management of oxygen during wine production

Background

This project uses both model systems and pilot-scale fermentations to investigate the impacts of oxygen exposure at crushing or during fermentation on fermentation efficiency and wine style. It will also monitor wines with known oxygen exposure as they age, to assess oxygen-related chemical changes that occur after fermentation. Different approaches to oxygen delivery will be explored in collaboration with industry partners.

Exploring influence of aeration during fermentation on simultaneous MLF

Aeration of ferments and simultaneous MLF inoculation are two winemaking techniques that have shown benefits in recent years. However, until now, the interaction of these two techniques had not been tested. During the 2017 vintage, a 2 x 2 factorial experiment was carried out looking at timing of MLF inoculation and a repeated oxygen addition. Chemical and descriptive sensory analyses were conducted six months after bottling. Statistical analysis revealed five sensory attributes that differed significantly among treatments. Generally, oxygen had a large effect on wine colour intensity, and wines sparged with oxygen during primary fermentation were rated relatively low in opacity and higher for sweetness and 'fruit' aftertaste. The MLF inoculation treatment effect had a relatively small influence only on opacity and 'boiled potato' aroma, with wines from the sequential inoculation treatment rated highest in both attributes. The interaction of the oxygen treatment with the inoculation treatment had a moderate effect on reductive aroma, indicating that sequential inoculation without the addition of oxygen, and simultaneous inoculation with the addition of oxygen may both result in some level of reductive aromas.

Non-*Saccharomyces* yeast use oxygen differently

In ferments conducted by *Saccharomyces cerevisiae,* oxygen availability helps drive the formation of yeast biomass by providing the resources for lipid biosynthesis. However, even in the presence of oxygen, *S. cerevisiae* will ferment sugar to ethanol. When oxygen is made available to many non-*Saccharomyces* yeast species, sugar metabolism can be directed towards endpoints other than ethanol. To explore this concept, experiments were conducted to evaluate conditions that might enable aerobic sugar consumption by non-*Saccharomyces* yeasts. In a collaboration with Università Politecnica delle Marche, Italy, several strains were evaluated under a range of aeration conditions. Ethanol reductions of between 0.8% and 1.8% v/v, depending on the degree of aeration, were observed without significant production of acetic acid. Given that non-*Saccharomyces* yeasts are already available for commercial use, this work is one example of how altered production practices may be used to lower alcohol concentration in wine.

Changes in tannin structure and interaction with protein after exposure to oxygen

Wines sparged with oxygen during fermentation were previously shown to be less astringent than reductively treated wines, and had meaningful changes in tannin concentration and structure, both of which might have contributed to the sensory effect (Bekker et al. 2016). To further investigate this, a collaboration was initiated with Dr Aude Watrelot from the University of California, Davis, to characterise tannin which had been isolated from wines undergoing either oxygen or nitrogen sparging during fermentation. Tannins extracted from red wine exposed to oxygen had a higher percentage of galloylation and were more pigmented than tannins from reductively treated wine. Particle size of tannins was analysed using NTA and the interaction of tannins with a model protein (poly-L-proline) was measured by isothermal titration calorimetry. The interaction of tannins from oxygen-treated wine with protein involved fewer hydrogen bonds than hydrophobic interactions, suggesting that oxidised tannins were more hydrophobic. The assessment of particle size suggested that oxidised tannins were prone to greater self-association, leading to a larger overall particle size than the tannins from the nitrogen treatment. The study has shown that the structural changes in tannins conferred by oxygen can result in significant changes in their colloidal behaviour and their interaction with protein. This may have implications for the perception of astringency, and is being further investigated.

Reference

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Winemaking interventions to modulate glutathione status

Background

Glutathione (GSH) is a naturally occurring antioxidant present in grapes that plays an important role during winemaking. It can preserve wine colour and aroma by reacting sacrificially with quinones and acting as an antioxidant. It can also act as a precursor to a range of desirable and undesirable sulfur aroma compounds. The concentration of glutathione in wine can be enhanced by direct addition, or indirectly as a consequence of winemaking practices. The OIV has passed resolutions

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permitting the addition of GSH to juice and wine. With the possibility that glutathione could become a permitted additive to juice or wine in Australia, this project aims to extend current understanding about the effects of glutathione additions in white juices and wines.

Predictability of glutathione consumption

OIV resolution OIV-OENO 445-2015 provides limited guidance on the addition of glutathione to must, advising only that practitioners should ensure that the assimilable nitrogen level is sufficient to avoid the metabolism of glutathione by yeast. While the resolution limits the addition of glutathione to 20 mg/L, the conditions under which glutathione consumption by yeast is likely to occur are not specified and have not yet been determined. The capacity of different yeasts to consume glutathione and the metabolic endpoints are also not clear. To address this, the effects of nitrogen concentration on the consumption of glutathione during fermentation were evaluated in defined medium and freshly prepared low YAN must. While consumption of glutathione was reduced in ferments with higher nitrogen concentrations, substantial glutathione consumption was observed at all nitrogen concentrations. The consumed glutathione did not alleviate growth limitations in low nitrogen conditions, indicating it was not used as a nitrogen source in these experiments. Finally, increased glutathione consumption in low nitrogen ferments was not associated with changes to the volatile sulfur compound profile of the finished wines. In all cases the volatile profile was driven by nitrogen concentration rather than glutathione concentration.

In parallel work, the effects of inert pressing and aerobic pressing on the consumption of glutathione added prior to inoculation were evaluated. Inertly processed must has, in some reports, been shown to have much higher concentrations of glutathione, with the glutathione preserved following disruption of the berry. It was predicted that the addition of glutathione under this condition would raise concentrations to levels higher than are usually encountered. Conversely, it was predicted that addition of glutathione to aerobically pressed juice would result in additional glutathione oxidation and in the formation of glutathione adducts. In this work, however, differences in glutathione concentration in pre-fermentation musts did not relate to pressing treatment. Glutathione was consumed during ferment similarly in both oxidatively and anaerobically prepared ferments, resulting in similar final glutathione concentrations in both wines. Analysis of aroma compounds revealed little interaction between pressing and glutathione treatments; however, unlike in the nitrogen work, a small number of volatile sulfur compounds, specifically hydrogen sulfide and methanethiol, were found to have higher concentrations in wines made from glutathione-treated musts.

Effects of glutathione on Chardonnay and Riesling wine

In the 2017 vintage the effect of glutathione addition pre- and post-inoculation was evaluated in combination with standard and low SO_2 concentrations at bottling. In total 36 wines were produced. Sensory evaluations of those wines were completed this year. Overall, glutathione additions to both Riesling and Chardonnay had a detrimental effect on wine sensory qualities, with control wines rated higher in fruit-related attributes and glutathione-treated wines rated higher in 'dank'/'drain' and 'capsicum' attributes. Correlation of sensory and chemical data is in progress. The same wines are due to be re-assessed one year after the initial sensory evaluation.

Building and measuring the quality of fine Australian sparkling wines

Background

This project, led by the University of Tasmania, will contribute to identification of impact compounds for desirable flavour, mouth-feel and texture of fine Australian sparkling wine. It also aims to identify the key processes in the production chain that have the greatest impact on the quality of sparkling wines.

AusIndustry crop load and pruning trials

Chemical and sensory differences were measured in wines and linked to vineyard management practices. The most notable differences were in the aroma profiles of wines produced from either high or low crop load vines, although these differences were not consistent across vintages and were more distinct in the 2010 wines than the 2011 wines. A sensory panel preferred the low crop load wines from the dry 2010 vintage and the high crop load wines from the wet 2011 vintage wines.

Differences in wines were also noted as a result of leaf removal, with preferences in the treatment varying between the 2010 and 2011 vintage wines. For 2010, the panel preferred wines made following leaf removal at veraison and pre-flowering to the control wines without leaf removal. For the 2011 wines, the panel preferred wines made following leaf removal at veraison or at pea-sized berries to the control wines or wines made following leaf removal pre-flowering. The differences may be due to the weather conditions for each vintage, with 2010 being a dry year and 2011 being wetter. These results further emphasise that vineyard management can play a significant role in the sensory and chemical profiles of sparkling wines. This work was presented by Dr Fiona Kerslake in the AWRI webinar program.

Autolysis trials

Chardonnay and Pinot Noir sparkling wines were produced using different treatments to induce autolytic or aged character in the wines. Treatments included ultrasound, microwave, enzymes, storage at 15°C or 25°C or spiking with aged wine or lees. At regular intervals post-production, wines were tasted by an industry panel for autolytic or aged characters and were analysed for volatile and non-volatile components. Results will be compiled after the next analysis timepoint, and assessed for any trends in the development of autolytic characters and any associated changes in chemical composition.

Putting microbial diversity to work in shaping wine style

Background

While there are a large number of wine yeasts currently available for winemaking, extensive genetic analysis has shown the genetic diversity among these yeasts to be extremely shallow. This limited genetic depth provides substantial scope to expand the genetic diversity of wine yeasts through breeding and selection. This project builds on previous work in which *Saccharomyces cerevisiae* was mated with non-*cerevisiae* members of the *Saccharomyces* genus to produce genetically complex hybrids and work where non-GM methods of selection were employed to develop low hydrogen sulfide and low acetate producing yeasts. Together these breeding and selection strategies will deliver non-genetically modified germplasm that can be used by industry and will provide new microorganisms for winemakers seeking a point of differentiation in their wines.

Production of yeasts that enhance 'floral' characteristics of wine

Through the targeted use of amino acid analogues, it was possible to isolate a wine yeast that substantially overproduced 2-phenylethanol and 2-phenylethyl acetate (Cordente et al. 2018) and hence produced wines with enhanced 'floral' characteristics. However, the high concentrations of 2-phenylethanol and the associated tryptophol and tyrosol produced by this yeast were only suited to the production of a narrow range of wines. Work in the past year has focused on yeasts producing intermediate concentrations of 2-phenylethanol and 2-phenylethyl acetate. These yeasts not only produced different concentrations of these 'floral' aroma compounds but produced them in different ratios and with different concentrations of tryptophol and tyrosol. These strains were evaluated at pilot scale during the 2018 vintage and sensory and chemical analysis are scheduled for later in the year. It is hoped that they will both expand the range of wines for which 'floral' aromatic enhancement can be used and also shed light on yeast secondary metabolism and the production of indole-related metabolites and their oenological qualities.

Bringing stability to hybrid yeasts

The bringing together of two different species of yeast, as occurs during the production of interspecific hybrids through rare mating, can expose genomic incompatibilities, with genomic instability often the result. Genomic incompatibilities can cause the seemingly random loss of sometimes large genetic elements during propagation, and with this loss comes the potential for loss of desirable traits. A program of adaptive conditioning of an F1 hybrid (a child of two parents) was undertaken using serial fermentation of Chardonnay (Bellon et al. 2018). Analysis of chromosomal loss at the end of each fermentation in the series revealed loss of *S. uvarum* chromosome 14 to be the most prominent alteration, and this occurred early in the series. In short, genome stabilisation happened quickly, with subsequent genetic alterations representing sporadic events that did not propagate through the population. The advantage of this approach is that traits critical for performance during fermentation of grape juice are perpetuated while ensuring that strains resulting from this process are able to be propagated without further loss of critical genomic elements.

A vintage trial comparing a large group of interspecific hybrids, all products of rare mating with diverse non-*cerevisiae* species, was undertaken in 2018. This is the first 'head-to-head' comparison of such a diverse array of hybrids and will provide a robust understanding of the different characters that diversifying the genetic basis of *S. cerevisiae* can bring to wine.

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The relationship between grape juice composition and the progress of alcoholic and malolactic fermentation

Background

This project brings together two previously separate research areas, yeast and bacterial fermentation, in order to realise an integrated approach to the study of fermentation performance. Poor fermentation progress can occur even in juices and wines that satisfy the usual criteria for appropriate fermentation progress (e.g. YAN, Baume, SO_2). The starting point for any ferment, the juice, is a rich ecosystem and the uncontrolled growth of non-target microorganisms can be inhibitory to alcoholic or malolactic fermentation (MLF), either through competition for nutrients or through the production of secondary metabolites. In addition, simultaneous alcoholic and malolactic fermentation are increasingly being used to more efficiently manage scheduling in the winery. The interactions of different microorganisms with the grape juice environment both individually and as a community, and how those interactions shape fermentation performance outcomes, are key areas of focus for this work.

Overcoming MLF sensitivity to SO_2

In an effort to improve MLF reliability, the MLF performance of *Oenococcus oeni* strains in model wines and in white wines with limiting conditions was investigated. The intrinsic sensitivity of *O. oeni* to SO_2 was confirmed, a characteristic which can restrict its ability to conduct MLF in wines with moderate to high SO_2 content. Further, investigation of the MLF performance of two commercial malolactic starter cultures highlighted the critical importance of starter culture acclimatisation on the success or failure of MLF induction in difficult wine conditions. After direct inoculation of non-acclimatised starter cultures into 2018 vintage Chardonnay wine, both strains rapidly died off and failed to induce MLF. However, one strain was capable of MLF induction following acclimatisation to the wine conditions. Investigations are continuing to identify acclimatisation steps that enhance the performance of malolactic starter cultures in challenging white wine conditions.

Production of SO_2 by wine yeast

Concentrations of SO_2 in musts can vary considerably due to additions in the vineyard and winery, but a second major potential source of SO_2 can be the yeast used to undertake alcoholic fermentation. This can be inhibitory to MLF conducted post-alcoholic fermentation but also to *O. oeni* when simultaneous MLF is initiated. The yeast-derived SO_2 works additively with earlier additions. To better facilitate SO_2 management, the SO_2 contribution of 96 different *S. cerevisiae* wine yeasts to final total SO_2 concentration was evaluated following fermentation of Chardonnay juice containing 40 mg/L total SO_2. The yeasts' capacity to produce SO_2 varied dramatically, with most strains contributing only incrementally to total SO_2. However, four strains were found to double the initial SO_2 concentration, and in the most extreme case yeast-derived SO_2 contributed an additional 150 mg/L above the initial must concentration. The use of such yeasts would essentially make MLF impossible in the wines produced using them.

Interspecies microbial interactions during fermentation

With yeast species that require co-inoculation with *S. cerevisiae* becoming available on the market, there is the potential for antagonistic or beneficial interactions to occur. Yeasts such as *Metschnikowia pulcherrima* and *Torulaspora delbrueckii* can be added prior to addition of *S. cerevisiae*. There is evidence that nutrient competition can exist between *Saccharomyces* and non-*Saccharomyces* yeasts. Co-inoculation of *O. oeni* generates an added level of complexity. In work initiated this year the project team has begun to explore the extent of these interactions, whether they are strain-dependent and what are the underlying genetic factors contributing to successful co-fermentations.

Management and optimisation of the AWRI Wine Microorganism Culture 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 to the AWMCC from wineries and researchers across Australia have developed a repository that houses the Australian wine industry's microbial germplasm heritage. The AWMCC currently holds more than 10,500 yeasts, more than 1,400 bacterial strains and two yeast genome deletion libraries containing a further 6,000 strains. An electronic database is used to record information about each strain and to manage their movement (deposition and supply) and intellectual property. 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.

Identification, storage and distribution of microbial strains

In 2017/2018, 489 yeast and bacterial strains were submitted to the AWMCC from researchers and wineries, bringing the total in the collection to approximately 18,500. All strains submitted were checked for purity, had their identity determined and were placed into cryogenic storage at -80°C. The AWMCC holds 7,200 yeasts isolated from Australian ferments as part of the AWRI's bioprospecting project. During the year, the AWMCC distributed 377 microbial samples from cryogenic stocks. The collection's primary -80°C freezer was upgraded and a PIXL automated colony picking robot was installed. This instrument enables high throughput selection of yeast and bacterial colonies from agar for downstream analysis.

Objective measures of quality and provenance in Australian vineyards

Background

This project aims to assess differences between premium quality grades of Shiraz fruit and wine from vineyards within the Barossa Valley. The purpose is to establish chemical and spectral indicators which define different vineyard grades. The primary output of the study will be the determination of key chemical indicators associated with quality rating and wine style in premium Shiraz, and how they vary by quality grade and region. Secondary objectives are to identify vineyard or winery management options for shifting lower grades to premium grades, and for reducing the cost of producing premium grapes.

Predicting wine quality grade from grape-based measurements

The initial goal of this study was to apply a limited set of analyses to grape samples sourced across two premium Shiraz quality grades to attempt to identify objective chemical measures which could delineate them. Determining the relevance of within-vineyard variability or relative homogeneity as a predictor of quality was an additional research goal. The initial dataset incorporated pre-vintage grade assignments, and using these it was found that the quality grades could not be

distinguished by chemical measures. What was clearly evident from the pre-vintage analysis was that some vineyards were highly variable, with certain analyses showing as wide a range as previously observed across growing regions. Post-vintage, the final quality grade was assigned retrospectively, based on sensory assessment of wines by the producer. The final quality grades spanned four categories rather than the initial two assigned pre-vintage and were: 1 (highest quality), 1.5, 2, and 3 (lowest quality). Using multivariate statistics, only grade 3 could be successfully separated from the better quality streams. Grape-based measures which were important predictors of grade 3 were high total (homogenate) tannin, low total anthocyanin, high °Brix and high nitrogen measures including ammonia, alpha-amino nitrogen and certain amino acids. Interestingly, when small-scale ferment information was included in the model, it was found that grade 3 grapes produced wines higher in volatile acidity and lower in certain esters. Non-targeted spectra from homogenates and juice were also used to develop multivariate models. It was found that mid infrared spectra could be successfully used to discriminate grade 3 grapes. The preliminary work showed that objective measures were of use only to identify parcels of fruit which met quality targets based on vineyard assessment, but which lacked the necessary chemical composition to reach the expected wine quality grade. Ongoing work is looking more deeply at the question of vineyard variability, as well as seeking to better understand why particular vineyards fail to meet quality targets.

Defining the sensory attributes of premium Shiraz wines

Fruit from the premium Shiraz vineyards used for the grape objective measures study was kept as separate parcels in the winery, and commercial wines were prepared from each using older oak barrels to minimise oak effects on wine flavour and aroma. These commercial wines were then graded by a winemaker panel, and put through descriptive sensory analysis. Twenty-six attributes were assigned which could clearly describe the wines, and then multivariate statistical analysis of the results was performed. As for the objective chemical data in grapes, it was found that wines of grade 3 could be successfully distinguished from higher grades (1, 1.5 and 2) by their sensory attributes. Generally, grade 3 wines were lower in the attributes 'opacity', 'purple colour', 'dark fruit' aroma, 'vanilla'/'chocolate' aroma, 'woody' aroma, 'dark fruit' flavour, 'vanilla'/'chocolate' flavour, 'woody' flavour and 'viscosity' than higher quality grades. Grade 3 wines also had higher brown colour, 'tinned vegetable' aroma, 'drain' (reductive) aroma, 'stalky' aroma and 'red fruit' flavour. Using the grape data to predict wine sensory attributes, it was found that grape nitrogen measures, including certain key amino acids, were more important than other grape measures in defining the sensory attributes relevant to the study, and were better predictors of final quality grade. This points to nitrogen management in the vineyard as being critical to ensure wine quality outcomes are maintained, particularly in premium categories.

Digital solutions for grape quality measurement and management

Background

Currently, subjective (visual) methods are used to quantify grape condition at the weighbridge. The development of a process to objectively measure bunch rot and matter other than grapes (MOG) would provide greater transparency of the assessment process and help prevent the production of poor quality wine. Commercially available Visible-NIR hyperspectral imaging systems will be used at the weighbridge to provide objective data on the degree of infection by fungal rots and subsequent deterioration of fruit quality. The project will provide viticulturists and winemakers with tools to help optimise grape production towards desired quality targets, preferred wine styles and premium price points. This project is funded by Wine Australia and the Australian Government Department of Agriculture and Water Resources as part of its Rural R&D for Profit program.

Assessment of *Botrytis* in berries

Hyperspectral imaging is an emerging technique used in food manufacture and so far has mainly been used in the wine industry for assessing vineyard variability through aerial imaging. Individual berries offer the simplest system as proof of principle for hyperspectral imaging of *Botrytis*. Figure 13 shows an RGB (red, green and blue) image and a false colour overlay of individual berries where the *Botrytis* infection has been identified. In this case the image analysis system was trained using Colombard berries grown in the Riverland that were either clean or infected with *Botrytis* in the laboratory, and was then able to identify and discriminate between Adelaide Hills Sauvignon Blanc berries that were clean or had a wild *Botrytis* infection. The hyperspectral imaging could also easily identify matter other than grapes. Analysis of the hyperspectral images of individual berries was also able to discriminate damaged *Botrytis*-infected berries from healthy damaged berries, shrivelled berries from sound berries and berries infected with sour rot from berries infected with *Botrytis*. The small mis-identified areas on the Sauvignon Blanc berries are likely the consequence of reflection from shiny berry skins. This highlights one of the challenges of this technique: the lighting is critical and needs to be set up so that it prevents shadows which can lead to false identification, while still avoiding reflections from the fruit surface.

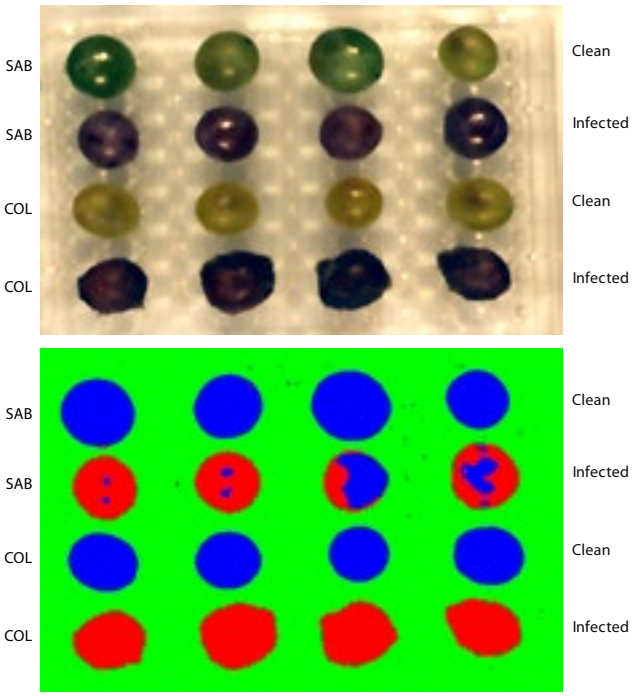

Figure 13. An image of Sauvignon Blanc (SAB) and Colombard (COL) grapes that were infected with *Botrytis* (infected) or healthy (clean). The upper image is the conventional RGB image and the lower image is the false colour overlay designating the clean (blue) and infected (red) portions of each berry.

Kate Cuijvers, Anthony Borneman

Understanding *Brettanomyces* and its adaptation to control measures

Background

Brettanomyces yeast can cause wine spoilage by producing 4-ethylphenol and 4-ethylguaiacol, which are responsible for 'phenolic', 'leather', 'sweaty' and 'medicinal' aromas (collectively often 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 potential market pressures to minimise levels of sulfur dioxide (SO_2) in wine, and augmented with rapid detection methods.

Sulfur dioxide tolerance of new industry isolates

The results of laboratory-scale directed evolution provided the first direct evidence that *Brettanomyces bruxellensis* strains have the capacity to adapt to the use of SO_2 as a control agent by increasing their level of SO_2 tolerance. However, a key question for the Australian wine industry is whether this may be happening in the field. Previous industry-based population surveys in the early 2000s had already shown that the strains of *Brettanomyces* with the highest levels of SO_2 resistance were most frequently isolated from Australian wineries (Curtin et al. 2008, Curtin et al. 2012). Since this original study was performed, Australian winemakers have become increasingly aware of the importance of SO_2 management for *Brettanomyces* spoilage control. However, these changing practices could potentially provide conditions that could promote the evolution of SO_2 tolerance.

Historical industry isolates were therefore sourced from the AWRI Wine Microorganism Culture Collection (including those isolated during the original Curtin et al. 2008 study), in addition to new industry isolates sourced from a commercial partner in 2016 and 2017. The strains were tested to determine if average levels of SO_2 resistance had changed over time (Figure 14). Strains isolated from 2000 to 2004 displayed levels of SO_2 resistance that broadly represented the range of tolerances observed in the original study. Strains isolated from 2010 to 2014 did not show a significant difference in their median SO_2 resistance, although there were a small number that displayed higher levels of SO_2 resistance than those seen in the 2000-2004 cohort. Interestingly, the 2016-2017 isolates, sourced from 16 different tank and barrel samples, displayed greater tolerance to SO_2, growing at concentrations significantly higher than those observed from the two previous cohorts. It should be noted that the 2016-2017 isolates were sourced from only two wine companies (although one is a multi-site producer). As such, they represent a small part of the overall industry; however, these preliminary data suggest that strains with significantly higher levels of SO_2 resistance are present in the field. While this situation will need to be monitored by further sampling, results from a recent AWRI survey of Australian bottled wine suggest that the existence of these SO_2-tolerant strains is not yet translating to elevated 4-ethylphenol levels in wines in the market.

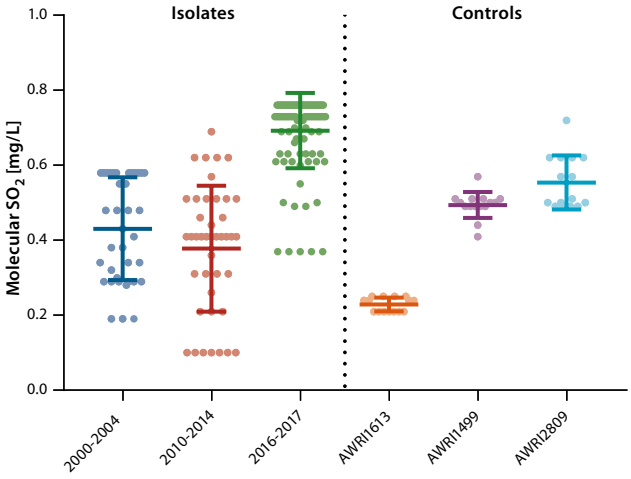

Figure 14. SO_2 tolerance of industry isolates of *Brettanomyces bruxellensis* sourced from wineries and/or the AWRI culture collection over three time periods. Maximum SO_2 tolerance was calculated for each isolate. Maximum SO_2 tolerances for AWRI1613, AWRI1499 and AWRI2809 (all isolated during the 2000-2004 period) are shown as controls.

Genetic transformation of *Brettanomyces*

Genetic transformation is a foundational technology that enables the comprehensive study of a species by applying a multitude of molecular biology tools, such as gene overexpression, gene deletion, incorporation of marker genes for competition experiments and tagging for visualisation or purification. Transformation has been available in *Saccharomyces cerevisiae* for more than 30 years, with much of the knowledge that has been generated for this species due to the early development of this technique. While, genetic transformation for *B rettanomyces bruxellensis* has been developed very recently (Miklenic et al. 2015, Schifferdecker et al. 2016), it has suffered from a very low efficiency that limited the scope of tools that could be developed. To address these shortcomings, a new set of gene transformation cassettes was developed that were specifically tailored for *B. bruxellensis*. While these new cassettes provide multiple drug markers, they also provide for increased transformation efficiencies. In addition to the standard drug-selections cassettes, constructs were created that enable *Brettanomyces* cells to be labelled with either green- or blue-fluorescent proteins. Cells that express these proteins glow when exposed to certain wavelengths of light and this enables the rapid identification and enumeration of these cells during fermentation (Figure 15).

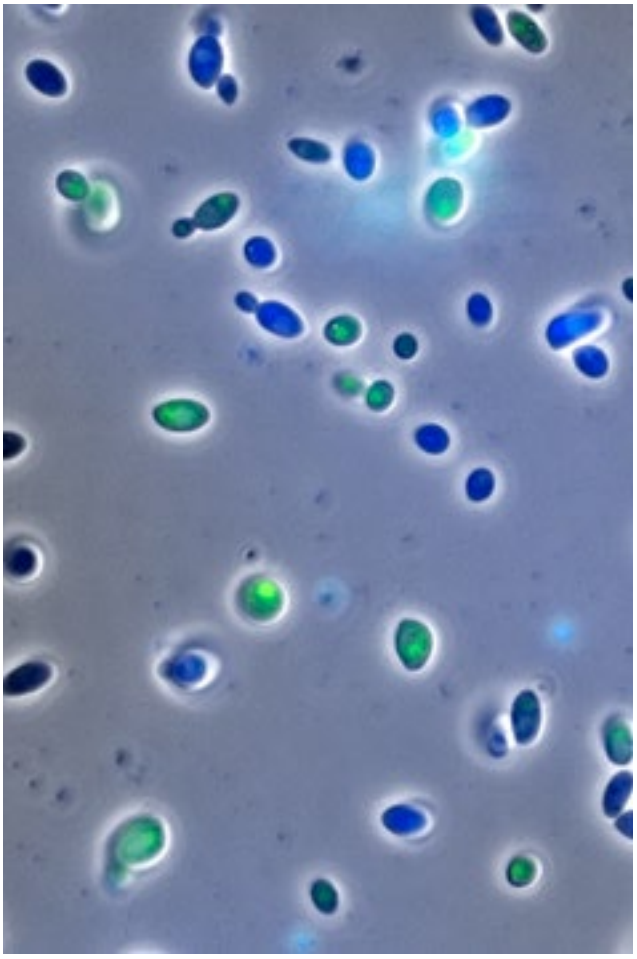

Figure 15. Microscopy of *Brettanomyces* cells tagged with either green- or blue- fluorescent proteins. A mixed culture (1:1 ratio) of AWRI2804 labelled with green fluorescent protein and AWRI2804 labelled with blue fluorescent protein was visualised with a 100x oil immersion objective. A superimposed image was created combining normal visualisation and green and blue fluorescence channels.

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Formation and fate of sulfur compounds associated with negative attributes in wine

Background

Volatile sulfur compounds (VSCs) can contribute both positive and negative attributes to wines, and it is therefore desirable to be able to control their concentrations in a winery environment. 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. 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 and maximise positive aromas.

Polysulfanes as precursors to hydrogen sulfide

Diorgano-polysulfanes are a class of putative precursors to hydrogen sulfide (H_2S) that may be produced during fermentation when thiols are oxidised in the presence of copper. They have the potential to act as latent sources of H_2S in finished wine. The stability of dicysteinyl-polysulfanes was investigated in model wine, as well as factors influencing the liberation of H_2S from these compounds. The stability of the polysulfanes was dependent both on the length of the sulfur-linking atoms (S_n) and on the presence of a reducing agent, such as SO_2 or ascorbic acid (Figure 16). Dicysteinyl-polysulfanes containing up to three sulfur-linking atoms were the most stable, with 84% of these polysulfanes remaining in solution after six months, compared to polysulfanes containing four or more sulfur-linking atoms that decomposed rapidly with only 26% remaining after six months. Importantly, SO_2 was associated with the rapid degradation of polysulfanes and subsequent liberation of H_2S.

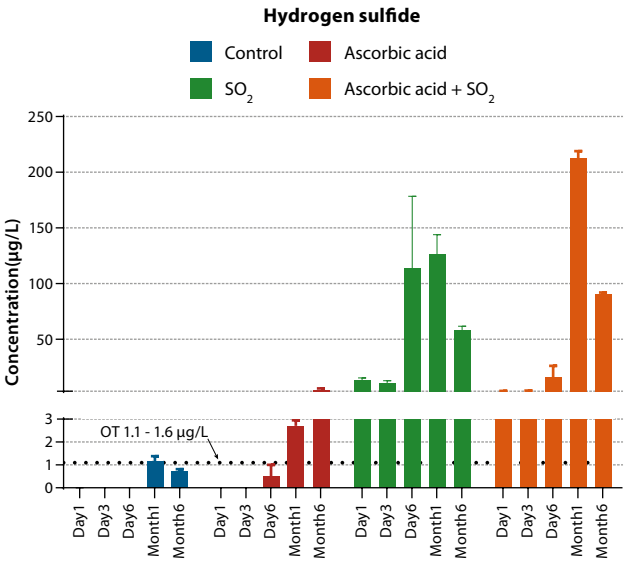

Figure 16. The liberation of H_2S from dicysteinyl polysulfanes in model wine treated with ascorbic acid, SO_2, and the combination of ascorbic acid and SO_2, measured over the course of six months. The odour threshold (OT) of H_2S at 1.1 to 1.6 µg/L is indicated by the dashed line parallel to the x-axis.

Improved understanding of the role of microbiological factors in VSC formation

The sulfur-containing amino acid methionine has been identified as a possible precursor of the undesirable VSCs methanethiol (MeSH) and methylthioacetate (MeSAc) in laboratory-scale fermentations. High concentrations of methionine in a synthetic grape juice resulted in increased formation of both MeSH and MeSAc at the end of fermentation. In addition, the formation of these undesirable sulfur compounds depended on the genetic make-up of the yeast used, and four of the genes that might be involved in the release of MeSAc and/or MeSH during fermentation were identified.

Commercial yeast manufacturers offer a wide range of yeast strains, but little information is known about their winemaking characteristics, particularly for red ferments. From a 2017 vintage trial of Grenache (50 kg) with six different wine strains, it was confirmed that one of the strains (AWRI 1776) produced high concentrations of MeSAc and MeSH. Formal sensory evaluation showed that wines with high concentrations of these undesirable sulfur compounds were rated highly in 'drain' (reductive) and 'tinned vegetable' aroma attributes. AWRI 1776 will be used to study in more detail the formation of MeSAc and MeSH under different winemaking conditions.

In the same Grenache wines, it was also confirmed that the choice of yeast strain has a great influence on the release of the fruity thiol 3-MH, with one of the yeast strains assessed (AWRI 2914) producing twice as much 3-MH as the other strains. Future work will assess whether this increased formation of 3-MH has any effect on the sensory characteristics of these red wines.

Smoke taint research and extension

Background

The AWRI, Agriculture Victoria, La Trobe University and Wine Victoria are collaborating on a project supported by Wine Australia through funding from the Australian Government Department of Agriculture and Water Resources as part of its Rural R&D for Profit program and the AWRI. The AWRI's primary role in the project is to evaluate a range of possible remedial management options and processing tools for dealing with smoke-affected grapes and wine. The AWRI has also continued to expand its database of 'background' levels of smoke taint compounds in non-smoke-exposed grapes and wines. In addition, the project team is collaborating with Agriculture Victoria and La Trobe University to evaluate a range of possible monitoring, preventative and remedial management options and tools for dealing with the variable composition of atmospheric smoke and associated risk of smoke taint in wine. The AWRI extension team also delivers support to industry personnel if they experience a smoke event and liaises with state government departments and regional organisations about scheduling and management of planned burns.

Smoke taint mitigation studies

Sensory dilution studies

A low to moderately smoke-affected 2016 Pinot Noir wine was diluted with unaffected Pinot Noir of a similar style, sourced from the same vintage and state, to investigate the practicality of using dilution to diminish or eliminate the sensory impact of smoke taint. The dilution series included no dilution (100% smoke-affected wine), dilutions of 1 in 2 (50% smoke-affected wine), 1 in 4 (25% smoke-affected wine), 1 in 8 (12.5% smoke-affected wine) and 1 in 16 (6.25% smoke affected wine). The unaffected Pinot Noir was also evaluated unadulterated (0% smoke-affected wine). A sensory panel rated 'smoke' aroma, 'smoke' flavour, 'overall fruit' aroma and 'overall fruit' flavour. Results showed significant differences ($p<0.05$ or lower) among wines for fruit and smoke-related attributes. Dilutions of smoke-affected wine with 75% or more unaffected wine resulted in smoke aroma and flavour scores not significantly different from the unaffected wine. When considering the concentrations of smoke glycosides, diluting the smoke-affected wine by a factor of four or more reduced their concentrations to what is typical of baseline levels for a Pinot Noir wine. This study highlighted that dilution of smoke-affected wine by an unaffected wine is a feasible option to diminish the sensory impact of smoke taint. However, this study was performed on a low to moderately smoke-tainted wine and additional studies will be needed to see if this result is more broadly applicable to different wines with varying levels of smoke taint.

Activated carbon

Fourteen types of activated carbon were investigated for their effectiveness in fining smoke-affected wine and juice. Carbon products that were more effective at removing smoke glycosides than free smoke volatiles were identified and the influence of contact time and the presence of ethanol versus sugar was investigated. Carbon was less effective at removing smoke glycosides and volatile phenols in red wine than in juice and preliminary investigations suggest this may be due to pigments and tannins in the wine rather than ethanol. Investigations are underway to characterise differences in the activated carbon products which may explain differences in their removal efficiencies (e.g. surface characteristics such as zeta potential). Studies to date have been largely limited to red juice and wine due to the limited availability of smoke-affected white juice and wine; however, with the latter now having been sourced, additional studies will commence shortly.

Glycosidases

The ability of six commercially available glycosidase enzymes to cleave smoke glycosides in smoke-affected juice and wine was investigated under various temperatures, contact times and dosage levels. In Pinot Noir wine, all glycosidases effectively cleaved the gentiobiosides; however, there was no subsequent increase in free smoke volatile phenols, a result which requires further exploration. The elevated sugar levels in juice inhibit the action of the glycosidases, so their use is best suited to wines that have completed fermentation. Glycosidase experiments on smoke-affected Cabernet Sauvignon wines from the USA have commenced.

Julie Culbert, Mark Krstic

Future studies will focus on the sensory impact of glycosidase treatment and whether this is a viable option for reducing smoke taint in wine, or whether it needs to be combined with other treatments such as fining with activated carbon.

Sourcing smoke-affected juice and wine

Fortunately for industry there were very few incidents of smoke affecting Australian vineyards in 2017; however, this meant that obtaining smoke-affected grape and wine samples for mitigation and sensory studies was a challenge. In February 2018, NSW experienced a bushfire caused by a storm event, resulting in several vineyards being affected by smoke. This provided the opportunity to source smoke-affected fruit (Sauvignon Blanc, Chardonnay, Riesling, Pinot Noir) for the project. Two smoke-affected blocks (Chardonnay and Pinot Noir) were surveyed to investigate the variation of levels of smoke taint compounds in fruit sampled across the vineyard. Smoke-affected juice from Riesling, Sauvignon Blanc and two clones of Chardonnay was sourced and two wines (Sauvignon Blanc and Pinot Noir) were produced from smoke-affected fruit. In addition, smoke-affected Cabernet Sauvignon wines were sourced from California. Smoke-affected juice and wine samples will be used in mitigation and sensory studies.

Baseline study

The AWRI's survey of baseline concentrations of volatile phenols and phenolic glycosides in non-smoke-exposed grapes and wines was completed at the end of 2017. The 'background survey database' now includes data for 12 varieties from more than 500 grape samples acquired from 23 regions across Australia. The database contains background levels for the white varieties Chardonnay, Pinot Gris/Grigio, Riesling, Sauvignon Blanc and Semillon, and the red varieties Cabernet Sauvignon, Grenache, Mataro/Mourvèdre, Merlot, Pinot Noir, Sangiovese and Shiraz.

The database is used by AWRI helpdesk staff to aid with interpretation of the results of AWRI Commercial Services' Smoke Taint Panel analysis. Interpretation involves comparing the Smoke Taint Panel results with those from the background survey database for the particular variety analysed.

Outreach activities

AWRI staff visited NSW in February 2018 to present an information and sensory evaluation session on smoke taint in response to a regional bushfire event. There has also been regular contact with wineries in California affected by bushfire smoke to provide technical expertise and diagnostic support, and to access smoke-affected wines. The AWRI has supported Wine Victoria, the Victorian Department of Environment, Land, Water and Planning and growers who were likely to be affected by smoke from planned burns to discuss management options.

Environment, sustainability and natural capital

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 grapegrowing across Australia. 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 adapt to the challenges of a variable climate; to make the most of the grapevine clonal resources available; to develop tools to verify the origin of Australian wines; and to improve management of pests and diseases.

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Managing the impact of vintage advancement and compression

Background

Vintage compression places significant stress on harvest and processing logistics and capacity. However, the contribution to this phenomenon of management practices (e.g. improved irrigation or pruning), has not been separated from the effect of higher temperatures. In addition, trends in fruit maturity parameters other than sugar accumulation need to be investigated, as does the balance between titratable acidity and pH with sugar concentration. An important symptom of vintage compression is delays in harvesting fruit and resulting high sugar/alcohol concentrations. Increases in grape sugar concentrations can be driven by the import of sugar from the vine, or by berry dehydration. Dehydration also results in a loss in yield, with a significant impact on vineyard profitability. A better understanding of these factors will assist with both winery and vineyard management decisions.

Can dilution of grape must address the effects of vintage compression without a loss of wine quality?

Vintage advancement and compression can result in the intake of fruit at higher sugar levels, due either to rapid ripening rates or the lack of resources to harvest fruit in the required timeframe. A study was undertaken with Barossa Shiraz to compare earlier harvesting (at 13.5, 14.5 and 15.5°Baume) versus dilution (lowering of grape must to 13.5 and 14.5°Baume) as potential approaches to achieve lower alcohol wines with positive sensory characteristics. Dilution was conducted either via the direct addition of water, or by running off juice and replacing it with water. It was found that dilution reduced wine tannin and colour independently of the mode of dilution. However, diluted wines had consistently higher tannin and colour than wines made from early-harvested fruit at an equivalent wine alcohol concentration. Sensory analysis showed that the wines could chiefly be defined by differences in 'dark fruit' aroma/flavour, hotness, viscosity and opacity. The 15.5°Baume wines were all rated higher in these attributes. These attributes were reduced in wines with lower alcohol, with the earliest harvest (13.5°Baume) rated lowest for all. The results showed that lowering must sugar to 13.5°Baume using dilution was more beneficial for both colour and sensory outcomes than earlier harvest, and the mode of dilution had little impact.

Supporting the sustainability of grape and wine businesses and Australia's sustainability credentials

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 AV, WFA and Wine Australia as the principal vehicle to convey the Australian wine industry's sustainability credentials. Entwine provides credentials that cover the fundamental components of sustainability (environmental, social and economic) 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.

Entwine best management practices survey

Benchmarking and continuous improvement of practices are highly valued aspects of sustainability programs. Being able to compare their performance against others allows members to view their businesses objectively, to think innovatively about alternative practices and to find efficiencies. In addition to benchmarking business metrics, last year for the first time Entwine vineyard members were also able to compare their management practices including soil, water and chemical management, biosecurity practices and business management. The survey has now been extended to wineries and, coupled with the information from the certified members whose practices are independently verified, the AWRI has gained data from more than 275 vineyards and wineries in 43 wine regions. Overall, members' performances were exceptional in agrochemical and water management, with improvement opportunities highlighted in biodiversity management and biosecurity systems.

Sustainability and business resilience

Last year the AWRI engaged with members of Entwine Australia to identify and describe the unique features of sustainable Australian wine-grape vineyard businesses. Thirty Entwine vineyard members provided information about their businesses, and this was combined with the data supplied annually by members to investigate the relationship between environmental performance and business resilience. The study found significant links between low energy use and low production costs, as well as between less and more efficient irrigation use and lower yields. Low energy users also produced grapes with a significantly lower emissions intensity, were more likely to graze sheep in the vineyard and were more likely to have an area of their property dedicated to the enhancement of biodiversity. Entwine members' vineyards that used less energy also demonstrated other positive attributes related to their environmental impact, economic performance and social awareness. Overall, Entwine members had a strong sense of social awareness, citing the ability to communicate their credentials externally as a valuable part of their membership.

Collectively, the survey responses suggest that vineyard energy use may be a useful quantitative indicator of overall sustainability, with low energy users more likely to be more sustainable than high energy users. This relationship will be investigated in a new project commencing next year that aims to identify appropriate financial metrics of sustainability. It is anticipated that the inclusion of economic indicators in Entwine's business metrics will further enhance the benchmarking capability of the program.

Global review of sustainability

Throughout 2017, the AWRI and the MVGWTA collaborated to develop a single national sustainability program – one that is simple, efficient, inexpensive and can deliver tangible benefits to all Australian vineyards and wineries. The proposed program strongly considered and sought to address the two major weaknesses of the grape and wine sector's current sustainability arrangements: the fragmentation of the existing framework and the lack of integration with industry marketing programs. The proposed solution was presented to Wine Australia, WFA and AV in April 2017, and received in-principle support.

Having made this positive progress, all five bodies jointly agreed that conducting a holistic independent review of the current global sustainability landscape would be beneficial. The goal of the review was to ensure that the proposed new program provides Australian grape and wine producers with the ability to exceed current global sustainability standards and to identify any alternative models worthy of consideration. An independent review of Australian wine's place in the global sustainability landscape was undertaken between mid-September and mid-December 2017 and included 65 interviews with independent growers, regional associations, international buying managers, national bodies and marketing and finance executives both in Australia and overseas. Three key recommendations from the review were:

1. The Australian wine sector should proceed with implementation of a single National Sustainability Program (NSP) based on the existing Sustainable Australia Winegrowing and Entwine resources, supported by robust verification services.

2. The NSP should be established under formal joint ownership of all the national industry bodies.

3. Sustainability should be integrated into all global marketing activity undertaken by the Australian wine sector. In particular, Wine Australia should increase the profile of sustainability in its promotional activities.

A business plan, including governance structures, milestones and outcomes, future funding requirements, marketing and auditing was developed and approved by AV and WFA. The four organisations AV, WFA, Wine Australia and the AWRI are working on an implementation plan to take effect in 2018/2019.

Characterising genomic diversity in Australia's grapevine germplasm

Background

The AWRI is engaged in two collaborative projects that study 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.

Understanding genetic variation in Chardonnay and Shiraz

A high-quality, diploid-phased Chardonnay genome assembly has been completed and, combined with re-sequencing data from 15 different commercial Chardonnay clones, was used to assess grapevine clonal diversity. It was possible to detect instances of differential inheritance from the Pinot Noir and Gouais Blanc parents of Chardonnay. Expanded gene families involved in wax biosynthesis were identified showing how gene expansion has enriched the Chardonnay genome for both redundancy and functionality. Mapping of clonal genetic variation revealed the breadth of nucleotide variation that has accumulated during the long-term asexual propagation of this woody plant species. However, most surprisingly, the patterns of nucleotide variation present in the Chardonnay genome were consistent with high levels of inbreeding and revealed that the two parents of Chardonnay, Gouais Blanc and Pinot Noir, share an extremely high degree of kinship that is not inconsistent with a direct parent-offspring relationship.

Evaluation of Shiraz clonal genetic diversity was the specific aim of the AWRI's contribution to a collaborative project *Clones for climate change,* led by SARDI. To this end, seven Australian-selected clones and three imported clones were compared using a whole genome sequencing approach. In the absence of a pre-existing reference genome for Shiraz, one was created, and inter-clonal genetic variation was determined through comparison to this reference. This analysis showed that the Australian-selected clonal material was genetically distinct from more recently imported Shiraz clones, forming a distinct group, but that genetic diversity within the group of Australian-isolated Shiraz was low.

Marlize Bekker, Martin Day

Defining regional variability and uniqueness of premium Australian Shiraz

Background

This project is part of a collaborative study with Charles Sturt University. The aim is to define sensory attributes of Shiraz wines from multiple regions that contribute to distinctive regional character, and to provide objective quality markers for both grapes and wine for future use in vineyard and winery assessment.

Sensory profiles of Shiraz wines that relate to regional and sub-regional differences

Commercially produced premium Shiraz wines, mainly sourced from single vineyards, were selected from the Barossa Valley, McLaren Vale, Heathcote, Yarra Valley, Canberra District and the Hunter Valley, and winemakers from each region assessed the wines from that region using the Pivot© Profile sensory assessment method. More than 70 winemakers were involved. This method allows a two-dimensional map to be produced showing the similarities and differences among the wines, overlaid with sensory descriptors used by the tasters.

For each of the regions studied, there were marked differences among the wines, with cluster analysis allowing groups of wines within each region with similar sensory properties to be identified. Descriptors such as 'mint', 'herbal', 'jammy', 'dark fruit', 'red fruit', 'spice'/'pepper', 'oak', 'concentration'/ 'weight' and 'tannin' separated the wines. Some regions had distinctive descriptors applied, although, as expected, there was a degree of commonality.

Wines from each region were then selected based on statistical criteria, to allow characterisation of representative wines from all the regions. A set of 22 wines that represented the sensory differences of wines from the six regions was then characterised by the AWRI's sensory descriptive analysis panel, to provide a detailed profile of each wine, with the intensity of defined attributes rated in replicate by the judges. There was good separation of the wines on the basis of region. There were important differences among the wines in 'mint', 'stalky' and 'pepper' attributes, with 'dried fruit' and colour descriptors also differing greatly. The sensory data will be related to chemical compositional results. A Pivot© Profile assessment was also completed on these wines using a separate panel of technically trained AWRI staff, which provides further information on the reliability and validity of this rapid method.

The study will allow definition of attributes that separate wines from the regions, allow the compounds driving the regional sensory differences to be identified and provide the basis for further investigations of the causes of these differences.

Sensory assessments by wine trade members

Sets of ultra-premium Australian Shiraz wines, selected on the basis of displaying regionally distinct sensory properties, were assessed by groups of wine trade participants at events held by Wine Australia in New York and Hong Kong. This allowed further evaluation of the Pivot© Profile method and examination of sensory differences among Australian Shiraz wines, benchmarked against international styles. The results from these tastings will be related to those provided by a group of international sommeliers and Australian winemakers earlier in the project.

Development of tools to verify origin and varietal nature of wines

Background

Wine is periodically the subject of substitution or counterfeiting. This project aims to protect the reputation of Australian wine by developing a robust way to determine the provenance of an unknown wine sample using several isotope ratios and a matrix of elemental concentrations. The initial promising results using strontium isotope ratios have been improved by project partners at CSIRO, with the development and validation of new methods for the isotope ratios of boron, lithium and lead.

Differentiation of Australian wines

Statistical analysis of data from 60 wines from Australia and overseas was carried out. The discriminating power of trace elements was much lower than that of isotope ratios. Using just isotope ratios of boron, lead, oxygen and strontium, Australian wines were separated from non-Australian wines (Figure 17) and linear discriminant analysis was 98% successful in correctly classifying the wines into the non-Australian wine group or the three regions that make up the Australian group, with just one misclassification.

For these parameters to be considered useful in statistical models, it was important to assess their variability across different vintages and different grape varieties. Vertical series spanning across ten years of three different single-vineyard wines from Margaret River, Hunter Valley and Clare Valley were analysed. Low variability was observed for isotope ratios of lead (maximum 2.4%) and strontium (maximum 0.13%), whereas oxygen-18 showed an increased variability (approximately 30%), as expected, in line with data published in Europe. A similar variability was seen for boron-11. To test the effect of grape variety, two sets of seven varieties grown on a single block, one in the Barossa and one in the Riverland, were harvested and fermented before analysis. The variability of isotope ratios due to variety showed a similar pattern to the vintage variation.

Bioprospecting Australian microbial genetic diversity

Background

Differences in wine microbiota are likely to be an important aspect of terroir, particularly where spontaneous fermentations are performed. Traditional microbiological research has shown that both vineyards and uninoculated wine 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 a complex concept as terroir has limited activity in this area. This lack of information is also an impediment to the exploitation of native microbial germplasm and spontaneous fermentation by the Australian wine industry. Recent advances in culture-independent microbiological techniques such as metagenomics (genomic sequencing of mixed microbial communities) can address these issues by efficiently providing detailed identification on the species, and their proportions, in complex microbial mixtures.

Microbial composition of wild ferments

More than 2,000 samples from uninoculated ferments have been collected from 34 wineries around Australia across the 2016-2018 vintages. In addition to these samples, 7,200 yeast isolates (*Saccharomyces* and non-*Saccharomyces*) have been added to the AWRI Wine Microorganism Culture Collection. These provide an important reservoir of Australian wine microbial biodiversity for future bioprospecting studies.

Analysis of samples from the 2016 and 2017 vintages showed that there is significant diversity in the species of fungi and yeast present in uninoculated ferments across Australia and that individual ferments can have markedly different microbial communities. Whole genome sequencing of hundreds of *Saccharomyces cerevisiae* strains isolated from these ferments found that uninoculated ferments also harbour significant diversity of this species. Interestingly, it appears that commercial strains do not generally dominate these fermentations, even when wineries are performing conventional ferments at the same location. 'Wild' and/or 'feral' (once domesticated) strains of *S. cerevisiae* are therefore responsible for carrying out the bulk of these fermentations, with many strains being specific to particular wineries and also appearing across multiple vintages.

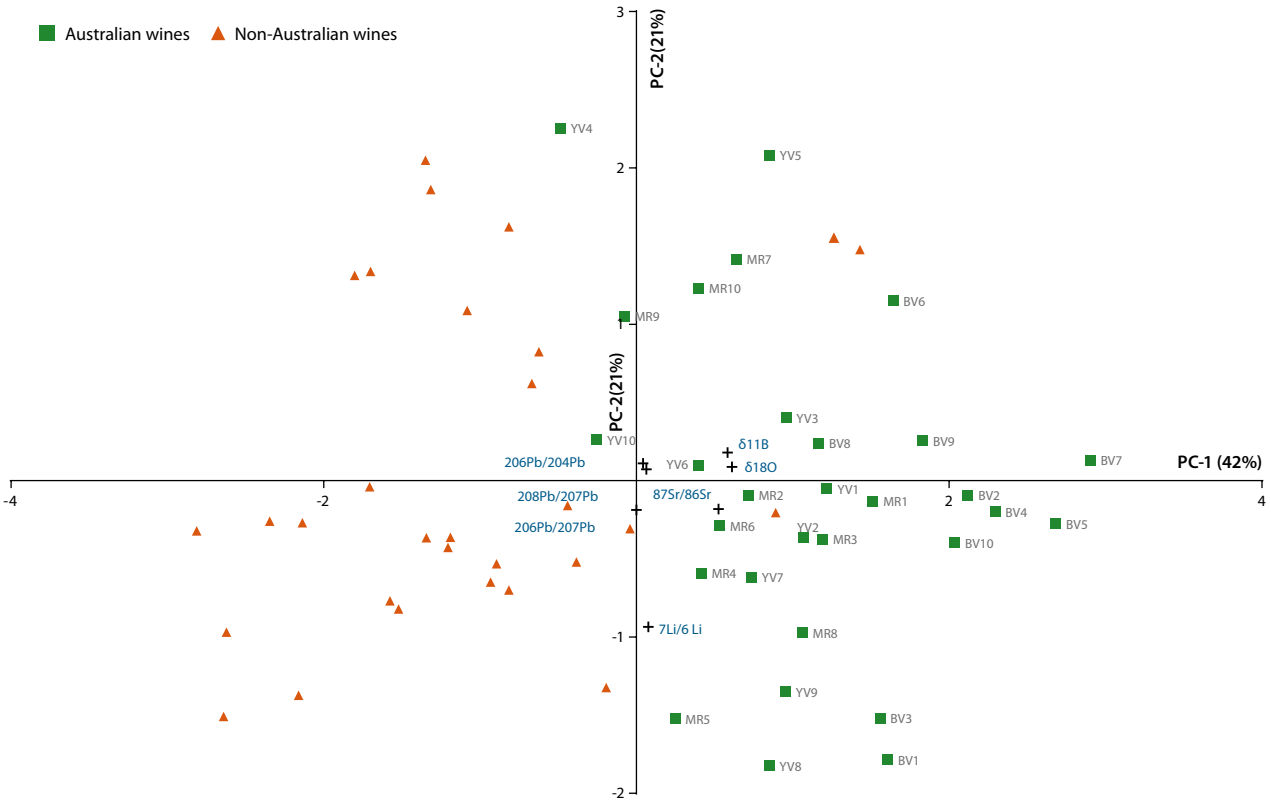


Figure 17. Separation of 30 Australian and 30 non-Australian wines achieved using seven isotope ratios

Rotundone and its role in defining terroir in iconic Australian cool climate 'peppery' Shiraz

Background

Rotundone is the potent, grape-derived compound responsible for 'black pepper' aroma in wine. Previous research demonstrated that the Grampians and Pyrenees regions in Victoria can produce wines with substantially higher levels of rotundone than other Shiraz-producing regions such as Barossa and McLaren Vale. Patterns of rotundone variation appear to be stable within an individual vineyard across different growing seasons. A new collaborative project with CSIRO commenced in 2017, focusing on premium cool climate Shiraz and aiming to define features at the within-vineyard scale that contribute to rotundone formation. The research seeks to identify genetic and biophysical factors responsible for large differences in rotundone concentrations at harvest, and will provide insights into how the rotundone element of terroir, and grape aroma in general, may be influenced and managed at a range of scales.

Grape aroma compounds in cool climate Shiraz

The first high resolution grape aroma map for a Shiraz vineyard in the Adelaide Hills showed significant berry rotundone concentrations ranging from 10 to 530 ng/kg in vintage 2017. It also demonstrated substantial within-vineyard variability, a clear spatial structure of rotundone (as observed for other sites in different regions) and for the first time, a clear spatial structure of rotundone's precursor α-guaiene. No clone effect was observed for rotundone in grapes; that is, the absolute grape concentration and spatial patterns were independent of the two Shiraz clones present in this block.

Analysis of sesquiterpenes in grapes from vineyards in Victoria and the Adelaide Hills also established that it is the biosynthesis of the precursor α-guaiene which is key to the subsequent formation of the rotundone in grapes. That is, availability of α-guaiene appears to be the driver of grape rotundone at harvest, not the oxidation reaction from α-guaiene to rotundone. The results confirm that both α-guaiene and rotundone concentrations in grapes are initially very low and stable from veraison onwards and only significantly increase close to harvest. In addition, the timing of the onset of α-guaiene and rotundone formation in grapes was very well synchronised in vintage 2017 and occurred at the same time for both compounds irrespective of final rotundone concentrations. This means that it is plausible that a singular environmental event triggers biosynthesis of α-guaiene across an entire vineyard.

Understanding the basis of agrochemical resistance in biotrophic grapevine pathogens

Background

Grapevine diseases caused by fungal/oomycete pathogens such as *Botrytis cinerea, Erysiphe necator* (powdery mildew) and *Plasmopara viticola* (downy mildew) are responsible for significant crop losses. Current control measures rely on spraying with agrochemicals; however, the development of resistance to agrochemicals is an ever-increasing problem in agriculture, and one from which the Australian wine sector is not immune.

Improving understanding of agrochemical resistance in powdery mildew

Results of a recent SARDI/AWRI collaboration showed that there is widespread prevalence of known resistance mutations to many commonly used agrochemicals in both powdery and downy mildew. However, links between the presence of the mutations and the loss of field efficacy for key agrochemicals are still not fully understood. The AWRI is applying next-generation sequencing to map the prevalence of known resistance mutations in laboratory-based populations of powdery mildew that are being studied by SARDI researchers. These experiments aim to provide information regarding the relationship of the mutations with the development of field-relevant levels of agrochemical resistance, such that a genetic test can be used to assist growers to make decisions on agrochemical use.

Genetic basis for metalaxyl resistance in downy mildew

While the molecular basis of resistance is well known for many agrochemicals, there remain some for which targets are not known. This includes metalaxyl (the key control measure for downy mildew), for which field resistance is readily observed but the genetic cause is not known and therefore a genetic test for resistance is not available. Whole genome sequencing is being used to attempt to determine the genetic basis for metalaxyl resistance in downy mildew, providing the means to design a simple genetic test for the presence of field resistance.

Viticulture biosecurity support

Background

The AWRI delivers biosecurity management activities on behalf of AV. As a signatory to the Emergency Plant Pest Response Deed, AV 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.

Technical support

AWRI viticulture staff provided technical support to AV in meetings and activities of the Consultative Committee for Emergency Plant Pests and the National Management Group. They also provided secretariat services for two meetings of the National Viticulture Biosecurity Committee (NVBC). Following surveillance and confirmation of the presence of Grapevine Pinot Gris virus (GPGV) in NSW, SA and Victoria, the project team published a fact sheet and provided regular updates to industry. Two detections of brown marmorated stink bugs (BMSB) led to the compilation of technical information for the categorisation of this exotic pest. Industry updates about BMSB were provided through *eBulletins* and an 'Ask the AWRI' column in *Australian & New Zealand Grapegrower & Winemaker*. The project team also facilitated communications about these two exotic pest incursions to the table and drying grape industries and to the Vine Improvement and Vine Industry Nurseries Associations. The AWRI is also contributing to a new research project on GPGV.

National approach to grape phylloxera management

The project team provided project management to complete a DAWR-funded project, 'Desktop review: to inform a national approach to grape phylloxera management' and facilitated industry consultation sessions in WA, NSW, Tasmania and Victoria to gather feedback on the review. Together with feedback collected in SA, this information was incorporated into an updated version of the review and presented to the NVBC.

Foundational data and support services

The research, development and extension activities of the AWRI are underpinned by an efficient service capacity that provides and supports infrastructure; delivers research support and analytical services; manages governance, legal and financial affairs, information technology and workplace safety; and monitors trends in Australian wine composition and production practices.

Staff

Tadro Abbott, Melissa Aitchison, Sheridan Barter, Ida Batiancila (from 4 December 2017), Linda Bevin, Laura Bey, Eleanor Bilogrevic, Catherine Borneman, Mark Braybrook, Natalie Burgan, Dr Dimitra Capone (to 7 February 2018), Josh Clift (to 17 January 2018), Jorge Comahig (to 13 September 2017), Geoff Cowey, Alfons Cuijvers, Chris Day, Dr Zung Do (from 25 January 2018), Shiralee Dodd, Damian Espinase Nandorfy, Dr Leigh Francis, Josephine Giorgio-Ion, John Gledhill, Robyn Gleeson, Dr Nuredin Habili (from 1 January 2018), Jesse Hall, Prof. Markus Herderich, Kieran Hirlam, Dr Josh Hixson, Adam Holland, Leanne Hoxey, Dr Vilma Hysenaj, Dr Dan Johnson, Pauline Jorgensen, Ross Kolouch (7 August 2017 to 6 April 2018), Esther Kristianto (to 9 February 2018), Dr Mark Krstic, Jillian Lee, Dr Natoiya Lloyd, Brigitte Lynch, Jacinta McAskill, Bryan Newell, Dr Luca Nicolotti, Dr Simon Nordestgaard, Jennifer O'Mahony, Wes Pearson, Lisa Pisaniello (from 16 January 2018), Tim Reilly, Dr Amy Rinaldo, Ella Robinson, Marco Schoeman, Neil Scrimgeour, Dr Tracey Siebert, Pamela Solomon, Fang Tang, Dr Maryam Taraji (from 15 January 2018), Randell Taylor, Deborah Thornton-Wakeford, Heather Tosen, Kylee Watson, Dr Matthew Wheal, Dr Eric Wilkes, Dr Patricia Williamson, Qi Wu (from 1 January 2018), Amanda Ylia (from 16 January 2018).

Collaborators

AB Biotek (Dr Tony Balzan, Dr Anthony Heinrich, Dr Tina Tran); Australian Institute for Bioengineering and Nanotechnology (Dr Esteban Marcellin Saldana); Compusense, Canada (Ryan Corrick); CSIRO (Dr Ian Dry); Murdoch University (Assoc. Prof. Robert Trengove); Lion Nathan (Alexandra Merry); QVMAG (Claire Campbell, Richard Mulvaney, David Thurrowgood); SARDI (Dr Kathy Ophel-Keller); South Australian Health and Medical Research Institute (SAHMRI) (Prof. David Lynn, Dr Miriam Lynn); University of Adelaide (Stephen Clarke, Assoc. Prof. Paul Grbin); University of Melbourne (Prof. Ute Roessner, Prof. Malcolm McConville); University of Western Australia (Assoc. Prof. Michael Clarke).

Visiting researcher

Dr Marc Pignitter (University of Vienna, Austria).

Visiting student

Kimmo Siren (Institut fur Weinbau und Oenologie DLR Rheinpfalz, Germany).

Efficient administration

Background

The AWRI's management and administration is carried out by a dedicated team of specialists who work together to efficiently and effectively provide leadership, infrastructure, financial, human resources, legal, contract management, risk management, work health and safety, corporate governance and IT services across the organisation. The team's objective is to enable all AWRI staff to focus on their core capabilities to ensure that the organisation is able to meet its 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 AWRI activities.

Finance

Core activities included financial management; budgeting; and reporting to the AWRI's management, the AWRI Board, funding organisations (particularly Wine Australia) and various arms of government. Back office support was provided to other entities such as the Australian Wine Industry Technical Conference, Interwinery Analysis Group and Wine Innovation Cluster. The AWRI's diversified investment portfolio continued to generate an appropriate level of return, underpinning the organisation's ability to further invest in critical capabilities and activities to support the Australian grape and wine industry.

Human resources

Significant human resources efforts during the year related to the renewal of the internal Employment Agreement, which covers all AWRI staff. The voting process achieved a 91% participation rate with 98% of those voting approving the agreement, which came into effect in June 2018. The annual staff survey once again highlighted the AWRI's positive working environment, with 98% of respondents confirming that 'all things considered, the AWRI is a great place to work'. Themes which consistently contribute to this outcome include the diversity of work; the collaborative, productive and passionate workplace culture; engagement with industry; and professional development opportunities. Many of the AWRI's directors make a substantial contribution in this regard by nominating for their directorship fees to be made available for such activities, and their support is gratefully acknowledged.

Operations

Cost-effective custom-designed and manufactured engineering solutions were provided to support a range of AWRI projects, with recent examples including sparging equipment for pilot-scale fermentations, supporting infrastructure for new instrumentation and apparatus for assessment of wine closures. Broader activities involved developing solutions to space constraints faced across the AWRI's laboratory, office and storage environments.

Corporate governance and legal support

A key activity for the year was an application to the Australian Tax Office (ATO) for the AWRI to be recognised as an Approved Research Institute (ARI) and receive Deductible Gift Recipient status. Central to this application were amendments to the AWRI's constitution to include, among other aspects, the establishment and operation of a Research Fund and a Research Committee, as required of ARIs.

Kylee Watson, Pauline Jorgensen

The ATO recently approved this application, backdating the ARI status to July 2000. Other corporate governance activities included the successful conduct of electronic Board elections, ongoing contract administration, maintaining and updating the organisation's strategic and operational risk registers, general policy review and the planning and conduct of an incident simulation.

Information technology

This year saw the implementation of a number of significant further initiatives contained within the previously developed IT Strategic Plan – supported and enabled by the IT Strategic Reserve previously created by the AWRI Board. Particular emphasis was placed on expanding storage capabilities, enhancing virtual server infrastructure, strengthening back-up procedures and network security, and implementation of several platforms to enhance system monitoring, reporting and software deployment. Such enhancements continue to add considerable value to almost every aspect of the AWRI's operations.

Partnership to produce beer from 'shipwreck' yeast

A partnership between the AWRI, QVMAG and Lion Nathan saw a beer produced using the yeast isolated from beer bottles salvaged from the wreck of the *Sydney Cove*. The beer, known as 'The Wreck – Preservation Ale', was released to the public at several events in May 2018, and then made available for a limited time at selected venues around Australia. A press release announcing the beer in early May received extensive international coverage across multiple media channels, including print, online, radio and TV. Significant progress was also made in planning for a special release 750 mL format to coincide with Father's Day in September 2018.

Information and knowledge management

Background

Knowledge is at the core of the AWRI's operations, and therefore effective information and knowledge management (IKM) is essential for the AWRI's core business. This project provides a flexible and agile IKM environment, which supports innovation and excellence at the AWRI. This will be achieved through harmonisation of existing IKM platforms and the information they contain; the adoption of emerging IKM technologies and solutions; improving access and collaboration capabilities; and the optimisation of business processes through the use of automated workflows.

Implementation of SharePoint Online

The AWRI has used SharePoint 2007 as an intranet and collaboration system since 2008. The implementation of SharePoint Online (a cloud-based version of SharePoint) has delivered improved collaboration tools and more efficient work practices. It also allows staff and external collaborators to access files from any device that has internet access. The migration from SharePoint 2007 to SharePoint Online involved transferring files from network drives and SharePoint 2007 to the new platform as well as redevelopment of automated business workflows for professional development plans and leave requests. To identify customisations required to set up project and team collaboration sites, a series of business needs analysis workshops were conducted with key users. From that process, end-user and site administration training modules were developed to ensure users receive training and support in the use of the new system. An online portal for the AWRI Board to access Board papers is in development.

SharePoint Online is one of many tools offered in the Office 365 suite of products. Bundled in this suite is OneNote, an online 'notepad'. The Research Group is currently trialling the use of OneNote as an electronic laboratory notebook to replace paper-based notebooks.

Matthew Wheal, Bryan Newell

Commercial Services

Background

AWRI Commercial Services continues to serve an important role in the Australian grape and 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 pre-competitively funded research projects in applied areas and provides services to the broader agricultural sector and producers of other foods and beverages.

Laboratory services

The Commercial Services laboratories had another record-breaking year in terms of services provided, with the laboratories processing more than 25,000 samples for the first time, an increase of more than 6% from the previous year. This was underpinned by a continued increase in customer base, with 172 new customers being added for the year (compared with 148 new customers the previous year). This continued growth highlights the value placed by the Australian industry on the services offered, as well as the importance of a centralised accredited laboratory capable of supplying both highly specialised analytical technologies and more general analysis for smaller producers and those that need internationally recognised certificates of analysis.

New services

A major highlight for the year was finalisation of an agreement with the University of Adelaide to transfer the grapevine virus testing and elimination services previously provided by Waite Diagnostics to the AWRI. The services offered include testing for 12 grapevine viruses and phytoplasmas, and continue to be provided by the same personnel, including virologist Dr Nuredin Habili. Dr Habili has more than 20 years' experience working with plant viruses and has been involved in the research and development of the services provided. This represents a major addition to the range of services offered by the AWRI, particularly in the area of viticulture. It is also important for the continued health of the Australian wine industry, with only limited alternatives available nationally for testing of grapevine viruses and an increasing awareness of their potential impact and prevalence in Australian vineyards. In its first six months of operation within the AWRI, this new service saw a marked increase in sample numbers compared to recent years. Efforts are continuing to streamline the customer interface and increase the range of information and services provided.

Reflecting the diversification of many traditional winemaking regions into craft brewing and distilling activities, a range of analytical services for beer and spirits have also now been validated and added to current commercial offerings. These include microbiological testing, basic beer analysis, water testing and hops analysis. These services were showcased at the Australian Craft Brewers trade show and the Australian National Amateur Wine and Beer Show and highlight the synergies to be gained from the AWRI's long experience in beverage analysis.

Continual improvement

In a significant collaboration with Treasury Wine Estates (and with support from a number of other major wine industry partners) the laboratory services team validated an alternative method for measuring free and total SO_2 to the international ISO 17025 standard using a sequential analyser. The method, originally developed at the Wolf Blass winery, will replace the flow injection analysis technique used at the AWRI for more than a decade, and compares favourably with the reference methods for SO_2 analysis. The new method is capable of processing well over 100 free and total SO_2 measurements per day with little staff intervention.

The method and a summary of its validation data was published in the December 2017 issue of *AWRI Technical Review*. The laboratories have also added a new sequential analyser for enzymatic analysis. This instrument will allow higher throughput within the laboratory and provide increased redundancy to minimise the impact of equipment breakdowns on service provision.

The AWRI Ferment Simulator, which allows winemakers to track and predict the progress of ferments online, was upgraded to incorporate key enhancements suggested by users during 2017. These new functions were available for use during the 2018 vintage. The software is free for Australian users, and a range of new enhancements are already planned for next vintage. Options for partnering with potential web application partners to incorporate the Ferment Simulator into existing commercial enterprise management software platforms are currently being considered to extend the usability of the tool.

Providing confidence to industry

AWRI Commercial Services continues to provide proof-of-performance services to suppliers to ensure that their offerings to the Australian wine industry meet the expectation of the final users. During 2017/2018, trials were carried out on products including screw cap and technical closures, yeasts and winery hoses. One notable trial involved evaluation of the effectiveness of 14 commercial bentonite products, a trial which was supported by a number of wine producers and bentonite suppliers. The bentonite products were evaluated for their impact on wine colour, protein removal, metal transfer and sensory characteristics. The results highlighted significant differences among the performances of various bentonites and the amounts of some metals, such as lead and aluminium, that they contributed to wine. It has become apparent that bentonite is a major source of lead in many Australian wines and while the levels in wine are well below any risk to human health and Australian regulatory limits, this should still be monitored due to the limits in place in many export markets.

Leveraging information

Data mining continued of AWRI Commercial Services' large datasets from routine analysis of wines to gain a better understanding of Australian wine composition and to identify potential issues that could arise in wine markets. Commercial Services provided survey data to Wine Australia and the peak industry bodies on cyanide and ochratoxin A, which had been identified as being subject to new export restrictions in certain markets. The ability to quickly and efficiently provide such data gives Australian peak bodies and government a significant advantage in being able to respond to regulatory issues in export markets before they affect the export of Australian wine.

Research services

Background

Access to cutting-edge equipment and highly trained staff is essential for the excellent 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 specialised skills, such as organic chemical synthesis, advanced analytical chemistry or sensory analysis. This project ensures that appropriate equipment and expertise are available to support AWRI research.

Sensory analysis

The AWRI runs several types of sensory evaluation methods: an expert technical quality panel, trained sensory descriptive analysis, difference testing and consumer hedonic testing. During 2017/2018, the technical quality panel evaluated 210 wines, as well as numerous training samples and research trial wines in preliminary 'bench tastings'. In the same period 27 major descriptive analysis studies were completed using the AWRI's highly trained external sensory panel. For most of these projects, the judges rated the intensity of carefully selected appearance, aroma and flavour attributes over multiple replicated occasions. In addition, projective mapping (Napping) studies to characterise similarities and differences among a set of wines were carried out regularly.

The studies in 2017/2018 included a large project conducted in collaboration with SARDI assessing the effect of grapevine clone on wine flavour. Several studies assessing closure performance were completed, as well as projects assessing flavour contributions from yeast strains, novel bitter compounds, white wine texture, water addition and viticultural treatments. A consumer preference study was completed in Sydney to evaluate the degree of acceptance of white wines with added flavour precursors derived from grape skins.

Difference testing, generally using the method of triangle testing, is an important sensory technique commonly used to find if a treatment has had a perceptible effect on wine aroma or flavour. Approximately 60 AWRI staff have been screened and are qualified to perform this task, usually assessing two or three sets per session. More than 65 tests were completed 2017/2018.

A major achievement during the year was the recruitment and training of an additional 12 part-time panellists, meaning that capacity for running sensory tests has greatly increased. Improvements to computerised data acquisition and statistical analysis methods also increased productivity.

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. The confirmation of the purity of analytical standards used for quantification of key aroma compounds has been a focus in the past year.

Aroma compound analysis

High-tech analytical instruments, including gas chromatography-mass spectrometry (GC-MS) and liquid chromatography-mass spectrometry (LC-MS), are carefully maintained to ensure they are in optimal operational order and capable of being used continuously to give timely results. Accurate and precise 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 300 samples. Some of these analyses are also available on a fee-paying basis through AWRI Commercial Services. In this period, improvements to training and operating procedures streamlined methods, with newly recruited staff better able to look after instruments to achieve high quality data outcomes. Acquisition of two LC-MS instruments, used for thiol analysis as well as for quantification of smoke taint compounds, has taken the ability to schedule and run samples to a new level.

WIC 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.

2018 vintage

WIC Winemaking Services processed 392 (6-150 kg) ferments during the 2018 vintage. A further 72 ferments will be conducted using frozen fruit or juice between July and October 2018. The 2018 vintage commenced in late January, with the majority of fruit received between mid-February and late March. The last ferments, other than two extended maceration trials, were pressed on 30 April, four weeks earlier than 2017. The busiest week was mid-March, with approximately 100 batches of grapes processed and more than 220 active ferments. Grapes were sourced from all South Australian regions.

During the year, further investments in new stainless steel storage vessels increased the flexibility and capability of the services offered, allowing WIC Winemaking to secure a new client with regional-specific ferments planned for the next three to five years. An upgraded screw capper improved the consistency of closure application during bottling.

Metabolomics and bioinformatics service platforms

Background

The AWRI established the South Australian node of Metabolomics Australia (Metabolomics SA) in 2008 as part of a national network with partners in WA, Victoria and Queensland. Metabolomics SA operates as a collaborative service platform that provides public and private researchers and industries with support, service and training as well as access to infrastructure and specialist expertise.

Metabolomics SA

In 2017/2018 Metabolomics SA successfully completed 91 jobs, with a total of 2,421 samples analysed, an increase in sample numbers of 30% compared to the previous financial year. Specifically, the number of samples analysed for external clients increased by 41%, which was reflected in a 46% increase in revenue. This excellent result was achieved despite two staff being on parental leave from February 2018.

Services were provided for researchers and industry working in the fields of food and beverages, agriculture, plant metabolomics and biomedical sciences. Collaborations with external researchers resulted in method development in the fields of lipidomics and biomedical sciences. One example is a collaboration established with Prof. David Lynn and Dr Miriam Lynn from SAHMRI for a project monitoring short-chain fatty acids (SCFAs) in biological extracts. Metabolomics SA contributed method development for the extraction and quantitation of SCFAs via GC-MS. An application for an NHMRC grant has been submitted by SAHMRI.

In 2017/2018 Metabolomics SA had two visitors: Kimmo Siren, a PhD student from Germany working on Riesling juice, and Dr Marc Pignitter, Assistant Professor from the University of Vienna, Austria. The collaboration allowed development of an LC-MS method for lipid profiling in grapeseed oil, with particular focus on triglyceride oxidation products.

Bioinformatics

New scripts and tools were developed to improve data processing workflows (data normality evaluation, equality of variance test, pairwise t test) and compound identification. R-based scripts were developed to extract LC-MS and LC-MS/MS spectra of standard compounds analysed. Additional coding efforts allowed translation of the obtained data into National Institute of Standards and Technology (NIST)-compatible files, so that the NIST search algorithm could be used to perform library matching and compound identification of key markers. A data processing workflow known as MStractor was implemented with Lobstahs, an R package for screening, annotation and putative identification of mass spectral features in lipid datasets.

Tracking trends in Australian wine composition and vineyard and winery practices

Background

It is important for the Australian wine sector to track how it is evolving – how common different production practices are and how wine composition is changing. This allows producers to compare their practices with their peers and helps organisations like the AWRI to choose relevant research and extension activities. This project addresses these goals through a five-yearly practices survey, aggregate analysis of chemical data from AWRI Commercial Services and other targeted activities.

AWRI Vineyard and Winery Practices Survey

In late 2016, the AWRI performed a large survey (691 responses) of Australian vineyard and winery practices. A presentation was made to the 2017 ASVO viticulture seminar, where it formed the basis for a panel discussion on topics including the use of destemming harvesters, recycle sprayers and precision viticulture. Presentations were also made to the 2017 Crush Symposium, to the 2018 Winery Engineering Association conference and as part of regional tasting sessions on red wine production techniques. Among many other findings, the survey emphasised the importance of cross-flow filtration and the increased adoption of flotation for juice clarification in the Australian wine industry. It also showed that carboxymethyl cellulose has only been adopted to a limited extent for cold stabilisation, with chilling being by far the dominant technique. Slides from the presentations given are available for download and the full survey report will be issued by the end of 2018.

Brettanomyces survey

The AWRI helpdesk has observed an increase in the number of queries about *Brettanomyces* yeast every year for the last five years. There was interest in finding out if this trend was translating to an increase in 4-ethylphenol (4EP, the main aroma marker compound for this spoilage yeast) in Australian wines and if it might be linked to increased SO_2 tolerance of strains currently being investigated in the research group. As such, a decision was made to revisit the *Brettanomyces* survey conducted by the AWRI in the 2000s. The original survey included commercially available bottled Cabernet Sauvignon wines from five regions across Australia over seven vintages, finishing with the 2005 vintage. That survey isolated and characterised any *Brettanomyces* sp. yeast present in the bottled wine and measured marker compounds including 4EP. The current update to the survey examined 91 wines from the 2015 vintage, from the same regions, providing a snapshot of the situation ten years later.

Maryam Taraji, Amanda Ylia, Luca Nicolotti

The mean concentration of 4EP in the 2015 wines tested was just 29 µg/L, even lower than levels reported in 2005 (Figure 18). The highest 4EP observed was 327 µg/L, which is below the sensory aroma threshold. Approximately 60% of the Australian wines tested contained 'not detectable' levels of 4EP. No viable *Brettanomyces* yeasts were isolated from any of the wines. These results suggest that the increased help-desk queries regarding *Brettanomyces* are not correlated with a higher mean 4EP concentration in bottled Australian wine. The increased query numbers could be linked to enquiries about new monitoring techniques or treatment options that have been adopted over the last five years, rather than any increased incidence of spoilage. While current research on *Brettanomyces* (presented elsewhere in this report) has provided some evidence of increased SO_2 tolerance of strains in some wineries, the survey results suggest that these strains are not yet having a widespread impact in Australian wineries, or that cases of viable *Brettanomyces* yeast are being treated more quickly and effectively during winemaking before production of 4EP, or that any badly affected wine is being identified earlier and not reaching the marketplace.

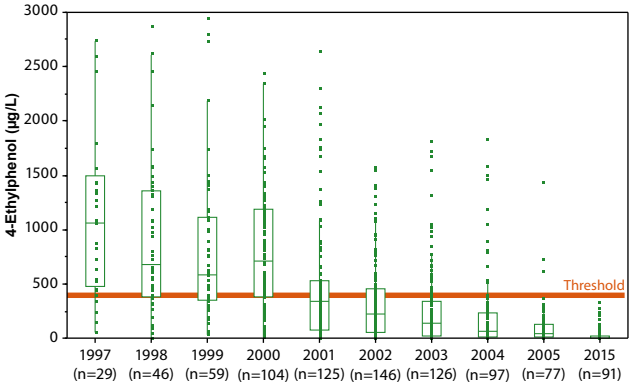


Figure 18. Incidence of 4EP in Cabernet Sauvignon wines from five regions (1997-2005 and 2015)

Metals in wine

Metals are naturally occurring components of wines, which can influence wine flavour, aroma and shelf life, as well as the health of fermentations. There are also regulatory limits for a number of metals in some of Australia's export markets. As such, an understanding of the typical levels found in wine is important. An extensive review of the metals data from more than 1,200 wines analysed over 12 months by AWRI Commercial Services was used to gain a picture of the metals content of Australian wine. The first important finding was that none of the metals were found at concentrations approaching levels that are of concern for human health and measured concentrations were typical of those found in other foods and beverages. All results were also well within Australian regulatory limits and similar to values seen in wines from around the world. A small number of wines, however, had concentrations of metals such as copper, iron, cobalt and zinc that exceeded the limits imposed in some export markets (which vary significantly between jurisdictions). Another interesting finding was the apparent elevation of metals such as lead and aluminium in white wines, possibly due to the use of wine processing aids such as bentonite. It is important that producers understand the contribution of bentonite to metals in wine so as to avoid approaching regulatory limits in export markets. The full results of the survey were published in the April 2018 edition of *AWRI Technical Review*.

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 2018.

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	–	4	4
Mr Tobias J. Bekkers	1 Jan 2014	–	4	4
Mr Ben Bryant	1 Jan 2017	30 Jun 2018	4	4
Ms Wendy Cameron	1 Jan 2018	–	2	2
Dr John S. Harvey	1 Jan 2016	–	4	4
Mr Kim R. Horton	1 Jan 2015	31 Dec 2017	2	2
Dr Daniel L. Johnson	1 Dec 2011	–	4	4
Mr Iain M. Jones	1 Jan 2018	–	2	2
Prof. Kiaran D. Kirk	1 Jan 2017	–	4	4
Dr Stuart C. McNab	1 Jan 2015	31 Dec 2017	2	2
Ms Elizabeth A. Riley	1 Jan 2012	–	3	4
Mr Mark R. Watson	24 Jun 2008	–	4	4

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 2018 the Company recorded a deficit of $468,196 (2017: deficit of $481,302). This deficit primarily relates to the Company's annual depreciation and amortisation expense recorded in relation to its property, plant, equipment and intangible assets (including its interest in the Wine Innovation Cluster Central building), net of funding received for such items during the period. The directors note that the reported 2018 accounting deficit as well of those in the preceding years are consistent with internal 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 8-Year *Research, Development and Extension plan 2017-2025* which was developed through a wide-ranging industry consultation process and formally commenced on 1 July 2017. This plan details 21 subthemes of activities designed to contribute to the achievement of the Company's mission, grouped within five main themes:

- *Customers, consumers and markets*
- *Extension, adoption and education*
- *Performance, products and processes*
- *Environment, sustainability and natural capital*
- *Foundational data and support services.*

Within these subthemes are 50 projects focusing upon specific outcomes. For each active project a project plan specifies relevant stakeholder needs, deliverables, approaches and methodologies as well as expected outcomes of benefit to the Australian wine industry. The consultation process with industry and other stakeholders remains ongoing, with active projects further developed and refined through Annual Operating Plans.

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 2018-2020*, clustered into four themes:

- World-class people and culture
- Expand the funding base and economic flexibility of the AWRI
- Improve infrastructure, systems and processes
- Build/retain relationships, strategic capabilities, services and partnerships.

The *Research, Development and Extension plan 2017-2025*, together with a status summary of the 50 projects within the plan, 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; and

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 2018-2020*, 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 established 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 2018-2020*, the *Research, Development and Extension plan 2018-2025* 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 (Oen), BSc, GAICD
Experience: Head of Winemaking, The Yalumba Wine Company and Hill-Smith Family Vineyards, Chair the Alumni Council of the University of Adelaide and member of the Council of Barons of Barossa. Previously director of the Barossa Grape & Wine Association, member of Wine Barossa and Co-Chair of the South Australian Wine Industry Council. National wine show judge, 27 years' technical, winemaking, viticultural and commercial experience in the Australian wine industry.
Special Responsibilities: Ms Rose is the Chair of the Personnel committee.

Mr Tobias J. Bekkers
Non-executive director
Qualifications: BAppSc (Ag) (Hons), GradCert (Mgt)
Experience: Principal of Bekkers Consulting and Bekkers Wine. Active as a viticulture and wine business consultant across Australia. Twenty-four 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 and Nuffield Farming Scholar (2017).
Special Responsibilities: Mr Bekkers is a member of the Audit committee.

Mr Ben Bryant
Non-executive director (to 30 June 2018)
Qualifications: BSc (Oen)
Experience: Chief Winemaker, Vice President and Board Member of Mission Hill Family Estate Winery (Canada), previously Chief Winemaker and Director of Pernod Ricard Winemakers Australia, over 18 years' experience in winemaking, viticulture, commercial business, international marketing and international business development. Previously member of the Executive of the South Australian Wine Industry Association and actively involved in the Wine Barossa Committee since 2015.
Special Responsibilities: Mr Bryant was a member of the Personnel committee.

Ms Wendy Cameron
Non-executive director (from 1 January 2018)
Qualifications: BAppSc (Biochem and Microbiol), MSc (Biochem), BAppSc (Wine Sci), GradDip (Ed), GradCert (Bus), MW
Experience: Winemaking consultant, previously Head of Winemaking at Brown Brothers Milawa Vineyards. Over 20 years' experience in the Australian wine sector including winemaking, wine show judging and wine business. Inaugural recipient of the ASVO Winemaker of the Year Award (2012) and Gourmet Traveller Wine Winemaker of the Year finalist (2015). Current PhD candidate at the University of Melbourne.

Dr John S. Harvey
Non-executive director
Qualifications: BSc (Hons), PhD, MBA, GAICD
Experience: Owner of Bathe Wines Pty Ltd. Former Australian Grape and Wine Authority regional mentor for McLaren Vale, past President of the Adelaide Hills Wine Region and previous Member of the South Australian Wine Industry Association Executive. Former Executive Director of the Grape and Wine Research and Development Corporation. Eighteen years' wine industry research, R&D management and commercial experience. Chair of the Can:Do Group, Independent Chair of Studio Nine Architects, Deputy Chair of Rural Business Support, Non-Executive Director of headspace and Revenir Winemaking Pty Ltd, SA Committee Member of the Winston Churchill Memorial Trust (Australia).
Special Responsibilities: Dr Harvey is a member of the Audit committee.

Mr Kim R. Horton
Non-executive director (to 31 December 2017)
Qualifications: BAppSc (Wine Sci)
Experience: Senior Winemaker, Willow Bridge Estate, previously Chief Winemaker, Ferngrove Vineyards Estate Pty Ltd. Twenty-four 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 *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, member of the South Australian Food Innovation Centre partners group, graduate of the Harvard Business School Authentic Leadership Development Program, graduate of the Australian Wine Industry Future Leaders Program, graduate of the INSEAD Blue Ocean Strategy Program, graduate of the IESE Creative Negotiation program, graduate of the Oxford Advanced Management and Leadership Program, Honorary Adjunct Professor at the Macquarie Graduate School of Management, 21 years' experience in research, development and innovation.

Mr Iain M. Jones
Non-executive director (from 1 January 2018)
Qualifications: BSc, MSc
Experience: General Manager – Technical Services at Treasury Wine Estates. Over 18 years' experience in the Australian wine sector across laboratory, quality assurance, environmental management, research and development, health and safety, engineering and lean business improvement functions. Member of WFA Wine Industry Technical Advisory Committee.

Prof. Kiaran D. Kirk
Non-executive director
Qualifications: BSc (Hons), PhD, DPhil
Experience: Dean of the College of Science at the Australian National University (ANU), Chair of Clonakilla Wines. Previously Director of ANU Research School of Biology, Head of ANU Department of Biochemistry and Molecular Biology, and Research Fellow at University of Oxford. More than 20 years' experience in the Australian research sector with a publication record of over 150 research papers in the field of biochemistry.
Special Responsibilities: Prof. Kirk is a member of the Personnel committee.

Dr Stuart C. McNab
Non-executive director (to 31 December 2017)
Qualifications: BAgSc (Hons), PhD
Experience: Wine industry and agribusiness consultant, 26 years' experience in the Australian and global wine sectors across technical, winemaking, viticulture, marketing, logistics, operations, commercial and research functions. Independent Chair of Clare Valley Wine and Grape Association, 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 was a member of the Audit committee.

Ms Elizabeth A. Riley
Non-executive director
Qualifications: BAppSc (Wine Sci)
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. Previously a Viticulturist with Southcorp Wines between 1993 and 1999 in national and NSW-based roles, 26 years' experience in the Australian wine industry. 2017 ASVO Viticulturist of the Year.

Mr Mark R. Watson
Non-executive director
Qualifications: BEc, MBA, CA, RITP, MAICD
Experience: Investment Director of Blue Sky Private Equity, previously Chief Executive Officer of Water Utilities Australia, 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 $24 (2017: $24).

Auditor's independence

The auditor's independence declaration as required under section 60-40 of the *Australian Charities and Not-for-profits Commission (ACNC) Act 2012* is attached and forms part of the directors' report for the financial year ended 30 June 2018.

Dated at Urrbrae on this the 18th day of September 2018.

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

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 2018, 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, 25 September 2018

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 2018

	Note	2018	2017
Revenue from operating activities			
Wine Australia			
Investment agreement project funding		8,649,266	6,106,546
Investment agreement capital funding		84,731	104,064
Other project funding		658,215	2,944,516
Other capital funding		90,293	8,181
Capital specific grant funding		-	5,283
Other grant funding		671,574	1,006,777
Commercial services analytical and consulting income		2,979,733	2,549,043
Contract research and other commercial income		1,256,875	1,405,050
Other revenue		139,603	301,197
Total revenue		14,530,290	14,430,657
Other income	2	(13,012)	60,029
Expenses from operating activities			
Personnel expenses	3	10,195,529	10,070,985
Analytical and project operating expenses		2,502,750	2,607,873
Infrastructure and general services expenses		1,334,661	1,402,392
Depreciation and amortisation expense	8, 9	1,023,993	951,678
Travel expenses		418,414	392,003
Total expenses		15,475,347	15,424,931
Results from operating activities		(958,069)	(934,245)
Finance income		489,873	452,943
Profit/(loss) for the period		(468,196)	(481,302)
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		75,354	262,995
Total comprehensive income for the period		(392,842)	(218,307)

The notes on pages 63 to 70 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 2018

	Retained earnings	Co-investment reserve	Strategic IT investment reserve	Fair value reserve	Total equity
Balance at 1 July 2016	14,780,103	987,500	142,743	3,793	15,914,139
Total comprehensive income for the period					
Profit or loss	(481,302)	–	–	–	(481,302)
Other comprehensive income					
Net change in fair value of available-for-sale financial assets	–	–	–	262,995	262,995
Total other comprehensive income	–	–	–	262,995	262,995
Total comprehensive income for the period	(481,302)	–	–	262,995	(218,307)
Transfers between retained earnings and other reserves					
Transfers to (from) reserves	–	(122,551)	(94,451)	–	(217,002)
Transfers to (from) retained earnings	217,002	–	–	–	217,002
Balance at 30 June 2017	14,515,803	864,949	48,292	266,788	15,695,832
Balance at 1 July 2017	14,515,803	864,949	48,292	266,788	15,695,832
Total comprehensive income for the period					
Profit or loss	(468,196)	–	–	–	(468,196)
Other comprehensive income					
Net change in fair value of available-for-sale financial assets	–	–	–	75,354	75,354
Total other comprehensive income	–	–	–	75,354	75,354
Total comprehensive income for the period	(468,196)	–	–	75,354	(392,842)
Transfers between retained earnings and other reserves					
Transfers to (from) reserves	–	(70,000)	(6,113)	–	(76,113)
Transfers to (from) retained earnings	76,113	–	–	–	76,113
Balance at 30 June 2018	14,123,719	794,949	42,179	342,142	15,302,990

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 of available-for-sale financial assets until the investments are derecognised or impaired.

The notes on pages 63 to 70 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 2018

	Note	2018	2017
Assets			
Cash and cash equivalents	4	2,614,033	1,334,701
Held-to-maturity investments	5	2,150,000	2,115,292
Trade and other receivables	6	953,469	2,108,833
Inventories	7	87,522	92,000
Prepayments		350,234	260,340
Total current assets		6,155,258	5,911,166
Available-for-sale financial assets	5	9,206,837	8,968,608
Property, plant and equipment	8	2,121,069	2,264,824
Intangible assets	9	4,530,166	4,841,958
Total non-current assets		15,858,072	16,075,390
Total assets		22,013,330	21,986,556
Liabilities			
Payables and accruals	10	4,514,366	4,110,971
Project funds not expended	11	201,906	258,409
Provisions	12	1,776,574	1,658,612
Total current liabilities		6,492,846	6,027,992
Provisions	12	217,494	262,732
Total non-current liabilities		217,494	262,732
Total liabilities		6,710,340	6,290,724
Net assets		15,302,990	15,695,832
Equity			
Retained earnings		14,123,719	14,515,803
Co-investment reserve		794,949	864,949
Strategic IT investment reserve		42,179	48,292
Fair value reserve		342,142	266,788
Total equity		15,302,990	15,695,832

The notes on pages 63 to 70 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 2018

	Note	2018	2017
Cash flows from operating activities			
Cash receipts from project grants and other income		15,829,772	13,125,675
Cash paid to suppliers and employees		(14,442,760)	(14,008,861)
Net cash from operating activities		1,387,011	(883,186)
Cash flows from investing activities			
Cash receipts from capital specific funding		175,024	109,347
Interest received		306,911	318,359
Dividends and imputation credits received		193,162	63,558
Proceeds from sale of property, plant and equipment		2,800	71,310
Acquisition of property, plant, equipment and intangibles		(503,114)	(1,107,287)
(Acquisition)/proceeds from disposal of held-to-maturity investments		(34,708)	1,609,708
Acquisition of available-for-sale investments		(200,000)	(2,517,500)
Payment of transaction costs related to financial investments		(47,755)	(44,296)
Net cash used in investing activities		(107,679)	(1,496,801)
Net increase (decrease) in cash and cash equivalents		1,279,332	(2,379,987)
Cash and cash equivalents at 1 July		1,334,701	3,714,688
Cash and cash equivalents at 30 June	4	2,614,033	1,334,701

The notes on pages 63 to 70 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* (ACNC Act). 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 18th day of September 2018.

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 intangible assets including its interest in the 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 classification

The Company has not implemented any changes to its accounting policies for the year ended 30 June 2018 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 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. Value in use is determined as the depreciated replacement cost of an 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.

(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 period.

(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. Dividend income is recognised in profit or loss on the date on which the Company's right to receive payment is established.

Finance costs comprise interest expense on borrowings and impairment losses recognised on financial assets other than trade receivables. Borrowing costs that are not directly attributable to the acquisition, construction or production of a qualifying asset are recognised in profit or loss using the effective interest rate method.

(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

	2018	2017
Net gain/(loss) on sale of property, plant and equipment	(13,012)	60,029
	(13,012)	60,029

3. Personnel expenses

	2018	2017
Wages and salaries	8,883,313	8,801,641
Other associated personnel expenses	479,488	446,626
Contributions to defined contribution plans	832,728	822,718
	10,195,529	10,070,985

4. Cash and cash equivalents

	2018	2017
Cash on hand	107	280
Bank deposits at-call	2,613,926	1,334,421
Cash and cash equivalents in the statement of cash flows	2,614,033	1,334,701

5. Other investments

	2018	2017
Current		
Held-to-maturity investments	2,150,000	2,115,292
Non-current		
Available-for-sale financial assets, comprising listed investments at fair value in:		
Interest rate securities	5,807,952	5,676,867
Equity securities	3,398,885	3,291,741
	9,206,837	8,968,608

Held-to-maturity investments consist of term deposits with interest rates between 2.50 and 2.80 percent (2017: between 2.55 and 2.75 percent) and mature within 9 months of balance date (2017: 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.

6. Trade and other receivables

	2018	2017
Trade receivables due from those other than related parties	586,359	717,718
Trade receivables due from related parties	127	30,281
Other receivables	366,983	1,360,834
	953,469	2,108,833

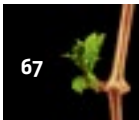
Trade receivables are shown net of impairment losses amounting to $7,347 (2017: $4,431) at reporting date. This allowance account is used to record impairment losses until the Company is satisfied that no recovery of the amount owing is possible; at that point the amounts are considered irrecoverable 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:

	2018	2017
Balance at 1 July	4,431	5,694
Payments received in relation to previously impaired balances	–	(2,000)
Impairment charge for the year	6,610	737
Written off during the year	(3,694)	–
Balance at 30 June	7,347	4,431

7. Inventories

	2018	2017
Course materials on hand – wine	87,522	92,000
	87,522	92,000



8. Property, plant and equipment

	Plant and machinery	Office furniture and IT	Laboratory equipment	Capital WIP	Total
Cost					
Balance at 1 July 2017	554,588	1,168,114	9,555,797	-	11,278,499
Additions	1,779	108,612	464,868	3,247	578,506
Transfers	-	-	-	-	-
Disposals	(1,495)	(134,861)	(157,826)	-	(294,182)
Balance at 30 June 2018	554,872	1,141,865	9,862,839	3,247	11,562,823
Depreciation and impairment losses					
Balance at 1 July 2017	328,139	829,090	7,856,446	-	9,013,675
Depreciation charge for the year	54,787	142,742	508,920	-	706,449
Transfers	-	-	-	-	-
Disposals	(1,495)	(119,049)	(157,826)	-	(278,370)
Balance at 30 June 2018	381,431	852,783	8,207,540	-	9,441,754
Carrying amounts					
at 1 July 2017	226,449	339,024	1,699,351	-	2,264,824
at 30 June 2018	173,441	289,082	1,655,299	3,247	2,121,069

9. Intangible assets

	Interest in WIC building	Computer software	Intangible assets under development	Total
Cost				
Balance at 1 July 2017	6,100,140	619,683	–	6,719,823
Additions	–	5,752	–	5,752
Transfers	–	–	–	–
Disposals	–	(2,794)	–	(2,794)
Balance at 30 June 2018	6,100,140	622,641	–	6,722,781
Amortisation and impairment losses				
Balance at 1 July 2017	1,747,527	130,338	–	1,877,865
Amortisation charge for the year	203,338	114,206	–	317,544
Disposals	–	(2,794)	–	(2,794)
Balance at 30 June 2018	1,950,865	241,750	–	2,192,615
Carrying amounts				
at 1 July 2017	4,352,613	489,345	–	4,841,958
at 30 June 2018	4,149,275	380,891	–	4,530,166

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 is being amortised over a period of 30 years from the date of practical completion (26 November 2008).

Computer software

Computer software assets are recognised as the attributable software licence and development costs paid to third parties, and do not include employee costs or an attribution of relevant overheads, as only an immaterial component of software development and testing processes are performed in-house. These software assets are amortised over periods of between three and five years, based upon their estimated useful lives and expected technical obsolescence.

10. Payables and accruals

	2018	2017
Current		
Trade payables due to those other than related parties	298,395	194,270
Trade payables due to related parties	38	–
Income received in advance	1,163,011	898,657
PAYG and GST	439,438	406,744
Non-trade payables and accrued expenses	2,613,484	2,611,300
	4,514,366	4,110,971

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 2018 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 $97,260 (2017: $82,349), relating only to funding to be provided to project collaborators in future periods. The unexpended funds from other WA contracts for the current year totalled $104,646 (2017: $176,060).

During the year WA approved the retention by the Company of no unspent prior years' funds for the purpose of capital purchases (2017: $1,481) and $137,254 for other purposes (2017: $370,747). During the year $121,155 in unspent prior years' funds relating to WA projects were returned to WA (2017: none).

	2018	2017
WA current year's investment agreement funding unexpended	97,260	82,349
WA current year's other contract funding unexpended	104,646	176,060
WA prior years' funding unexpended and uncommitted	–	–
	201,906	258,409

12. Provisions

	2018	2017
Current		
Employee entitlements	1,776,574	1,658,612
Non-current		
Employee entitlements	217,494	262,732
Number of employees (full time equivalents)	96.9	95.5

13. Operating leases

Leases as lessee

Non-cancellable operating lease rentals are payable as follows:

	2018	2017
Within one year	12,841	13,697
One year or later and no later than five years	12,870	13,699
Later than five years	–	–
	25,711	27,396

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

During the year ended 30 June 2018 an amount of $13,697 was recognised as an expense in respect of operating leases (2017: $19,961).

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:

	2018	2017
Within one year	8,000	8,000
One year or later and no later than five years	9,333	17,333
Later than five years	–	–
	17,333	25,333

During the year ended 30 June 2018 an amount of $8,259 was recognised as rental income (2017: $8,143).

14. Capital commitments

	2018	2017
Property, plant and equipment		
Contracted but not provided for and payable		
Within one year	162,830	18,893
One year or later and no later than five years	–	–
Later than five years	–	–
	162,830	18,893

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:

	2018	2017
Total remuneration	1,865,846	1,625,458

During the year non-executive directors became entitled to compensation totalling $83,000 (2017: $82,500). A number of directors voluntarily elected not to receive $51,000 of this entitlement (2017: $51,000), 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, as well as providing support to visiting scientists.

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:

Bathe Wines Pty Ltd

Oenologie Requin Pty Ltd (trading as Bekkers Wine)

Revenir Winemaking 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	
	2018	2017	2018	2017
Services received from related parties	2,787	64,665	38	–
Services provided to related parties	94,428	274,612	127	30,281

16. Contingencies

In the opinion of the Directors, there were no material or significant contingent liabilities at 30 June 2018 (2017: 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 other 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 $24 (2017: $24).

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 2018 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 18th day of September 2018.

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

Report on the Audit of the Financial Report

Opinion

We have audited the financial report of The Australian Wine Research Institute Limited (the registered entity), which comprises the statement of financial position as at 30 June 2018, the statement of profit or loss and other comprehensive income, the statement of changes in equity and the statement of cash flows for the year then ended, and notes to the financial report, including a summary of significant accounting policies, and the responsible entities' declaration.

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

(i) Giving a true and fair view of the registered entity's financial position as at 30 June 2018 and of its financial performance for the year then ended; and

(ii) Complying with Australian Accounting Standards – Reduced Disclosure Requirements and Division 60 of the *Australian Charities and Not-for-profits Commission Regulation 2013*.

Basis for opinion

We conducted our audit in accordance with Australian Auditing Standards. Our responsibilities under those standards are further described in the *Auditor's responsibilities for the audit of the Financial Report* section of our report. We are independent of the registered entity in accordance with the auditor independence requirements of the *Australian Charities and Not-for- profits Commission Act 2012* (ACNC Act) and the ethical requirements of the Accounting Professional and Ethical Standards Board's APES 110 *Code of Ethics for Professional Accountants* (the Code) that are relevant to our audit of the financial report in Australia. We have also fulfilled our other ethical responsibilities in accordance with the Code.

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

Other information

Those charged with governance are responsible for the other information. The other information obtained at the date of this auditor's report is the Chair and Managing Director's Report and Directors' Report included in The Australian Wine Research Institute Limited's annual report.

Our opinion on the financial report does not cover the other information and accordingly we do not express any form of assurance conclusion thereon.

In connection with our audit of the financial report, our responsibility is to read the other information and, in doing so, consider whether the other information is materially inconsistent with the financial report or our knowledge obtained in the audit or otherwise appears to be materially misstated.

If, based on the work we have performed on the other information obtained prior to the date of this auditor's report, we conclude that there is a material misstatement of this other information, we are required to report that fact. We have nothing to report in this regard.

Responsibilities of responsible entities for the Financial Report

The responsible entities of the registered entity are responsible for the preparation and fair presentation of the financial report in accordance with Australian Accounting Standards – Reduced Disclosure Requirements and the ACNC Act, and for such internal control as the responsible entities determine is necessary to enable the preparation of the financial report that is free from material misstatement, whether due to fraud or error.

In preparing the financial report, responsible entities are responsible for assessing the registered entity's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless the responsible entities either intends to liquidate the registered entity or to cease operations, or has no realistic alternative but to do so.

Those charged with governance are responsible for overseeing the registered entity's financial reporting process.

Auditor's responsibilities for the audit of the Financial Report

Our objectives are to obtain reasonable assurance about whether the financial report as a whole is free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with the Australian Auditing Standards will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of this financial report.

A further description of our responsibilities for the audit of the financial report is located at the Auditing and Assurance Standards Board website (http://www.auasb.gov.au/Home.aspx) at: http://www.auasb.gov.au/auditors_responsibilities/ar4.pdf

This description forms part of our auditor's report.

BDO Audit (SA) Pty Ltd

Paul Gosnold
Director

Adelaide, 25 September 2018

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 2018; and

(ii) the statements of financial position give a true and fair view of each Trust's state of affairs as at 30 June 2018.

(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 18th day of September 2018.

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 2018	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**
Income								
Interest	984	1,035	660	715	639	675	766	821
Donations and other income	-	-	-	-	-	-	-	-
Total income	984	1,035	660	715	639	675	766	821
Expenses								
Bank charges	-	3	-	3	-	3	-	3
Contribution towards Library Management System	3,909	-	-	-	-	-	-	-
Sponsorship	-	-	-	10,000	-	-	-	7,000
Total expenses	3,909	3	-	10,003	-	3	-	7,003
Profit/(loss) from ordinary activities	(2,925)	1,032	660	(9,288)	639	672	766	(6,182)
Other comprehensive income	-	-	-	-	-	-	-	-
Total comprehensive income for the period	(2,925)	1,032	660	(9,288)	639	672	766	(6,182)

STATEMENTS OF FINANCIAL POSITION								
As at 30 June 2018	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**
Assets								
Cash at bank	-	-	-	-	-	-	-	-
Investments	133,876	132,882	89,794	89,127	87,011	86,365	104,207	103,433
Receivables	77	87	52	59	50	57	60	68
Total current assets	133,953	132,969	89,846	89,186	87,061	86,422	104,267	103,501
Investments	-	-	-	-	-	-	-	-
Total non-current assets	-	-	-	-	-	-	-	-
Total assets	133,953	132,969	89,846	89,186	87,061	86,422	104,267	103,501
Liabilities								
Committed funding contribution	3,909	-	-	-	-	-	-	-
Total current liabilities	3,909	-	-	-	-	-	-	-
Net assets	130,044	132,969	89,846	89,186	87,061	86,422	104,267	103,501
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	120,184	119,152	64,136	73,424	66,422	65,750	103,451	109,633
Profit/(loss) for the year	(2,925)	1,032	660	(9,288)	639	672	766	(6,182)
Closing balance	117,259	120,184	64,796	64,136	67,061	66,422	104,217	103,451
Total trust funds	130,044	132,969	89,846	89,186	87,061	86,422	104,267	103,501

APPENDIX 1

External presentations

Staff	Title of presentation	Presented to and where	Date
S. Nordestgaard	Technology adoption in viticulture – how many people are doing what?	ASVO Seminar, Mildura, Vic	2 Jul 17
G.D. Cowey	Wine flavours, faults and taints	Pernod Ricard Winemakers sensory evaluation workshop, Barossa Valley, SA	14 Jul 17
	Mouth-feel and wine show judging		
	Strategies to manage high alcohol and stuck ferments in the winery	Victorian regional focus workshop, Mornington Peninsula, Vic	18 Jul 17
P.R. Petrie	Managing seasonal heatwave events		
G.D. Cowey	Strategies to manage high alcohol and stuck ferments in the winery	Victorian regional focus workshop, Yarra Valley, Vic	19 Jul 17
P.R. Petrie	Managing seasonal heatwave events		
D.L. Johnson, P.W. Godden	How R&D is shaping the international view of Australian wine	WFA industry briefing, Adelaide, SA	20 Jul 17
G.D. Cowey	Strategies to manage high alcohol and stuck ferments in the winery	Victorian regional focus workshop, Geelong, Vic	
P.R. Petrie	Managing seasonal heatwave events		
M. Essling	Managing powdery mildew in difficult seasons	Victorian regional focus workshop, Wangaratta, Vic	26 Jul 17
M.G. Holdstock	Strategies to manage high alcohol and stuck ferments in the winery		
P.R. Petrie	Using delayed pruning to manage vintage compression		
M. Essling	Managing powdery mildew in difficult seasons	Victorian regional focus workshop, Ararat, Vic	27 Jul 17
M.G. Holdstock	Strategies to manage high alcohol and stuck ferments in the winery		
P.R. Petrie	Using delayed pruning to manage vintage compression		
J.M. McRae	Protein stability in wine, what's new and how can we test for it?	Interwinery Analysis Group seminar, Thebarton, SA	28 Jul 17
M.P. Krstic	Yarra Valley terroir	Yarra Valley Wine Program, Healesville, Vic	8 Aug 17
P.W. Godden	Control of scale and mealybug in the vineyard	Pernod Ricard Winemakers Pinot Noir winemaking trial and sooty mould workshop, Barossa Valley, SA	11 Aug 17
	Sooty mould red winemaking trial: its impacts on processing, composition and sensory attributes of Shiraz wine		
C.A. Simos	Evaluation of winemaking treatments in Australian Pinot Noir		
S. Nordestgaard	New technologies and different approaches to wine production	Accolade Wines Technical Conference, Margaret River, WA	15 Aug 17
M.L. Longbottom	Sheep in vineyards	Clare Region Winegrape Growers Association winter workshop	16 Aug 17
J.M. McRae	Predicting heat stability of wine: the heat test revisited	AWRI webinar	17 Aug 17
I.L. Francis	Cloves, kerosene and cat pee: the science of wine flavour	LogicMonitor, Santa Barbara, California, USA	18 Aug 17
D.L. Capone	Investigations of aroma compounds and sensory profiles affected by the addition of grape leaves or stalks in a red wine fermentation	254th American Chemical Society National Meeting, 'From Fermentation to Fume Hood: The Chemistry of Wine' symposium, Washington DC, USA	20 Aug 17
K.A. Bindon	Cap on red wine macromolecules? Updates on how winemaking interventions influence tannin and polysaccharide composition in Shiraz wines		

Staff	Title of presentation	Presented to and where	Date
M.J. Herderich	Metabolomics tools for the analysis of non-volatile polyphenols in grapes, wine and humans	254th American Chemical Society National Meeting, 'From Fermentation to Fume Hood: The Chemistry of Wine' symposium, Washington DC, USA	21 Aug 17
D.L. Capone	Quantitation of potent polyfunctional thiols and their enantiomers in wine using HPLC-MS/MS after derivatisation	254th American Chemical Society National Meeting, 'Advances in Flavour Analysis' symposium, Washington DC, USA	22 Aug 17
M. Essling	Review/discussion of typical spray practices	Powdery mildew workshop	23 Aug 17
I.L. Francis	French origin or fermented bean curd flavour? The influence of intrinsic and extrinsic properties of red wines on Chinese consumers' hedonic responses	12th Pangborn Sensory Science Symposium, Providence, Rhode Island, USA	
M. Essling	Review/discussion of typical spray practices	Powdery mildew workshop	24 Aug 17
D.L. Johnson	Ausbiotech panel	AusAg & Foodtech Summit 2018, Adelaide, SA	29 Aug 17
D.L. Capone	Exogenous sources of flavour compounds in wine	Cornell University Seminar Series, Ithaca, New York, USA	
K.A. Bindon	The search for the holy grail of viticulture: objective measures of grape quality		
M.P. Krstic	Drought management and other challenges within the Australian wine industry	South African Society of Enology and Viticulture Conference, Stellenbosch, South Africa	
	New table grape cultivars used by the Australian table grape industry		30 Aug 17
C.A. Simos	Linking the AWRI's wine flavour research with regionality	Australian Wine Grand Tasting, Tokyo, Japan	4 Sep 17
K.A. Bindon	Managing phenolics in the vineyard and winery	Northwest Michigan Horticultural Research Station, Traverse City, Michigan, USA	5 Sep 17
N. Scrimgeour	Protecting wine integrity with best practice bottling	Winery Engineering Association Conference, Nuriootpa, SA	6 Sep 17
P.W. Godden	Eden Valley Riesling		
S. Nordestgaard	Grape crushing – history and recent developments		
C.A. Simos	Linking the AWRI's wine flavour research with regionality	Australian Wine Grand Tasting, Seoul, South Korea	7 Sep 17
M.J. Herderich	The AWRI	South Australia-Shandong Science and Research Exchange, Adelaide, SA	8 Sep 17
E.N. Wilkes	Copper – the good, the bad and the ugly	AWRI roadshow seminar, Clare Valley, SA	14 Sep 17
I.L. Francis	Struck match and tropical fruit: the role of varietal thiols in Australian Chardonnay		
	Complexity, texture and flavour... or green, hard and herbal? Incorporation of stems and leaves in cool climate Shiraz fermentation		
M.P. Day	The beneficial style and performance effects of oxygen addition during fermentation		
P.R. Petrie	Earlier, shorter, hotter? Is vintage compression really happening and what can you do about it?		
S. Nordestgaard	Innovations in on-harvester destemming and sorting		
J.L. Hixson	Shedding light on the modulation of key Riesling aroma compounds in a changing climate	15th Weurman Flavour Research Symposium, Graz, Austria	19 Sep 17
M. Parker	Flavour release from wine glycosides during tasting		20 Sep 17
A.D. Coulter	Sugar and estimating potential alcohol	AWRI roadshow workshop, Stanthorpe, Qld	21 Sep 17
	Filtration impact on colour/quality		
M. Essling	Benchmarking spray programs – how chemicals are used in your region versus other regions		
M.G. Holdstock	pH and TA – getting it right		
	Oxygen use in winemaking		

Staff	Title of presentation	Presented to and where	Date
M.L. Longbottom	Canopy management to optimise quality	AWRI roadshow workshop, Stanthorpe, Qld	21 Sep 17
	Your regional position – helpdesk, climate and wine composition trends		
J.L. Hixson	Winery waste, texture and flavour: a snapshot of diverse wine research	Hochschule Geisenheim University, Geisenheim, Germany	26 Sep 17
K.A. Bindon	How to maximise the phenolic potential of grapes through innovative winemaking	AWRI roadshow seminar, McLaren Vale, SA	28 Sep 17
M. Essling	Organic vs conventional practices compared – what's stopping you from going organic?		
	Scale and mealybug – what can I do to control these sap-sucking insects?		
M.L. Longbottom	Soil health – what is it and how can we manage it?		
S. Nordestgaard	Innovations in on-harvester destemming and sorting		
W.P. Pearson	What makes a red wine green?		
P.R. Petrie	Soil health – what is it and how can we manage it?	AWRI roadshow seminar, Barossa Valley, SA	5 Oct 17
P.W. Godden	Control of scale and mealybug in the vineyard and results of winemaking trial		
E.N. Wilkes	Copper – the good, the bad and the ugly		
P.R. Petrie	Canopy management using grower-friendly digital tools		
E.N. Wilkes	Cold stability, hitting a moving target		
I.L. Francis	Keep calm and keep face: understanding Chinese wine consumers		
G.D. Cowey	Wine flavours, faults and taints	UK/Ireland independent wine merchants' AWRI visit and tasting, Adelaide, SA	9 Oct 17
E.N. Wilkes	Wine industry experiences re phthalate regulations	Olive Oil Board, Adelaide, SA	
M.L. Longbottom	Biosecurity – everyone's business	AWRI webinar	12 Oct 17
Y.D. Grebneva	The formation, sensory contribution and management of 1,1,6-trimethyl-1,2-dihydronaphthalene (TDN) in grapes and wines of *Vitis vinifera* L. cv. Riesling	Staff and students, Hochschule Geisenheim University, Geisenheim, Germany	19 Oct 17
W.P. Pearson	Shiraz benchmarking workshop using Pivot© Profile sensory method	WSET Scholarship AWRI visit and tasting, Adelaide, SA	23 Oct 17
K.J. Dunne	Soil health – what is it and how can we manage it?	AWRI roadshow seminar, Rutherglen, Vic	24 Oct 17
I.L. Francis	Complexity, texture and flavour... or green, hard and herbal? Incorporation of stems and leaves in cool climate Shiraz fermentation		
P.W. Godden	Can you influence your wine styles through MLF?		
S. Nordestgaard	Innovations in on-harvester destemming and sorting		
M.P. Day	The beneficial style and performance effects of oxygen addition during fermentation		
I.L. Francis	Keep calm and keep face: understanding Chinese wine consumers		
K.J. Dunne	Soil health – what is it and how can we manage it?	AWRI roadshow seminar, Avoca, Vic	25 Oct 17
I.L. Francis	Complexity, texture and flavour... or green, hard and herbal? Incorporation of stems and leaves in cool climate Shiraz fermentation		
S. Nordestgaard	Innovations in on-harvester destemming and sorting		
P.W. Godden	Avoiding spoilage issues caused by wine bacteria: prevention is better than cure		
M.P. Day	The beneficial style and performance effects of oxygen addition during fermentation		

Staff	Title of presentation	Presented to and where	Date
I.L. Francis	Keep calm and keep face: understanding Chinese wine consumers	AWRI roadshow seminar, Avoca, Vic	25 Oct 17
K.J. Dunne	Soil health – what is it and how can we manage it?	AWRI roadshow seminar, Bendigo, Vic	26 Oct 17
I.L. Francis	Complexity, texture and flavour... or green, hard and herbal? Incorporation of stems and leaves in cool climate Shiraz fermentation		
P.W. Godden	Can you influence your wine styles through MLF?		
	Can I improve MLF performance and reliability?		
M.P. Day	The beneficial style and performance effects of oxygen addition during fermentation		
I.L. Francis	Keep calm and keep face: understanding Chinese wine consumers		
G.D. Cowey	Past, present and future. Where are we with *Brettanoymces?*	Treasury Wine Estates, Barossa Valley, SA	27 Oct 17
K.A. DeGaris	What are the strategies to better manage the risk of *Botrytis* bunch rot?	AWRI roadshow seminar, Orange, NSW	1 Nov 17
I.L. Francis	Complexity, texture and flavour... or green, hard and herbal? Incorporation of stems and leaves in cool climate Shiraz fermentation		
R. Gawel	White wine texture: the interactive effects of phenolics, polysaccharides, acidity and alcohol		
I.L. Francis	Struck match and tropical fruit: the role of varietal thiols in Australian Chardonnay		
K.A. DeGaris	What are the strategies to better manage the risk of *Botrytis* bunch rot?	AWRI roadshow seminar, Southern Highlands, NSW	2 Nov 17
	How to improve fruit set in cool climates		
C.A. Simos	Copper – the good, the bad and the ugly		
R. Gawel	White wine texture: the interactive effects of phenolics, polysaccharides, acidity and alcohol		
I.L. Francis	What makes a red wine green?		
K.A. DeGaris	How to improve fruit set in cool climates	AWRI roadshow seminar, Canberra, ACT	3 Nov 17
K.A. Bindon	How can I predict wine tannin and colour in the vineyard?		
I.L. Francis	Complexity, texture and flavour... or green, hard and herbal? Incorporation of stems and leaves in cool climate Shiraz fermentation		
K.A. Bindon	How to maximise the phenolic potential of grapes through innovative winemaking		
R. Gawel	White wine texture: the interactive effects of phenolics, polysaccharides, acidity and alcohol		
D.L. Johnson	From vine to glass: jobs in the wine supply chain	JOBEX Exhibition, Adelaide, SA	11 Nov 17
G.D. Cowey	Wine taints and faults	Introduction to winemaking taints and faults workshop, Adelaide, SA	13 Nov 17
T.E. Siebert	Deconstruction and reconstruction of 'apricot' aroma in white wine	Crush 2017 – the grape and wine science symposium, Adelaide, SA	
R.G. Dambergs	Taking yield forecasting into the digital age		
T.J. Abbott	Gazing into a ferment's future		
A.M. Mierczynska-Vasilev	Magnetic removal of haze-forming proteins from wines		
R.G. Dambergs	Hyperspectral imaging of *Botrytis* in grapes		14 Nov 17
Y.D. Grebneva	The effect of sunlight exposure on TDN development		
K.C. Hirlam	The higher values of wine industry waste streams		

Staff	Title of presentation	Presented to and where	Date
S. Nordestgaard	Trends in Australian winemaking practice	Crush 2017 – the grape and wine science symposium, Adelaide, SA	14 Nov 17
M.P. Day	Airy thoughts on winemaking		
A.R. Borneman	Wild wine: metagenomic analysis of microbial communities during wine fermentation		
P.J. Costello	Selecting robust Australian malolactic bacteria for Australian wine conditions		
J.R. Bellon	*Saccharomyces* interspecific hybridisation enhances the capacity for phenotypic improvements in wine yeast strain development		
I.L. Francis	A historical perspective of wine sensory science	ASVO seminar, Adelaide, SA	15 Nov 17
R. Gawel	Organoleptic assessment of olive oil		
P.O. Williamson	Consumer sensory: fermented bean curd, fruity or French?		
P.W. Godden	Sooty mould red winemaking trial – its impact on processing, composition and sensory attributes of Shiraz wine	AWRI webinar	16 Nov 17
C.A. Simos	Introduction to the Advanced Wine Assessment Course	Advanced Wine Assessment Course (AWAC 44), Adelaide, SA	20 Nov 17
W.P. Pearson	Flavours, taints and faults		
I.L. Francis	Practical approaches to sensory analysis of wine	Pinot Massif 2017 Victorian Pinot Noir Workshop, Hepburn Springs, Vic	22 Nov 17
R. Gawel	Palate performance and statistical evaluation	Advanced Wine Assessment Course (AWAC 44), Adelaide, SA	23 Nov 17
C.A. Simos	Introduction to the course	Institute of Masters of Wine one-day wine assessment course, Adelaide, SA	27 Nov 17
W.P. Pearson	Flavours, taints and faults		
S.A. Schmidt	The fight for dominance in grape juice and the genetics underpinning yeast strain performance	Yeast Products and Discovery 2017, Ballarat, Vic	30 Nov 17
A.R. Borneman	Wild wine: metagenomic analysis of microbial communities during wine fermentation		
D.L. Johnson	Career advice and the value of a professional network, potential jobs of the future and top tips for career success	STEM Careers in Industry, Adelaide, SA	
P.R. Petrie	Towards unravelling the factors leading to sooty mould	Viticulture innovation day, Lobethal, SA	
P.W. Godden	AWRI Annual Report 2016/2017	SA Wine Industry Association Executive Board Meeting, Adelaide, SA	7 Dec 17
D.L. Johnson		Wine Tasmania Board Meeting, Hobart, Tas	
M. Parker, J.L. Hixson	Adding glycosides to wine: gaining an industry perspective	Glycosides workshop, Barossa Valley, SA	
M.P. Krstic	Insights into vineyard and winery smoke taint mitigation options	Yarra Valley smoke forum, Yarra Valley, Vic	8 Dec 17
P.R. Dry	Why do we need new varieties for our region?	Research to practice workshop – Alternative varieties, Mildura, Vic	11 Dec 17
	Profiles of 10 white wine varieties with potential in the Murray Darling/Swan Hill regions		
	Profiles of 10 red wine varieties with potential in the Murray Darling/Swan Hill regions		
	How do we get new varieties into our region? How do we know that we have the right variety?		
W.P. Pearson	Defining regional sensory variability of premium Australian Shiraz wines	Research approval committee, Charles Sturt University, Wagga Wagga, NSW	13 Dec 17
C.A. Simos	Evaluation of winemaking treatments in Australian Shiraz	Shiraz winemaking trial tasting, Hunter Valley, NSW	15 Jan 18
	Wine flavours, faults and taints	Institute of Masters of Wine, Winter program, Rust, Austria	18 Jan 18
		The Wine Society, Institute of Masters of Wine, Winter program, Stevenage, UK	22 Jan 18

Staff	Title of presentation	Presented to and where	Date
G.D. Cowey	Smoke taint	Treasury Wine Estates winemaking team, Barossa Valley, SA	22 Jan 18
C.A. Simos	Australian Shiraz: pepper and provenance	Australia Day Tasting, Holburn, UK	23 Jan 18
	Evaluation of winemaking treatments in Australian Shiraz	Shiraz winemaking trial tasting, Institute of Masters of Wine, Winter program, London, UK	24 Jan 18
M.P. Krstic	Wildfires and wine: loss prevention, mitigation and management	Unified Symposium, Sacramento, California, USA	25 Jan 18
C.A. Simos	How Entwine, Australia's sustainability program, supports grapegrowers and winemakers	Institute of Masters of Wine, Winter program, Neustadt/Weinstraße, Germany	
M.G. Holdstock	Evaluation of winemaking treatments in Australian Shiraz	Shiraz winemaking trial tasting, Clare Valley, SA	
K.J. Dunne	The good, the bad and the ugly – assessing and managing fungal pathogens near harvest	Pre-vintage workshop and Shiraz winemaking trial tasting, Yarra Valley, Vic	30 Jan 18
P.W. Godden	Managing sluggish and stuck ferments		
	New water addition rules		
G.D. Cowey	Evaluation of winemaking treatments in Australian Shiraz	Shiraz winemaking trial tasting, Mount Barker, WA	
K.J. Dunne	The good, the bad and the ugly – assessing and managing fungal pathogens near harvest	Pre-vintage workshop and Shiraz winemaking trial tasting, Grampians, Vic	31 Jan 18
P.W. Godden	Managing sluggish and stuck ferments		
	New water addition rules		
G.D. Cowey	Evaluation of winemaking treatments in Australian Shiraz	Shiraz winemaking trial tasting, Margaret River, WA	
C.A. Simos	Trouble-free winemaking – the identification, avoidance and management of common wine instabilities	Plumpton College, East Sussex, UK	1 Feb 18
G.D. Cowey	Evaluation of winemaking treatments in Australian Shiraz	Shiraz winemaking trial tasting, Swan Valley, WA	
K.J. Dunne	The good, the bad and the ugly – assessing and managing fungal pathogens near harvest	Pre-vintage workshop and Shiraz winemaking trial tasting, Rutherglen, Vic	6 Feb 18
P.W. Godden	Managing sluggish and stuck ferments		
	New water addition rules		
M.G. Holdstock	Evaluation of winemaking treatments in Australian Shiraz	Shiraz winemaking trial tasting, Langhorne Creek, SA	
C.A. Simos		Shiraz winemaking trial tasting, Canberra, ACT	7 Feb 18
K.J. Dunne	The good, the bad and the ugly – assessing and managing fungal pathogens near harvest	Pre-vintage workshop and Shiraz winemaking trial tasting, King Valley, Vic	
P.W. Godden	Managing sluggish and stuck ferments		
	New water addition rules		
M.G. Holdstock	Evaluation of winemaking treatments in Australian Shiraz	Shiraz winemaking trial tasting, Barossa Valley, SA	8 Feb 18
C.A. Simos		Shiraz winemaking trial tasting, Orange, NSW	
K.J. Dunne	The good, the bad and the ugly – assessing and managing fungal pathogens near harvest	Pre-vintage workshop and Shiraz winemaking trial tasting, Bendigo, Vic	
P.W. Godden	Managing sluggish and stuck ferments		
	New water addition rules		
C.A. Simos	Evaluation of winemaking treatments in Australian Shiraz	Shiraz winemaking trial tasting, Mudgee, NSW	9 Feb 18
M.L. Longbottom	Your regional position – helpdesk, climate and wine composition trends, fuel and power use in your region, through Entwine Australia sustainability benchmarking	Addressing regional challenges workshop, Launceston, Tas	14 Feb 18
M. Essling	Benchmarking spray programs – how chemicals are used in your region versus other regions		

Staff	Title of presentation	Presented to and where	Date
M.L. Longbottom	Canopy management to optimise quality	Addressing regional challenges workshop, Launceston, Tas	14 Feb 18
M. Essling	Smart tools to manage vineyard variation		
M.L. Longbottom	Yield regulation – cost-benefit and the impact on quality		
M. Essling	Stretching water further		
I.L. Francis	Complexity, texture and flavour... or green, hard and herbal? Incorporation of stems and leaves in cool climate Shiraz fermentation	AWRI roadshow seminar, Limestone Coast, SA	
K.A. Bindon	The beneficial style and performance effects of oxygen addition during fermentation		
	How to maximise the phenolic potential of grapes through innovative winemaking		
M.G. Holdstock	Evaluation of winemaking treatments in Australian Shiraz		
M.L. Longbottom	Your regional position – helpdesk, climate and wine composition trends, fuel and power use in your region, through Entwine Australia sustainability benchmarking	Addressing regional challenges workshop, Hobart, Tas	15 Feb 18
M. Essling	Benchmarking spray programs – how chemicals are used in your region versus other regions		
M.L. Longbottom	Canopy management to optimise quality		
M. Essling	Smart tools to manage vineyard variation		
M.L. Longbottom	Yield regulation – cost-benefit and the impact on quality		
M. Essling	Smart tools to manage vineyard variation		
M.P. Krstic	Stretching water further		
D.L. Johnson	Innovation in agriculture	IIT Centre for Rural Development and Technology, New Delhi, India	16 Feb 18
G.D. Cowey, J.A. Culbert	Smoke taint Q&A	Smoke taint Q&A workshop, Orange, NSW	20 Feb 18
C.A. Simos	Evaluation of winemaking treatments in Australian Shiraz	Shiraz winemaking trial tasting, Stanthorpe, Qld	21 Feb 18
G.D. Cowey, J.A. Culbert	Smoke taint Q&A	Smoke taint Q&A workshop, Mudgee, NSW	
C.A. Simos	Introduction to the AWRI	Qilu University of Technology, China, AWRI visit, Adelaide, SA	23 Feb 18
I.L. Francis	Sensory and flavour		
G.D. Cowey	Helpdesk and extension		
S.A. Schmidt	Biosciences		
K.J. Dunne	Planned burn communication plan	Forest Fire Management Victoria and Macedon Wine Association meeting, Woodend, Vic	28 Feb 18
C.A. Simos	Evaluation of winemaking treatments in Australian Shiraz	Shiraz winemaking trial tasting, Hobart, Tas	1 Mar 18
M.J. Herderich	AWRI overview	Penn State University, State College, Pennsylvania, USA	19 Mar 18
	Making sense of terroir		
	Uptake of smoke-derived compounds and their effects on chemical and sensory properties of wines	ACS Symposium on smoky flavors in beverages, New Orleans, Louisiana, USA	21 Mar 18
	Fumé, flint and fire: smoky flavors in wine		
R. Gawel	Compositional factors affecting the mouth-feel of white wine	Agricultural University of Athens, Athens, Greece	29 Mar 18
P.W. Godden	New world winemaking innovation – what's old is new	Pure Taste Adelaide, Adelaide, SA	10 Apr 18
E.N. Wilkes	Fraud prevention in wine – where to now?	FIVS Global Trade Policy Conference, Brussels, Belgium	18 Apr 18
C.A. Simos	Australian Shiraz: pepper and providence	US sommeliers' AWRI visit, Adelaide, SA	24 Apr 18
M.L. Longbottom	Viticulture at the AWRI	Wine Grape Council of SA roadshow, Riverland, SA	27 Apr 18

Staff	Title of presentation	Presented to and where	Date
M.L. Longbottom	Viticulture at the AWRI	Wine Grape Council of SA roadshow, McLaren Vale, SA	1 May 18
D.L. Johnson, M.P. Krstic	AWRI Annual Report update	Wine Victoria Board meeting, Melbourne, Vic	8 May 18
C.A. Simos	Evaluation of winemaking treatments in Australian Shiraz	Shiraz winemaking trial tasting, Griffith, NSW	9 May 18
S. Nordestgaard	Trends in Australian winemaking practices		
P.R. Petrie	How to minimise your chances of frost damage	AWRI roadshow viticulture seminar, Griffith, NSW	
	What are the positives and pitfalls of grazing sheep in your vineyard?		
M.L. Longbottom	Viticulture at the AWRI	Wine Grape Council of SA roadshow, Clare Valley, SA	10 May 18
C.A. Simos	Evaluation of winemaking treatments in Australian Shiraz	Shiraz winemaking trial tasting, Mildura, Vic	
S. Nordestgaard	Trends in Australian winemaking practices		
P.R. Petrie	What can I do to protect my vineyard from climate change?	AWRI roadshow viticulture seminar, Mildura, Vic	
	Scale and mealybug – what can I do to control these sap-sucking insects?		
M. Essling	Agrochemical update	Murray Valley Winegrowers information forum, Mildura, Vic	
M.L. Longbottom	Viticulture at the AWRI	Wine Grape Council of SA roadshow, Barossa Valley, SA	11 May 18
C.A. Simos	Evaluation of winemaking treatments in Australian Shiraz	Shiraz winemaking trial tasting, Loxton, SA	
S. Nordestgaard	Trends in Australian winemaking practices		
P.R. Petrie	How to minimise your chances of frost damage	AWRI roadshow viticulture seminar, Loxton, SA	
	Canopy management using grower-friendly digital tools		
C.A. Simos	Introduction to the Advanced Wine Assessment Course	Advanced Wine Assessment Course (AWAC 45), Adelaide, SA	14 May 18
W.P. Pearson	Flavours, taints and faults		
R. Gawel	Palate performance and statistical evaluation		17 May 18
M.L. Longbottom	Viticulture at the AWRI	Wine Grape Council of SA roadshow, Coonawarra, SA	
C.A. Simos	Introduction to the Advanced Wine Assessment Course	Advanced Wine Assessment Course (AWAC 46), Adelaide, SA	21 May 18
W.P. Pearson	Flavours, taints and faults		
M.G. Holdstock	Palate performance and statistical evaluation		24 May 18
M. Essling	Agrochemical update	E.E. Muirs Agronomist Meeting, Macedon Ranges, Vic	29 May 18
A.M. Mierczynska-Vasilev	Using magnetic nanoparticles for protein stabilisation	Macrowine 2018, Zaragoza, Spain	30 May 18
R. Gawel	The effect of polysaccharides on wine texture		
W.P. Pearson	McLaren Vale's great Grenache	Vinexpo, Hong Kong	
	Benchmarking Australian Shiraz: a sensory exercise		31 May 18
M.Z. Bekker	The formation and remediation of stinky sulfur aromas in wines	AWRI webinar	
S. Nordestgaard	Wine storage and transport – research and practice	Enoforum 2018, Zaragoza, Spain	1 Jun 18
R. Gawel	The effect of polysaccharides on white wine texture	University of Montpellier/SupAgro, Montpellier, France	4 Jun 18
M.L. Longbottom	Managing nutrition in a changing environment	Research to practice workshop – Managing grapevine nutrition in a changing climate, Padthaway, SA	5 Jun 18
	Nutrients and grapevine growth		
	Nutrient analyses for grapevines		
K.A. DeGaris	Principles of grapevine nutrition		

Staff	Title of presentation	Presented to and where	Date
K.A. DeGaris	Key grapevine nutrients	Research to practice workshop – Managing grapevine nutrition in a changing climate, Padthaway, SA	5 Jun 18
	Alternative methods of nutrient management		
M.L. Longbottom	Climate and sustainability	9th International Symposium of The Institute of Masters of Wine, Logroño, Spain	14 Jun 18
J.M. McRae	Capitalising on consumer preferences through wine research	University of SA wine marketing workshop, Adelaide, SA	19 Jun 18
M.G. Holdstock	Flavours, taints and faults	Barossa wine assessment training, Barossa Valley, SA	
J.A. Culbert	Identifying the chemical and sensory drivers of consumer preference for Australian sparkling wine	Sparkling wine symposium, Melbourne, Vic	26 Jun 18
M. Essling	Agrochemical update	Elders growers meeting, Tanunda, SA	
C.A. Simos, M.P. Krstic, G.D. Cowey, K.J. Dunne	Smoke taint Q&A	Smoke taint Q&A workshop, Macedon, Vic	27 Jun 18

APPENDIX 2

Events organised by AWRI staff

Staff	Title of event	Held	Date
G.D. Cowey, F. Blefari	Pernod Ricard Winemakers sensory evaluation workshop	Barossa Valley, SA	14 Jul 17
V.F. Phillips, M.P. Krstic, P.R. Petrie, G.D. Cowey	Victorian regional focus workshop	Mornington Peninsula, Vic	18 Jul 17
		Yarra Valley, Vic	19 Jul 17
		Geelong, Vic	20 Jul 17
V.F. Phillips, M.P. Krstic, P.R. Petrie, M.G. Holdstock, M. Essling		Wangaratta, Vic	26 Jul 17
		Ararat, Vic	27 Jul 17
C.A. Simos, V.F. Phillips, P.W. Godden	Pernod Ricard Winemakers Pinot Noir winemaking trial and sooty mould workshop	Barossa Valley, SA	11 Aug 17
C.E. Bartel, S.R. Barter, M.Z. Bekker, L.E. Bey, E.O. Bilogrevic, M.P. Day, S. Dillon, D. Espinase Nandorfy, E. Kristianto, J.M. McRae, V.F. Phillips, T.E. Siebert, C.S. Stockley	'The complete wine science spectrum', National Science Week event	North Adelaide, SA	15 Aug 17
M. Essling, V.F. Phillips	Powdery mildew workshop	Swan Hill, Vic	23 Aug 17
		Mildura, Vic	24 Aug 17
S.R. Barter, C.A. Simos	Aroma bar	Australian Wine Grand Tasting, Tokyo, Japan	4 Sep 17
		Australian Wine Grand Tasting, Seoul, South Korea	7 Sep 17
C.A. Simos, V.F. Phillips, M.G. Holdstock, P.R. Petrie, S. Nordestgaard, I.L. Francis, M.P Day, E.N. Wilkes	AWRI roadshow seminar	Clare Valley, SA	14 Sep 17
G.D Cowey, V.F. Phillips, M. Essling, M.L. Longbottom, M.G. Holdstock, A.D. Coulter	AWRI roadshow workshop	Stanthorpe, Qld	21 Sep 17

Staff	Title of event	Held	Date
C.A. Simos, V.F. Phillips, G.D. Cowey, M.L. Longbottom, M. Essling, S. Nordestgaard, W.P. Pearson, K.A. Bindon	AWRI roadshow seminar	McLaren Vale, SA	28 Sep 17
C.A. Simos, V.F. Phillips, P.W. Godden, P.R. Petrie, E.N. Wilkes, I.L. Francis	AWRI roadshow seminar	Barossa Valley, SA	5 Oct 17
C.A Simos, G.D. Cowey	UK/Ireland independent wine merchants' AWRI visit and tasting	Adelaide, SA	9 Oct 17
M. Essling, V.F. Phillips	Spray application workshop	Clare Valley, SA	10 Oct 17
		Renmark, SA	11 Oct 17
		Riverland, SA	12 Oct 17
		Padthaway, SA	13 Oct 17
C.A. Simos, M.F. Calabrese, W.P. Pearson	WSET Scholarship AWRI visit and tasting	Adelaide, SA	23 Oct 17
C.A Simos, V.F. Phillips, P.W. Godden, K.J. Dunne, I.L. Francis, S. Nordestgaard, M.P. Day	AWRI roadshow seminar	Rutherglen, Vic	24 Oct 17
C.A Simos, V.F. Phillips, P.W. Godden, K.J. Dunne, I.L. Francis, S. Nordestgaard	AWRI roadshow seminar	Avoca, Vic	25 Oct 17
C.A Simos, V.F. Phillips, P.W. Godden, K.J. Dunne, I.L. Francis, M.P. Day		Bendigo, Vic	26 Oct 17
C.A Simos, V.F. Phillips, K.A. DeGaris, I.L. Francis, R. Gawel		Orange, NSW	1 Nov 17
		Southern Highlands, NSW	2 Nov 17
C.A. Simos, V.F. Phillips, K.A. DeGaris, K.A. Bindon, I.L. Francis, R. Gawel		Canberra, ACT	3 Nov 17
N. Scrimgeour, G.D. Cowey, D. Espinase Nandorfy	Introduction to winemaking taints and faults workshop	Adelaide, SA	13 Nov 17
C.A. Simos, M.F. Calabrese, F. Blefari, G.D. Cowey, M.G. Holdstock, V.F. Phillips	Advanced Wine Assessment Course (AWAC 44)		20-23 Nov 17
C.A Simos, F. Blefari, G.D. Cowey, M. Calabrese, M.G. Holdstock, V.F. Phillips	Institute of Masters of Wine one-day wine assessment course		27 Nov 17
M. Parker, J.L. Hixson, I.L. Francis	Glycosides workshop	Barossa Valley, SA	7 Dec 17
M.P. Krstic	Yarra Valley smoke forum	Yarra Valley, Vic	8 Dec 17
M. Essling, V.F. Phillips. P.R. Dry	Research to practice workshop – Alternative varieties	Mildura, Vic	11 Dec 17
M.P. Krstic	Annual fire management and wine industry forum	Melbourne, Vic	14 Dec 17
C.A. Simos, V.F. Phillips	Shiraz winemaking trial tasting	Hunter Valley, NSW	15 Jan 18
		London, UK	24 Jan 18
C.A. Simos, V.F. Phillips, M.G. Holdstock		Clare Valley, SA	25 Jan 18
C.A. Simos, V.F. Phillips, G.D. Cowey		Mount Barker, WA	30 Jan 18
K.J. Dunne, V.F. Phillips, P.W. Godden	Pre-vintage workshop and Shiraz trial tasting	Yarra Valley, Vic	
C.A. Simos, V.F. Phillips, G.D. Cowey	Shiraz winemaking trial tasting	Margaret River, WA	31 Jan 18
K.J. Dunne, V.F. Phillips, P.W. Godden	Pre-vintage workshop and Shiraz winemaking trial tasting	Grampians, Vic	
C.A. Simos, V.F. Phillips, G.D. Cowey	Shiraz winemaking trial tasting	Swan Valley, WA	1 Feb 18
C.A. Simos, V.F. Phillips, M.G. Holdstock		Langhorne Creek, SA	6 Feb 18
K.J. Dunne, V.F. Phillips, P.W. Godden	Pre-vintage workshop and Shiraz winemaking trial tasting	Rutherglen, Vic	
		King Valley, Vic	7 Feb 18
C.A. Simos, V.F. Phillips	Shiraz winemaking trial tasting	Canberra, ACT	
K.J. Dunne, V.F. Phillips, P.W. Godden	Pre-vintage workshop and Shiraz winemaking trial tasting	Bendigo, Vic	8 Feb 18

Staff	Title of event	Held	Date
C.A. Simos, V.F. Phillips	Shiraz winemaking trial tasting	Orange, NSW	8 Feb 18
C.A. Simos, V.F. Phillips, M.G. Holdstock		Barossa Valley, SA	
C.A. Simos, V.F. Phillips		Mudgee, NSW	9 Feb 18
C.A. Simos, V.F. Phillips, M.G. Holdstock, I.L. Francis, K.A. Bindon	AWRI roadshow seminar	Limestone Coast, SA	14 Feb 18
V.F. Phillips, G.D. Cowey, P.R. Petrie, M. Essling, M.P. Krstic	Addressing regional challenges workshop	Launceston, Tas	14 Feb 18
V.F. Phillips, G.D. Cowey, P.R. Petrie, M. Essling, M.P. Krstic		Hobart, Tas	15 Feb 18
G.D. Cowey, J.A. Culbert	Smoke taint Q&A workshop	Orange, NSW	20 Feb 18
		Mudgee, NSW	21 Feb 18
C.A. Simos, V.F. Phillips	Shiraz winemaking trial tasting	Stanthorpe, Qld	
C.A. Simos, G.D. Cowey, I.L. Francis, S.A. Schmidt	Qilu University of Technology, China, AWRI visit	Adelaide, SA	23 Feb 18
Y. Hayasaka	Yamanashi Winery Association AWRI visit		26 Feb 18
C.A. Simos, V.F. Phillips	Shiraz winemaking trial tasting	Hobart, Tas	1 Mar 18
C.A. Simos, V.F. Phillips	US sommeliers' AWRI visit	Adelaide, SA	24 Apr 18
C.A. Simos, V.F. Phillips, P.R. Petrie	AWRI roadshow viticulture seminar	Griffith, NSW	9 May 18
C.A. Simos, V.F. Phillips, S. Nordestgaard	Shiraz winemaking trial tasting		
C.A. Simos, V.F. Phillips, P.R. Petrie	AWRI roadshow viticulture seminar	Mildura, Vic	10 May 18
C.A. Simos, V.F. Phillips, S. Nordestgaard	Shiraz winemaking trial tasting		
C.A. Simos, V.F. Phillips, P.R. Petrie	AWRI roadshow viticulture seminar	Loxton, SA	11 May 18
C.A. Simos, V.F. Phillips, S. Nordestgaard	Shiraz winemaking trial tasting		
C.A. Simos, M.F. Calabrese, V.F. Phillips, G.D. Cowey, M.G. Holdstock	Advanced Wine Assessment Course (AWAC 45)	Adelaide, SA	14-18 May 18
	Advanced Wine Assessment Course (AWAC 46)		21-24 May 18
M.G. Holdstock, W.P. Pearson	Aroma wall	Vinexpo, Hong Kong	29-31 May 18
M. Longbottom, V.F. Phillips	Research to practice workshop – Managing grapevine nutrition in a changing climate	Padthaway, SA	5 Jun 18
M.F. Calabrese, M.G. Holdstock	Barossa wine assessment training	Barossa Valley, SA	19-20 Jun 18
M.P. Krstic, K.J. Dunne, J.A. Culbert, V.F. Phillips, G.D. Cowey	Sparkling wine symposium	Melbourne, Vic	26 Jun 18
C.A. Simos, M.P. Krstic, K.J. Dunne, V.F. Phillips, G.D. Cowey	Smoke taint Q&A workshop	Macedon, Vic	27 Jun 18
M.P. Krstic, K.J. Dunne, V.F. Phillips	Vine pruning workshop	Yarra Valley, Vic	29 Jun 18

APPENDIX 3

Posters

Staff	Title of poster	Presented at	Date
T.E. Siebert, S.R. Barter, A. Barker, W.P. Pearson, M.A. de Barros Lopes[1], P. Darriet[2], M.J. Herderich, I.L. Francis	Why does this wine smell like apricots?	15th Weurman Flavour Research Symposium, Graz, Austria	18-22 Sep 17
P.J. Costello, E.J. Bartowsky[3], P.J. Chambers, C. Jordans, S.A. Schmidt	Selecting stress tolerant malolactic bacteria for Australian winemaking	ComBio 2017, Adelaide	2-5 Oct 17
J.M. McRae, N.I. Warnock[4], S.A. Schmidt, A.M. James[5], J.S. Mylne[5], P. Anderson[5], P.A. Smith[6]	Towards a ferment-active protease for white wine protein stability: a sunflower asparaginyl endopeptidase and a grape pathogen protease		
L. A. Hartmann, S.A. Schmidt, A.R. Borneman	Bioprospecting the regional diversity of Australian wine microbiota		

Affiliations: [1]University of South Australia, [2]University of Bordeaux, France, [3]Lallemand Australia, [4]Flinders University, [5]University of WA, [6]Wine Australia

APPENDIX 4

Teaching responsibilities (lectures) of AWRI staff

Institution	Subject number	Subject name	No of lectures	Staff member
University of Adelaide	3530WT	Plant production and global climate change	1	M.L. Longbottom
			1	M. Essling
	7520WT	Advances in wine science	1	G.D. Cowey
	3046WT	Fermentation technology	2	I.L. Francis
	3047WT	Winemaking at vintage	1	M.P. Day
	CHEM2530	Environmental and analytical chemistry II	2	J.A. Culbert
	3007WT	Stabilisation and clarification	1	R. Gawel
			3	A.D. Coulter
			1	J.M. McRae
	2500WT	Animal and plant biochemistry II	1	C.A. Varela
	2520WT	Microbiology and biotechnology II	1	S.A. Schmidt
	3500WT	Grape and wine industry practice, policy and communication	1	I.L. Francis
			1	M.L. Longbottom
			1	C.S. Stockley
University of Melbourne	UNIB10009	Food for a healthy planet	1	
University of South Australia	Mark 1008 006434	Consumer behaviour	2	I.L. Francis

APPENDIX 5

Student supervision responsibilities of AWRI staff

Student	Supervisors	Source of funds
PhD		
Lisa Hartmann	A.R. Borneman, S.A. Schmidt	University of Adelaide, Wine Australia
Mango Parker	I.L. Francis, M.J. Herderich, J.L. Hixson, M.A. de Barros Lopes[1]	Wine Australia, Australian Government Research Training Program Scholarship
Wes Pearson	I.L. Francis, J.W. Blackman[2], L.M. Schmidtke[2]	Wine Australia
Stipe Zekanovic	S.A. Schmidt, I.W. Dawes[3], G. Perrone[4]	Wine Australia, Western Sydney University
Gail Gnoinski	S.A. Schmidt, D.C. Close[5], F.L. Kerslake[5]	University of Tasmania
Yevgeniya Grebneva	M.J. Herderich, J.L. Hixson, M. Stoll[6], D. Rauhut[6]	Hochschule Geisenheim University, Germany, AWRI
Olaf Schelezki	D.W. Jeffery[7], P.A. Smith, P.R. Petrie	Australian Research Council Industrial Transformation Training Centre, University of Adelaide
Naomi Verdonk	K.L. Wilkinson[7], K.L. Pearce[1], R. Ristic[7], J.A. Culbert	University of Adelaide, Wine Australia
Yihe (Eva) Sui	K.L. Wilkinson[7], J.M. McRae	University of Adelaide
Ryan Zeppel	A.R. Borneman, C.D. Curtin, J. Kelly[7]	University of Adelaide
Liang Chen	D.W. Jeffery[7], D.L Capone	University of Adelaide, China Scholarship Council, Wine Australia
Fangzhou Chen	K.A. Bindon, C.M. Ford[7]	Wine Australia, University of Adelaide
Sijing Li	K.A. Bindon, K.L. Wilkinson[7], S.E.P. Bastian[7], V. Jiranek[7]	Australian Research Council Industrial Transformation Training Centre, University of Adelaide
Julie Tang	M.A. Whitty[3], N.A. Lee[3], P.R. Petrie[8]	Wine Australia, UNSW
Martin Moran	V.O. Sadras[8], S.E.P. Bastian[7], P.R. Petrie[8]	SARDI, University of Adelaide
Lucy Kendall	P.R. Petrie[8], V.O. Sadras[8], M. Bonada[8]	Self-funded
Wendy Cameron	S. Fuentes[9], K.S. Howell[9], P.R. Petrie[8]	University of Melbourne
Qi Wu	S.D. Tyerman[7], A.R. Rinaldo, N. Habili, F.E. Constable[10]	University of Adelaide, Wine Australia
MSc		
Lin Sun	D.W. Jeffery[7], M.Z. Bekker	University of Adelaide
Vinifera Masters		
Lauren Barrett	S.A. Schmidt, M.M. Ferreira[11]	University of Montpellier, France

Theses completed

Student	Hons/PhD	Title of Thesis	Supervisors
Patricia Williamson	PhD	The effect of communication and sensory properties on Chinese consumers' initial and repeated red wine choices	I.L. Francis, S. Mueller-Loose[1,6], L. Lockshin[1]
Tracey Siebert	PhD	Identification of compounds responsible for 'apricot' and 'stone fruit' aroma and flavour in wine	I.L. Francis, M.J. Herderich, M.A. de Barros Lopes[1]
Richard Gawel	PhD	Compositional factors affecting the mouth-feel of white wine	R.J. Keast[12], S. Cicerale[12], P.A. Smith
Jenny Bellon	PhD	The development and evolution of *Saccharomyces* interspecific hybrids for improvement, industry relevant phenotypes	P.J. Chambers, A.R. Borneman, C.M. Ford[7]

Affiliations: [1]University of South Australia, [2]Charles Sturt University, [3]University of NSW, [4]Western Sydney University, [5]University of Tasmania, [6]Hochschule Geisenheim University, Germany, [7]University of Adelaide, [8]South Australian Research and Development Institute, [9]University of Melbourne, [10]Agriculture Victoria, [11]University of Lisbon, Portugal, [12]Deakin University

APPENDIX 6

Media interviews

Date	Staff member	Discussed	Media
28 Jul 17	D.L. Johnson	The AWRI, research and innovation	Wine Grape Council of SA Summit
16 Aug 17		Wine research	*National Geographic*
28 Aug 17	S.A. Schmidt	Researcher profile	Nick Carne, *Wine Australia RD&E@work*
31 Aug 17	P.R. Petrie	Frost management in vineyards	Isabella Pittaway, *ABC Rural*, Gippsland
6 Sep 17	C.A. Simos	Research, development and extension at the AWRI	Ravi Kewalram, Deputy Head of Mission, *Australian Embassy Seoul podcast*
7 Sep 17	S.A. Schmidt	Yeast research	Anthony Madigan, *WBM*
12 Sep 17	Y. Hayasaka	General information about the AWRI	Koichi Nakagomi, *www.cavewine.net*, Japan
13 Sep 17	C.S. Stockley	Five good reasons to drink red wine	Ed Phillips, *2GB*
29 Sep 17	P.R. Petrie	Climate change and the wine industry	Stephanie Aikins, journalism student, *HIP Media*
	M.J. Herderich	Glucosylation of smoke-derived volatiles in grapevine (*Vitis vinifera*) by a promiscuous resveratrol/guaiacol glucosyltransferase	Doug Main, *Scientific American*
11 Oct 17	A.M. Mierczynska-Vasilev	Use of magnetic nanoparticles to remove protein from wine	Mathilde Leclercq, *Réussir Vigne*, France
12 Oct 17	E.N. Wilkes, M.P. Day	Authenticity research in collaboration with CSIRO	Rebecca Blackburn, *Ecos Magazine*
	W.P. Pearson	Shiraz regionality project	Jeni Port, freelance journalist
14 Oct 17	M.P. Krstic	Smoke taint in wine	Jancis Robinson, *Financial Times* and *JancisRobinson.com*
17 Oct 17	D.L. Johnson	New AWRI/Wine Australia funding agreement	Sonya Logan, *Wine & Viticulture Journal*
18 Oct 17	M.J. Herderich	Smoke taint threat of wildfires to California wineries	Jesse B. Staniforth, *Food Quality & Safety*, USA
24 Oct 17	P.R. Petrie, R.G. Dambergs	Hyperspectral imaging at the weighbridge	Nick Carne, *Wine Australia RD&E news*
26 Oct 17	K.A. Bindon	Researcher profile	Nick Carne, *Wine Australia RD&E@work*
30 Oct 17	M.P. Krstic	Smoke taint in wine	Lexi Williams, *Wine Spectator*
			Amanda Gallagher, *Western Fruit Grower*, USA
		Regional program in Victoria	Nick Carne, *Wine Australia RD&E news*
8 Nov 17	P.O. Williamson	Chinese consumer behaviour	Caroline Winter, *ABC Radio*
7 Dec 17	M.P. Krstic	Smoke taint in wine	Danielle Beurteaux, *NPR 'The Salt' blog*, USA
8 Dec 17	S.A. Schmidt	Influence of SO_2 on microbes in grape must and ferments	Darren Smith, *Imbibe.com*, UK
18 Dec 17	W.P. Pearson	Shiraz regionality project and Pivot© Profiling	Nick Carne, *Wine Australia RD&E news*
28 Dec 17	E.N. Wilkes	Authenticity research	Sarah Sedghi, *ABC Radio Current Affairs*
31 Jan 18	S.A. Schmidt	Yeast research	Nick Carne, *Wine Australia RD&E news*
16 Feb 18	C.S. Stockley	Preservatives and pasteurisation in winemaking	Huon Hooke, *Sydney Morning Herald Good Food*
28 Feb 18	P.J. Costello	Researcher profile	Nick Carne, *Wine Australia RD&E@work*
5 Mar 18	C.A. Simos	AWRI Shiraz winemaking trial and associated extension events	Nick Carne, *Wine Australia RD&E news*
15 Mar 18	D.L. Johnson	Possible involvement in *Catalyst* story on food, filming at the Waite in late April	Laura Grace, *ABC Catalyst*
21 Mar 18	M.J. Herderich	Smoke taint management	Lauren Wolf, *ACS C&EN news*
29 Mar 18	R. Gawel	The importance of mouth-feel in white wines	*Hellenic Broadcasting Corporation*, Greece
5 April 18	A.R. Borneman	*Brettanomyces* research	Nick Carne, *Wine Australia RD&E news*
4 May 18		Shipwreck yeast	Narelle Graham, *ABC Radio Adelaide*
21 May 18	A.D. Coulter	Mousiness	Darren Smith, *Harpers Wine & Spirit*, UK
1 Jun 18	P.R. Petrie	Sooty mould and sap-sucking insects	Christine Webster, *Murray Valley Winegrowers News and Views*
		Research on climate change and viticulture	
12 Jun 18	A.D. Coulter	Storage orientation of bottles sealed with natural cork closures	Sagi Cooper, *The Daily Spittoon*, Israel

APPENDIX 7

Papers published by AWRI staff recorded during 2017/2018

1920 Coulter, A. Ask the AWRI: The tricks and traps of deacidification. *Aust. N.Z. Grapegrower Winemaker* (642): 56-57; 2017.

1921 Longbottom, M. Ask the AWRI: Soil analysis and soil carbon. What should you be looking for when getting your soil tested? *Aust. N.Z. Grapegrower Winemaker* (641): 44-45; 2017.

1922 Capone, D.L., Barker, A., Williamson, P.O., Francis, I.L. The role of potent thiols in Chardonnay wine aroma. *Aust. J. Grape Wine Res.* 24(1): 38-50; 2018.

1923 Wilkes, E. Why is predicting alcohol so hard? *WBM* (May/June): 64-65; 2017.

1924 Wilkes, E. Setting up a winery lab. *WBM* (July/August): 60-61; 2017.

1925 Dry, P.R. Understanding the components of terroir. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 16th Australian Wine Industry Technical Conference: Adelaide, South Australia, 24-28 July 2016*. Glen Osmond, SA: The Australian Wine Industry Technical Conference Inc.: 39-44; 2017.

1926 Petrie, P.R., Sadras, V.O. Practical options to manage vintage compression. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 16th Australian Wine Industry Technical Conference: Adelaide, South Australia, 24-28 July 2016*. Glen Osmond, SA: The Australian Wine Industry Technical Conference Inc.: 63-67; 2017.

1927 Schmidt, S.A., Roach, M.J., Borneman, A.R. Genetic diversity in clones of Chardonnay. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 16th Australian Wine Industry Technical Conference: Adelaide, South Australia, 24-28 July 2016*. Glen Osmond, SA: The Australian Wine Industry Technical Conference Inc.: 84-86; 2017.

1928 Hall, B.H., McKay, S.F., Lopez, F., Harper, L., Savocchia, S., Borneman, A., Herderich, M. Fungicide resistance in Australian viticulture. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 16th Australian Wine Industry Technical Conference: Adelaide, South Australia, 24-28 July 2016*. Glen Osmond, SA: The Australian Wine Industry Technical Conference Inc.: 87-90; 2017.

1929 Parker M., Barker, A., Black, C.A., Pearson, W., Hayasaka, Y., Herderich, M.J., Francis, I.L. In-mouth release from grape-derived precursors: unlocking hidden flavour during tasting. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 16th Australian Wine Industry Technical Conference: Adelaide, South Australia, 24-28 July 2016*. Glen Osmond, SA: The Australian Wine Industry Technical Conference Inc.: 111-114; 2017.

1930 Costello, P.J., Chambers, P.J., Bartowsky, E.J. High-throughput phenotyping of malolactic bacteria. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 16th Australian Wine Industry Technical Conference: Adelaide, South Australia, 24-28 July 2016*. Glen Osmond, SA: The Australian Wine Industry Technical Conference Inc.: 115-117; 2017.

1931 Day M.P., Wilkes, E.N. Measuring up authentication: analytical tools to test wine provenance. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 16th Australian Wine Industry Technical Conference: Adelaide, South Australia, 24-28 July 2016*. Glen Osmond, SA: The Australian Wine Industry Technical Conference Inc.: 141-143; 2017.

1932 Bindon, K.A., Schulkin, A., Dambergs, R.G., Solomon, M., Barter, S., Capone, D., Kassara, S., Cynkar, W., Francis, I.L., Smith, P.A. Objective measures of grape quality. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 16th Australian Wine Industry Technical Conference: Adelaide, South Australia, 24-28 July 2016*. Glen Osmond, SA: The Australian Wine Industry Technical Conference Inc.: 161-164; 2017.

1933 Culbert, J.A., McRae, J.M., Schmidtke, L.M., Nicholson, E., Boss, P., Smith, P., Wilkinson, K.L. Compositional variation amongst Australian sparkling white wines. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 16th Australian Wine Industry Technical Conference: Adelaide, South Australia, 24-28 July 2016*. Glen Osmond, SA: The Australian Wine Industry Technical Conference Inc.: 165-169; 2017.

1934 Avramova, M., Cibrario, A., Coton, M., Coton, E., Salin, F., Albertin, W., Curtin, C., Masneuf-Pomarède, I. Why is the genetic diversity of *Brettanomyces bruxellensis* important for winemakers and is it related to sulfur dioxide tolerance? Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 16th Australian Wine Industry Technical Conference: Adelaide, South Australia, 24-28 July 2016*. Glen Osmond, SA: The Australian Wine Industry Technical Conference Inc.: 170-172; 2017.

1935 Scrimgeour, N., Hirlam, K., Wilkes, E.N. Using cross-linked polymers to sequester metals and extend shelf life of wine. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 16th Australian Wine Industry Technical Conference: Adelaide, South Australia, 24-28 July 2016*. Glen Osmond, SA: The Australian Wine Industry Technical Conference Inc.: 173-177; 2017.

1936 Rose, L.E. Australian wine in 2050. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 16th Australian Wine Industry Technical Conference: Adelaide, South Australia, 24-28 July 2016*. Glen Osmond, SA: The Australian Wine Industry Technical Conference Inc.: 188-192; 2017.

1937 Moran, M.A., Sadras, V.O., Petrie, P.R. Late pruning and carry-over effects on phenology, yield components and berry traits in Shiraz. *Aust. J. Grape Wine Res.* 23(3): 390-398; 2017.

1938 Longbottom, M. Scholarship, membership, sensory evaluation and excellence. *Wine Vitic. J.* 32(3): p. 11; 2017.

1939 Stockley, C., Johnson, D. WineHealth 2017 – Navigating the health effects of alcohol consumption. *Wine Vitic. J.* 32(3): 26-30; 2017.

1940 Essling, M. Ask the AWRI: Vineyard snail control: exploring the options and the timing. *Aust. N.Z. Grapegrower Winemaker* (643): 46-47; 2017.

1941 Longbottom, M. Viticulturist of the Year finalists announced at Mildura seminar. *Wine Vitic. J.* 32(4): p. 10; 2017.

1942 Coulter, A., Cowey, G., Petrie, P., Essling, M., Holdstock, M., Stockley, C., Simos, C., Johnson, D. Vintage 2017 – observations from the AWRI helpdesk. *Wine Vitic. J.* 32(4): 29-31; 2017.

1943 Dry, P. Roussanne. *Wine Vitic. J.* 32(4): p. 56; 2017.

1944 Sternes, P.R., Lee, D., Kutyna, D.R., Borneman, A.R. A combined meta-barcoding and shotgun metagenomics analysis of spontaneous wine fermentation. *GigaScience* 6(7): 1-10; 2017.

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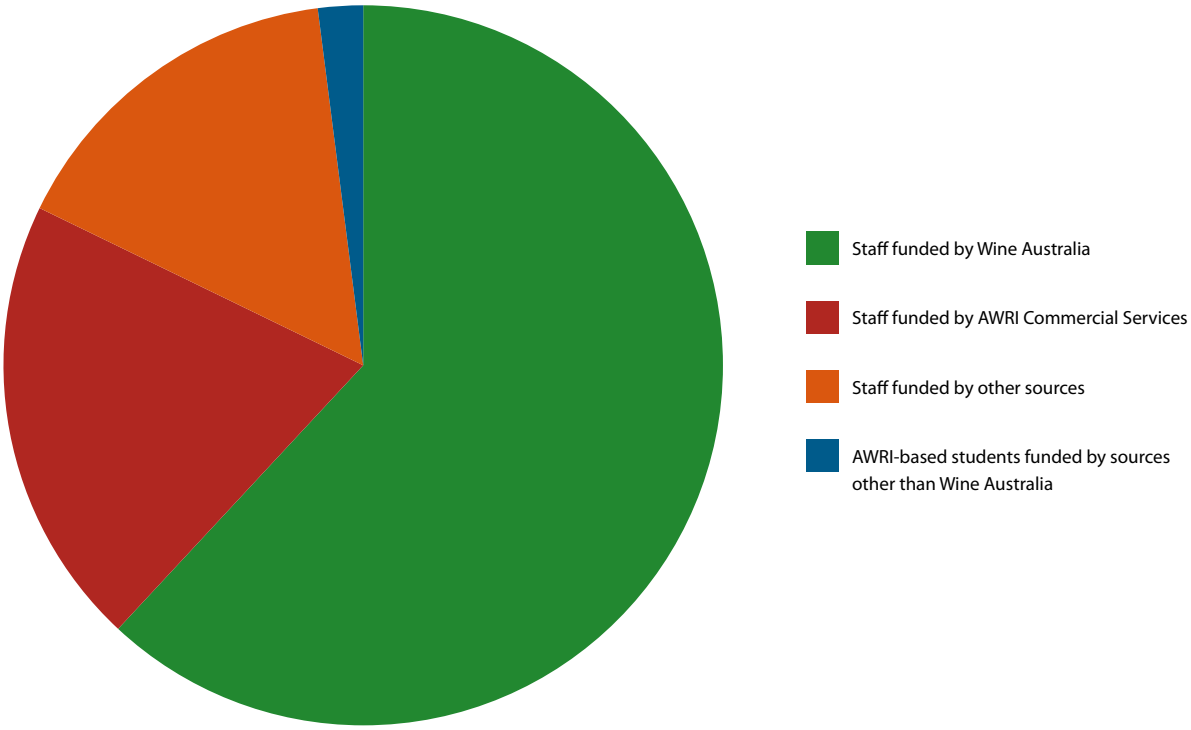

Figure 19. Funding of AWRI staff and students, excluding visiting researchers and visiting students

Staff of The Australian Wine Research Institute

SIX Michael Roach, Paul Petrie, Josh Hixson, Simon Nordestgaard, Angus Forgan, Alex Schulkin, Toni Garcia Cordente, Eric Wilkes, Markus Herderich, Mark Solomon, Kieran Hirlam, Leigh Francis, Tracey Siebert, Peter Costello, Jesse Hall, Bryan Newell

FIFTH Jacinta McAskill, Natalie Burgan, Marco Schoeman, Luca Nicolotti, Anthony Borneman, Marlize Bekker, Damian Espinase Nandorfy, Tim Riley, Randell Taylor, Bob Dambergs, Matthew Wheal, Allie Kulcsar, Adrian Coulter, Heather Tosen

FOURTH Paul Henschke, Con Simos, Mark Braybrook, Chris Day, Michael Downie, Tadro Abbott, Robyn Gleeson, Darek Kutyna

THIRD Matt Holdstock, Yevgeniya Grebneva, Lisa Hartmann, Keren Bindon, Yoji Hayasaka, Laura Bey, Lisa Pisaniello, Anne Lord, Sheridan Barter, Eleanor Bilogrevic, Sarah Ballantine, Steven Van Den Heuvel, Felipe Laurie

SECOND Kate Cuijvers, Leanne Hoxey, Deborah Thornton-Wakefield, Amanda Ylia, Ida Batiancila, Pamela Solomon, Neil Scrimgeour, Mango Parker, WenWen Jiang, Melissa Aitchison, June Robinson, Radka Kolouchova, Ella Robinson

FRONT Qi Wu, Julie Culbert, Mark Rullo, Caroline Bartel, Pauline Jorgensen, Brigitte Lynch, Cristian Varela, Shiralee Dodd, Dan Johnson, Patricia Williamson, Geoff Cowey, Virginia Phillips, Francine Gapper, Jacqui McRae, Simon Schmidt

Absentees

Adam Holland
Agnieszka Mierczynska-Vasilev
Alfons Cuijvers
Amy Cantor
Amy Rinaldo
Cameron Grant
Carrie Hill
Catherine Borneman
Chandnee Ramkissoon
Charlotte Jordans
Creina Stockley
Cristobal Onetto
David Owen
Desiree Likos
Fang Tang
Flynn Watson
Francesca Blefari
Gayle Baldock
Gina Sellars
Gurinder Khera
Heather Smith
Jacqueline Stone
Jane McCarthy
Jenny Bellon
Jennifer O'Mahony
Jillian Lee
John Gledhill
Josephine Giorgio-Ion
Junko Nagashima
Kate Beames
Kylee Watson
Laura Evans
Linda Bevin
Loretta Royal
Marcel Essling
Mardi Longbottom
Mark Krstic
Martin Day
Mary Likos
Maryam Taraji
Natoiya Lloyd
Nicole Dunkley
Nuredin Habili
Paul Cleland
Paul Lindner
Penelope Elliot
Peter Dry
Peter Godden
Philippa Hall
Richard Gawel
Sara Davis
Simon Dillon
Sonya Henderson
Stella Kassara
Sue Robinson
Thomas Hensel
Tony Hoare
Vilma Hysenaj
Wes Pearson
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