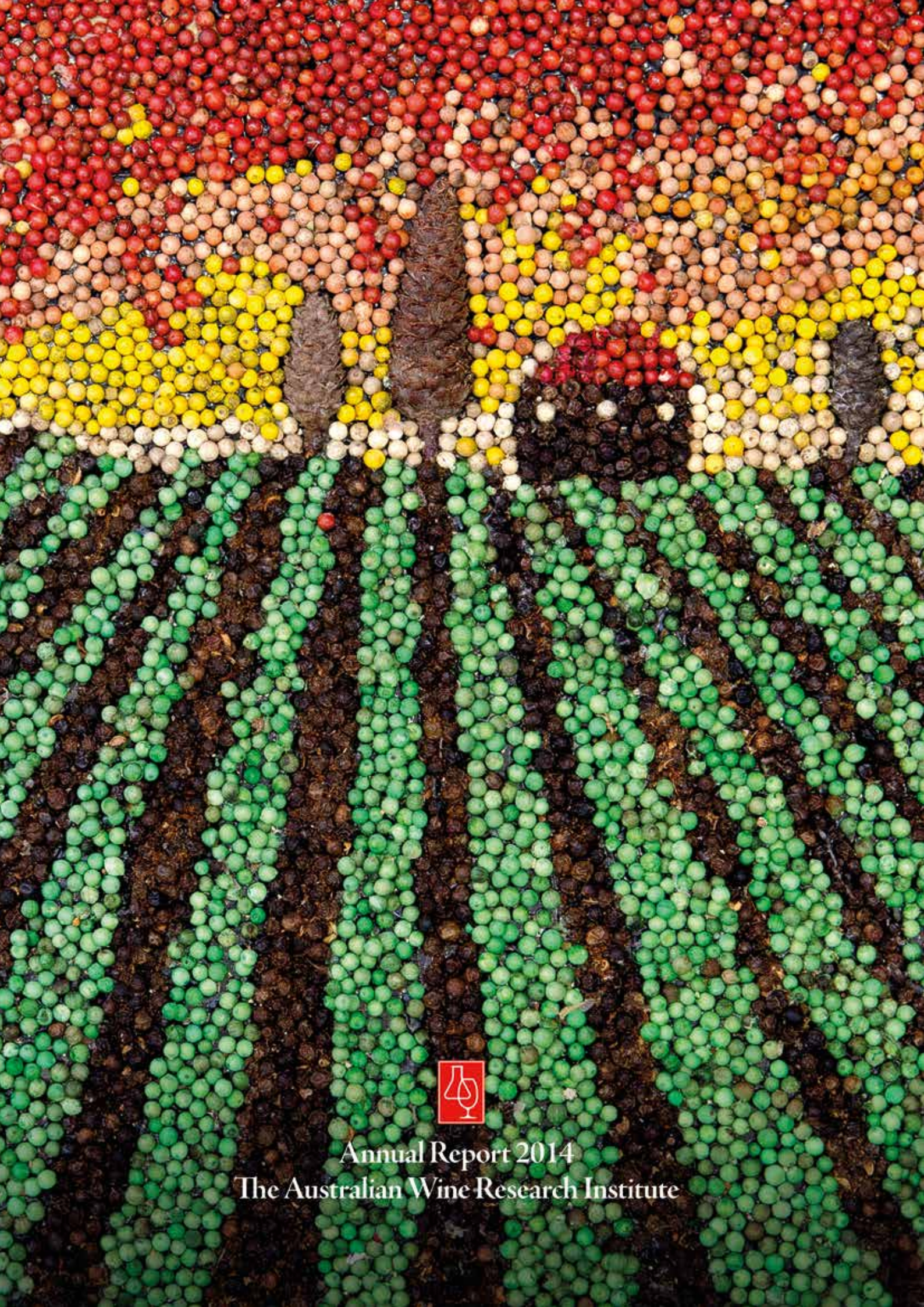


Annual Report 2014
The Australian Wine Research Institute

Board members

Ms L.E. Rose BAppSc, BSc, GAICD
Chair – Elected a member under clause 25.2(c) of the Constitution (levy payer elected director)

Mr J.C. Angove, BSc
Elected a member under clause 25.2(c) (levy payer elected director)

Mr. T.J. Bekkers BAppSc (Ag) (Hons), GCertMgt
Elected a member under clause 25.2(c) of the Constitution (from 1 January 2014) (levy payer elected director)

Mr J.F. Brayne, BAppSc (Wine Science)
Elected a member under clause 25.2(c) of the Constitution (levy payer elected director)

Mr P.D. Conroy, LLB (Hons), BComm
Elected a member under clause 25.2(b) of the Constitution (special qualifications director)

Mr P.J. Dawson, BSc, BAppSc (Wine Science)
Elected a member under clause 25.2(c) of the Constitution (until 31 December 2013) (levy payer elected director)
Elected a member under clause 25.2(b) of the Constitution (from 1 January 2014 – 24 February 2014) (special qualifications director)

Dr J.S. Harvey, BSc (Hons), PhD, MBA, GAICD
Elected a member under clause 25.2(c) of the Constitution (levy payer elected director)

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

Mr B.M. McKinnon, BAgSc (Oenology) (Hons)
Elected a member under clause 25.2(c) of the Constitution (levy payer elected director)

Mrs E.A. Riley, BAppSc (Wine Science)
Elected a member under clause 25.2 (b) of the Constitution (special qualifications director)

Prof. B.P. Schmidt AC, FAA, FRS, BS (Astronomy), BS (Physics), AM (Astronomy), PhD
Elected a member under clause 25.2(c) of the Constitution (from 25 February 2014) (special qualifications director)

Mr M.R. Watson, BEc, MBA, ACA, IPAA , MAICD
Elected a member under clause 25.2(b) of the Constitution (special qualifications director)

The company

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

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

Mission

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

Values

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

- Excellence
- Integrity
- Passion

Behaviours

The behaviours that support those values are:

Excellence

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

Integrity

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

Passion

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

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

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

Registered office

Cnr Hartley Grove and Paratoo Road,
Urrbrae, SA 5064

Postal Address:

PO Box 197, Glen Osmond, SA 5064

Telephone: (08) 8313 6600

Fax: (08) 8313 6601

Internet: www.awri.com.au

Facebook: www.facebook.com/The.AWRI

Twitter: www.twitter.com/The_AWRI

ABN: 83 007 558 296

Peppercorn vineyard cover art

The 2014 cover art is inspired by the publication this year of a map of the distribution of rotundone (the 'pepper' compound) in a Shiraz vineyard. Results suggest that the spatial variability is linked to degree of grape ripeness, soil characteristics and ambient temperature or solar radiation. This is believed to be the first study of within-vineyard spatial variability of a key grape-derived flavour compound. It highlights a potential opportunity to use viticultural practices to influence wine style – in this case the 'pepperiness' of Shiraz. The 'pepper mapping' study was conducted with Dr Rob Bramley of CSIRO Ecosystem Sciences and the late Nathan Scarlett of Rathbone Wine Group.

Creative Director Geoffrey Reed and Senior Designer Phil Easson collaborated with 'Seed Artist' Scott Cardamatis to render a vineyard made entirely of peppercorns for this special wrap around cover.

Scott sculpts Australian seed pods and flowers to create designer artwork and his quest for originality with sustainability meant using Australian Shiraz and other wines to literally dye some of the peppercorns to achieve some of the special colours required.

Photograph of the peppercorn vineyard by Tom Ferguson. www.tfad.com.au

Contents

60th Annual Report – 30 June 2014
Presented to the Australian grape and wine sector

Chair's report


Louisa Rose

This report is my first as Chair of the Board of the Australian Wine Research Institute. Having served on the Board since 2010, and collaborated with the AWRI for many years before that, I am delighted to take up this new role. I strongly believe that research and technical innovation are essential for our industry to meet its current challenges and achieve sustainable success. The AWRI and its people are in a position to make a real contribution in this area and it is both exciting and humbling to be involved in influencing its future direction.

I would like to start by acknowledging the enormous contribution of my predecessor as Chair, Peter Dawson. Peter served for twelve years on the AWRI Board including the past four as Chair. During his time on the Board, Peter oversaw a period of both change and achievement for the AWRI, with dedication and strong industry focus. Some of the highlights of this time include:

- Comprehensive industry consultation leading to the development of a 5-year Research, Development and Extension (RD&E) plan for 2013–2018
- A new funding agreement with the Grape and Wine Research and Development Corporation (GWRDC)
- A successful Managing Director transition.

Peter leaves behind an efficient and highly professional organisation and will be missed by all members of the Board. We look forward to working with him in his new role as Chair of the Wine Innovation Cluster.

I'd also like to welcome the two newest Board members, Toby Bekkers and Prof. Brian Schmidt, who joined the Board during the year. Toby is a viticulturist, consultant and business manager from McLaren Vale with more than 20 years' experience in our industry. Brian is Laureate Fellow and Distinguished Professor at the Australian National University's Mount Stromlo Observatory and also runs Maipenrai Vineyard and Winery in the Canberra District. The perspectives they have both contributed to the Board have been very valuable.

The AWRI is now one year into its 5-year RD&E plan. This first year has been one of establishment for a number of important research projects, setting the foundations for future experiments, gathering important initial datasets and implementing plans. Despite most projects being in their early stages, a number of interesting results have emerged during the year. These include insights into the influence of timing of oxygen exposure, new understanding of the role of metals in formation of reductive characters and an exciting new method for analysing grape tannin in a way that better predicts the final wine tannin. More details of these and other research outcomes from the year can, of course, be found in this report.

Extension activities have been at an all-time high during the year, with an AWRI event delivered somewhere across Australia on average once per week. The combination of on-the-ground events with printed and electronic communications allows excellent reach and gives industry every opportunity to stay in touch with the latest technical developments. The 15th Australian Wine Industry Technical Conference and WineHealth 2013, both held in Sydney in July 2013 were highlights, with AWRI staff making major contributions to planning and executing both events.

Looking forward, there is much to be positive about. I am very excited about the AWRI's new projects. The new extension program 'Opportunities in a New Climate', funded by the Department of Agriculture, is one of these. This program aims to gather the most relevant and up-to-date information on carbon farming and climate adaptation from a wide range of sources and package it into a useful form for the Australian grape and wine industry. To be delivered via an extensive series of workshops and a collection of online resources, this very practical project should make a real difference to growers and winemakers.

Another new area of activity is the delivery of viticulture extension activities on behalf of the NSW Department of Primary Industries. This project will involve the commissioning of ten new weather stations in Griffith and Mudgee which will provide real-time reporting via the AWRI's website. Drawing on the data gathered by this network, a fortnightly bulletin with information on weather, vine phenology and pest and disease risks will be distributed to growers and winemakers during the growing season. Field days and workshops will also form part of the project.

Both of these initiatives build on the AWRI's existing extension expertise and information resources that grape and wine producers have been accessing for many decades. They add to the scope of information that is delivered and may potentially reach new stakeholders. The winning of grants and tenders in this area is a strong endorsement of the AWRI as the industry's trusted source of technical information.

In terms of the industry landscape, the formation of the Australian Grape and Wine Authority from the merger of the GWRDC and Wine Australia Corporation is a positive change. It brings with it opportunities for enhanced collaboration and perhaps new possibilities for research to be better integrated with marketing. The AWRI Board looks forward to collaborating with the new AGWA Board on directions for grape and wine research in Australia.

Implementing a new plan always takes considerable effort and dedication. I would like to thank Dan Johnson and all of the AWRI staff for their hard work and enthusiasm in launching so many new projects this year, adapting to different processes and always maintaining their focus on industry.

Finally, I acknowledge my fellow Board members for their unflagging commitment to both the AWRI and the broader wine industry and look forward to working together in the year ahead.

Louisa Rose
Chair

Managing Director's report


Dan Johnson

New beginnings

The past year has been one of new beginnings at the AWRI. After consulting widely on new industry priority topics and considering scientific trends and opportunities, the AWRI released a Research, Development and Extension plan for the period 2013-2018. The focus then quickly shifted from 'big picture strategy' to implementation and execution, with development of detailed plans for all 50 projects contained in the RD&E plan and associated financing and contracting activities.

Pleasingly, at the end of the first year of the plan, 42 of the 50 projects (84%) are active, with 88% of outputs and activities on or ahead of schedule. Starting such a large number of projects at the same time has required significant efforts from across the organisation, necessitating among other things realignment of personnel, new reporting systems, commencement of new domestic and international collaborations and substantial investment in capital infrastructure. I thank all staff for the enthusiastic way that they have launched the new projects, adapted to a new environment and the entrepreneurial, collaborative spirit shown in helping each other and other agencies where needed.

I have been very pleased with the administrative and technical progress made so far, in terms of both pre-competitive RD&E activities undertaken in support of levy payers and fee-for-service capabilities, the latter of which saw substantial growth. One particularly pleasing result was the continued increase in analytical service sample volumes, to record levels. This is an industry service that contributes to maintaining a strong database of Australian wine compositional trends and supports the broader RD&E agenda. In addition, AWRI cash reserves are now approaching the Board's target of a reserve that covers six months of operations.

A new business and operational plan was prepared to provide administrative support to the targets set out in the AWRI 2013-2018 RD&E plan and increase organisational productivity. Pleasingly, some of the targets identified in this plan were completed in the first few months of its operation, including the finalisation of a new Employment Agreement between the AWRI and its employees.

These are good results for the first year of a new RD&E plan, but there is still considerable work to be done. Some projects are active only across part of the original scope and others are yet to secure funding to allow them to commence. Inactive or marginally active areas which will be a priority to progress in the coming year include wine and health, wine authenticity and yeast strains with the ability to make lower alcohol, full flavour wine. Commencing new projects will not be easy in the current international research investment climate; new partnerships are likely to be required to make meaningful progress.

Commencement of a new suite of projects has been accompanied by substantial efforts in wrapping up, publishing and extending information generated in previous projects to ensure that industry has the maximum possible opportunity to adopt that information. The AWRI hosted or co-hosted events at a rate of more than one each week, an all time record. Particular highlights were the 15th Australian Wine Industry Technical Conference (in conjunction with ASVO), WineHealth 2013, themed masterclasses, and the introduction of a broader suite of viticulture topics, including areas such as climate adaptation, into the AWRI's regular roadshow program.

Welcome to the Australian Grape and Wine Authority

Another new beginning is the formation of the Australian Grape and Wine Authority (AGWA) through the merger of the Wine Australia Corporation and the Grape and Wine Research and Development Corporation on 1 July 2014. This new body will combine investment in RD&E with market development and compliance activities, bringing a wide range of capabilities under one roof. It is expected that industry will benefit from the streamlining and coordination of functions. The AWRI anticipates a very positive working relationship with the new entity, with which it shares a common purpose and single-minded focus on industry profitability and sustainability. Formation of such an entity is a once in a generation opportunity for AGWA and its key stakeholders, including the AWRI, to 'hit the refresh button' and ensure that our industry bodies are collectively operating as effectively as possible. I have been encouraged by the positive dialogue between AGWA and the AWRI to date and look forward to continuing our joint efforts to achieve reductions in red tape, minimise duplication and improve the value, clarity and cost-effectiveness of industry services.

A challenging research environment

Globally, the research sector is experiencing a very challenging period – this applies not only to grape and wine research but all fields of research endeavour. Despite the enormous promise of scientific research in prolonging life, improving productivity and growing economies, many prestigious organisations with a history of research excellence and strong international profiles are facing substantial funding cuts which have led to a reduction in scope or cancellation of entire research programs and loss of scientific capabilities. The Australian research sector has been among the hardest hit of the world's developed economies, and the Australian grape and wine research community has needed to contend with static or falling funding levels – or at least a reduction in the investment that hits the grassroots – and a reduction in staffing levels. These challenges are exacerbated in some quarters by short-term thinking on science and regular shifting of priorities that prevent meaningful progress on some of the biggest industry challenges.

The AWRI has been affected by these trends, with a need to increase the administrative load on otherwise productive scientists, carefully control costs and postpone plans to conduct some truly ground-breaking projects.

The research organisations involved in the Wine Innovation Cluster are developing a common vision for grape and wine research in Australia.

This vision presents the case for identifying and supporting long-term (30 year +) RD&E requirements for the Australian wine industry.

More than ever there is a need for industry policies and systems to be designed to allow as much of the available RD&E investment to reach its intended target and support our industry's best and brightest brains.

Technical trends

Vintage 2014 was dominated by weather-related challenges across many wine regions and this was reflected in the volume, timing and nature of enquiries received. Throughout the year a total of 4,747 information requests, helpdesk enquiries and problem investigations were addressed, and the AWRI Commercial Services laboratories completed analyses on more than 18,000 samples.

More than 1,900 enquiries and requests for assistance were addressed by the helpdesk, greater than 80% of which were answered within 24 hours.

The majority of the enquiries received were from wine companies and suppliers closely aligned with the wine industry, whilst the remaining queries were from government organisations, students, legal personnel and journalists. A total of 201 queries turned into investigations where samples were requested and further analysis performed (on 1,059 samples) to identify the problem and how it could be remediated. The source and proportion of the winemaking enquiries received were broadly aligned with the volume of wine-grape production of Australian states.

Viticulture (466 enquiries)

Greater than 30% of enquiries were 'agrochemical-related', with the remaining enquiries related to general viticulture issues including fungal and insect pest control, smoke taint, sustainability and alternative varieties.

Major assistance and associated extension efforts related to:

- frosts that occurred in October 2013 in many parts of Australia, contributing to yield losses of between 5 and 100% in affected areas
- three significant heatwaves during January 2014. Growers were advised in advance of the hotter temperatures to increase irrigation to maintain canopies and leaf condition. Those who were able to irrigate in time limited the heat damage
- thunderstorms in February 2014 that favoured the development of powdery mildew. Growers who were unable to control the disease early struggled later when many chemicals were no longer permitted.

Winemaking (1,309 enquiries)

During the early part of the 2014 vintage (January and February), queries were mainly associated with the keywords smoke taint, fermentation advice, taints and contaminations and analysis methods. Queries were also received on some topical issues at the time which included 'fracking' (unconventional gas exploration and extraction) and *Metschnikowia pulcherrima* yeast (a yeast strain able to make lower alcohol wines identified by AWRI research).

As vintage progressed an unusual number of enquiries relating to packaging issues emerged (greater than the number of fermentation-related enquiries) combined with a low number of haze and deposits. Taints and contaminant issues are always seen during vintage and 2014 was no exception with a number of investigations initiated from the initial enquiries.

Towards the end of vintage there were a number of enquiries and discussions with winemakers concerned about acidity levels and acidity adjustments. Strange pH and titratable acidity (TA) relationships from the vintage were observed, which were attributed in part to the heatwaves experienced across the country earlier in 2014. Additionally calcium-DL-tartrate precipitation issues are being seen more commonly, a likely flow-on effect from the use of the cheaper racemic tartaric acid during winemaking. The total number of investigations conducted into wines affected by hazes and deposits continues to be significant – more than 30% of the deposits identified during the period were crystalline, with approximately 50% of these being potassium hydrogen tartrate and 50% calcium tartrate. Calcium-based tartrates are harder to predict and often drop out a few months post-bottling.

Other winemaking enquiries that prompted a moderate or high number of investigations included:

- microbiological instabilities
- sparkling wine or sparkling wine product faults, taints and instabilities
- closure performance, stability and application
- remediation of copper over-additions
- faults and taints in still wine.

Health and regulatory (178 enquiries)

Health and regulatory enquiries included:

- approaches to complying with regulatory limits of manganese, copper and iron in wines exported to China
- measurement and usage of permitted additives such as sorbates, organic acids, liquid tannin extracts, glutathione and carboxy methyl cellulose
- adverse and allergenic effects from wine, its constituents and wine-related products such as balsamic vinegar
- the healthfulness of wines made from different grape varieties and wines made with or without preservatives.

Technical highlights

In a year focused on establishing new projects, there have nonetheless been some significant highlights across research, development and extension activities. A full list is published in this report, but some that I'd like to particularly mention are listed below.

- For the first time, the distribution of the 'pepper' compound rotundone was mapped in a Shiraz vineyard. Recently published results highlight a surprisingly wide concentration range of rotundone in grapes across a vineyard with spatial variability linked to differences in soil characteristics and topography. This is believed to be the first study of within-vineyard spatial variability of a key grape-derived flavour compound. It highlights the potential opportunity to use selective harvesting or targeted viticultural manipulation as a means of influencing wine style – in this case the 'pepperiness' of Shiraz. The study was conducted with Dr Rob Bramley of CSIRO Ecosystem Sciences and the late Nathan Scarlett of Rathbone Wine Group.
- Nitrous oxide emissions from Australian vineyards were evaluated, with data from vineyards across five Australian regions indicating that nitrous oxide (N_2O), a potent greenhouse gas, is released at much lower levels from vineyards than from other horticultural crops.
- The importance of metals in the reactions that form volatile sulfur compounds in wine was demonstrated. A storage trial of Chardonnay and Shiraz wines treated with metal ions found significant changes in sulfur compounds, with the Chardonnay samples showing increases in the compounds H_2S and DMS, and the Shiraz samples showing increases in the compounds H_2S and MeSH. These results have implications for the common winemaking practice of adding copper sulfate to wine to remove negative volatile sulfur aromas, as residual copper present in wine may, over time, worsen rather than improve the problem.
- Experiments showed that significant wine flavour produced in-mouth was derived from glycosylated flavour precursors. Time-intensity methodology was used, where a trained sensory panel rates the intensity of in-mouth flavour attributes continuously over a period of minutes, so that the progress of release can be tracked over time. The results may provide a new style measure to distinguish wines with desirable flavour persistence from those with a short finish.

Dan Johnson, Markus Herderich, Kate Beames, Chris Day

- A new tool to help reduce electricity costs associated with winery refrigeration was released and is available for download from the AWRI website. The development of the calculator was made possible through the strong industry networks at the AWRI's Riverina and Hunter nodes and built on existing in-house expertise in refrigeration. Workshops were delivered across several regions to demonstrate the calculator's functionality and ability to reduce winery costs.

- A new partnership has been forged with Macquarie University in the field of synthetic biology. The partnership will focus on building skills and capability in synthetic biology, providing leadership in this field in the Asia-Pacific region and facilitating participation in international projects. The first project the partnership is involved in is the exciting international collaboration to build a synthetic version of yeast, known as Sc2.0. Macquarie and the AWRI are jointly responsible for synthesising Chromosome XIV of the synthetic yeast's genome.

- In July 2013, the AWRI was involved in the staging of the 15th Australian Wine Industry Technical Conference and the WineHealth 2013 International Wine and Health Conference. These conferences brought together technical experts and industry to exchange scientific information and ideas. The staging for the first time of WineHealth in Australia resulted in strong media engagement on the topic of wine consumption and human health.

A new Chair for the AWRI Board

A further new beginning this year was the appointment of Louisa Rose to the position of AWRI Chair. Louisa is a widely respected winemaker with a palpable passion for both wine and science, and I have enjoyed working with her and the other highly capable, engaged members of the AWRI Board. Louisa replaces the outgoing Chair Peter Dawson, who had served his maximum term on the AWRI Board and is warmly thanked for his service.

Looking forward

The next year, in which the AWRI will celebrate its 60th anniversary, promises to be one of continued implementation of the AWRI's RD&E project portfolio. Results will begin to emerge from some of the new, shorter-term projects, with associated opportunities for extension and adoption. Every effort will be made, albeit in a difficult research funding climate, to progress the eight priority themes in the AWRI's RD&E Plan 2013-2018 that did not progress in a meaningful way this year.

The Australian wine sector's RD&E framework and its own research institution, the AWRI, are both global standards, and I have every confidence that the new beginnings this year will position the industry for a sustainable and profitable future befitting the AWRI's mission – *Supporting the Australian grape and wine industry through world class research, practical solutions and knowledge transfer.*

Dan Johnson
Managing Director

Board notes

Chair
Ms. L.E. Rose

Audit sub-committee
Mr M.R. Watson (Chair)
Mr P.D. Conroy
Dr. J.S. Harvey

Personnel sub-committee
Ms. L.E. Rose (Chair)
Mr B.M. McKinnon
Mr J.F. Brayne

Meetings
Ordinary General Meeting
The 59th Ordinary (Annual) General Meeting was held on 3 December 2013.

Extraordinary General Meeting
n/a

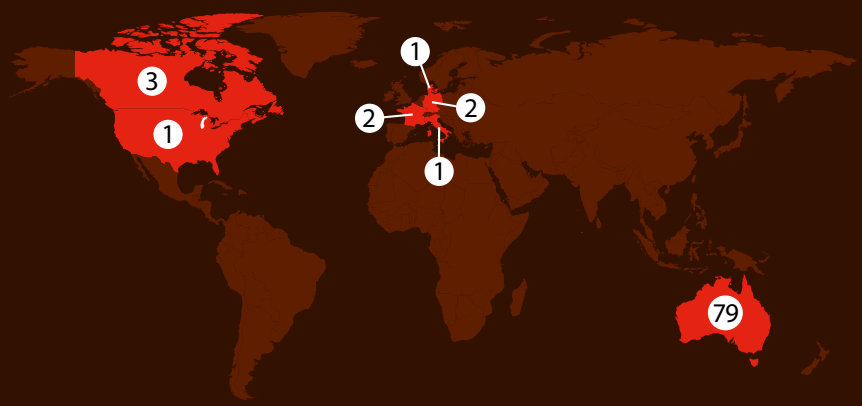
Board
The Board of the AWRI met on the following dates: 17 September 2013, 3 December 2013, 25 February 2014 and 3 June 2014.

Investment
The Board of the AWRI acknowledges the continuing financial support of the Grape and Wine Research and Development Corporation (now the Australian Grape and Wine Authority), the Government of South Australia (including the Premier's Research and Industry Fund), the Australian Government Department of Agriculture, Bioplatforms Australia and the Grains Research and Development Corporation, along with a large number of confidential commercial clients.

L to R: John Angove, Paul Conroy, Toby Bekkers, Brian Schmidt, Louisa Rose (Chair), Mark Watson, John Harvey, Dan Johnson. Absent: Jim Brayne, Brett McKinnon and Liz Riley.

Appreciation

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



Highlights of the year 2013–2014

General

Implementation of new RD&E plan

The AWRI's 5-year RD&E plan went live in 2013/2014 with new projects launched under 42 of the 50 project headings outlined in the plan.

Record year for AWRI Commercial Services

AWRI Commercial Services experienced a year of record demand, with 18,366 samples submitted for analysis.

New international networks

The AWRI has joined the Oenoviti/Oenodoc International Network, an association of research and education institutions involved in grape and wine science. This network fosters cooperation in teaching and research and conducts activities such as exchange programs, conferences, student placements and co-supervision arrangements. The AWRI has also been invited to join the Innovative Training Network: 'INDULGAROMA' as part of a funding application by a large European consortium under the Horizon2020 program.

Environment and sustainability

Nitrous oxide emissions from Australian vineyards evaluated

An understanding of emissions of nitrous oxide (N_2O, a potent greenhouse gas) from Australian vineyards has been gained for the first time. Samples collected from vineyards across five Australian regions showed that N_2O is released at much lower levels from vineyards than from other horticultural crops. The influence of different viticultural management practices on N_2O emissions is also under investigation.

Climate-related workshop delivered

The AWRI roadshow workshop 'Adapting to difficult vintages' was presented across eight Australian wine regions. The workshop provides participants with strategies to adapt to weather extremes in a changing climate.

Comparative genomics of Chardonnay clones

A reference sequence is being created from one of the 14 clones of Chardonnay sequenced previously. Sequence data for the remaining clones will be mapped onto the reference genome in order to identify variations. The project is working towards identifying clone-specific markers that can be used to identify clones in the vineyard or nursery.

Consumers, customers and markets

Increasing choice of Australian wine by Chinese consumers

A shelf simulation online choice test was conducted in China with 1,670 consumers of imported red wine. The results revealed that reading an article about Australia considerably increased the choice of Australian wines over French, Italian or Chinese wines, especially when the article indicated that Chinese consumers prefer the taste of Australian wine, or reinforced the message that Australian food and beverages are clean and unpolluted. The effect of the messages was found to continue when consumers were re-tested more than a week after reading the article.

WineHealth 2013 conference hosted

The WineHealth 2013 International Wine and Health Conference was held in Sydney from 18 to 20 July 2013. Proceedings have been published in the peer reviewed journal *Nutrition and Ageing* and are freely available online.

MRL harmonisation sought

The AWRI is actively supporting the establishment of a maximum residue limit (MRL) for phosphorous acid (phos acid) in key export markets together with Wine Grape Growers of Australia, key regional associations and Nufarm Australia Ltd.

Approval sought for processing aids

Resolutions were introduced into the Organisation de la Vigne et du Vin's (OIV) eight-step resolution procedure to enable protease enzymes, potassium carbonate, dimethylpolysiloxane and agar to be permitted for winemaking and wines sold in the EU and potentially other member countries. An application to enable use of protease enzymes such as Proctase in Australian winemaking was lodged with Food Standards Australia New Zealand and is awaiting formal approval.

Improving products and processes

New synthetic biology collaboration

The AWRI has entered into a new partnership with Macquarie University in the field of synthetic biology. The partnership's first major project forms part of an international collaboration assembling the world's first synthetic yeast. Macquarie and the AWRI are jointly responsible for synthesising Chromosome XIV of the synthetic yeast's genome.

Impact of metals on 'reduced' aromas demonstrated

Metal ions were added to Chardonnay and Shiraz wines which were then stored for 12 months and monitored for the formation of volatile sulfur compounds. Significant changes were observed, with the Chardonnay samples showing increases in H_2S and DMS, and the Shiraz samples showing increases in H_2S and MeSH. This study has demonstrated that the presence of metals in wine can have a major influence on the evolution of unwelcome 'reduced' aromas during anaerobic storage. Winemakers looking to reduce the risk of such aromas can consider taking steps to minimise metal concentrations in wine.

'Pepper' mapping suggests ripeness and ambient temperature or solar radiation are important for rotundone formation

Studies continued into factors affecting the concentration of the 'black pepper' compound rotundone, a key flavour compound in Shiraz from cooler regions. The first ever study of within-vineyard spatial variability in a grape-derived flavour compound was published. Results suggest that degree of ripeness, and either ambient temperature or solar radiation are key factors in rotundone formation.

New tannin extraction method for grapes provides prediction of wine tannin

A new 'wine-like' extraction method for grape analysis of tannin and colour was evaluated against the standard extraction method. The 'wine-like' method was shown to better predict tannin content in the final wine than the standard method.

Metagenomics shedding light on wild ferments

Uninoculated Chardonnay ferments were subjected to metagenomic analysis to determine the species present throughout the fermentation. Initial results found a diverse ecosystem of yeasts present at the beginning of the ferment that converged on the wine yeast *Saccharomyces cerevisiae* as the ferment progressed. Further work will investigate how the levels of species and strains change during fermentation, and whether regions, wineries or vineyards can be broadly defined by the micro-organisms in their wild ferments.

In-mouth flavour release from monoterpene glycosides confirmed

Experiments showed that significant wine flavour produced in-mouth was derived from monoterpene glycosides, a group of flavour precursors. Time-intensity methodology was used, where a trained sensory panel rates the intensity of in-mouth flavour attributes continuously over a period of minutes, so that the progress of release can be tracked over time. The results may provide a new measure to distinguish wines with desirable flavour persistence from those with a short finish.

Consumer-oriented design program launched

In conjunction with the South Australian Government, the McLaren Vale Grape Wine and Tourism Association and Scholle, the AWRI established a Consumer Oriented Design program in McLaren Vale. This design approach aims to generate innovative business initiatives or product concepts with emotive appeal to consumers. Key personnel from ten wineries in McLaren Vale attended a four-stage workshop program delivered by the University of Technology, Sydney. Attendees collaborated to develop three unique business initiatives, one of which will be commercialised.

Juice clarification investigated

A broad scoping study has begun using laboratory-scale experiments to compare the effects of three methods for juice clarification: natural settling, centrifugation and clarification agents. Results obtained in 2013/2014 suggest that fermenting juice containing higher levels of solids may result in white wine with higher polysaccharide concentrations, and that wine polysaccharides are also affected by the juice clarification method used. Juice clarity also significantly affected both wine total phenolics and phenolic profiles.

'Green' flavours explored

Studies into 'green' flavour in red wines have used Gas Chromatography-Olfactometry to identify individual aroma compounds that give rise to 'grassy', 'vegetative' aromas in some Cabernet Sauvignon and Shiraz wines. Experiments are also assessing whether the presence of grape leaves or stalks in fermentations can impart 'vegetative' or other flavour compounds into wine.

Impact of grape composition on fruit grading investigated

Key compounds were quantified in 182 grape samples across Cabernet Sauvignon, Shiraz and Chardonnay grapes from multiple regions and compared with the commercial grading of the fruit. At this stage YAN, total phenolics, absorbance at 420 and 520 nm and β-damascenone appear to be positively associated with higher value grades and TA, cysteine, glutamate and glutathione appear to have reduced concentrations in higher value grades. Results also suggest that mid-infrared spectra of grape homogenates may provide an accurate way of predicting grape grade.

Genetic and performance profiling of yeast strains

Whole genome sequence data were obtained from 205 wine yeasts and cluster analysis was performed to assess genetic diversity. Strains were then selected for characterisation of fermentation kinetics and flavour outcomes. Model fermentations conducted with a large number of yeast strains have been extensively profiled for their chemical composition, and flocculation behaviour of these strains was also screened. This large multi-dimensional dataset is now being used for benchmarking of novel strains and the development of genomic markers for marker-assisted breeding.

New understanding of MLF strains

Genome sequences have been generated for 85 wine bacteria. A subset of these strains has been screened for MLF robustness at low pH, high alcohol, and low temperature in red and sparkling base wines. Analysis is underway to identify genetic markers for stress tolerance.

Sulfite effects on *Brettanomyces* explored

Work is underway to explore the mechanisms that enable *Brettanomyces* to adapt to environmental conditions, particularly sulfite stress. A collaboration with the University of Adelaide has been established, working on *Brettanomyces* cultures continuously exposed to sulfite stress and the next-generation sequencing methodologies needed to monitor them. Detailed genomic maps of 40 *Brettanomyces* strains from around the world have been created, against which novel variants from the sulfite exposure experiments can be benchmarked to identify relevant mutations.

Extension and adoption

15th AWITC staged

The AWRI and ASVO delivered a highly successful 15th Australian Wine Industry Technical Conference in Sydney from 13 to 18 July 2013. AWRI staff members contributed to program design and event management, managed the workshop program and the poster display, and gave numerous presentations in both workshops and plenary sessions. The proceedings of the 15th AWITC were edited, produced and distributed to delegates.

Roadshow program delivered

Sixteen AWRI grape and wine roadshow seminars and ten workshops were held during the year, covering 23 regions. A record-breaking crowd attended the Riverland roadshow seminar in Renmark in May.

Advanced Wine Assessment course brought in-house

For the first time the Advanced Wine Assessment course (AWAC) was held at the AWRI, with two courses held during the year. The move allows participants to gain a greater understanding of the AWRI's capabilities and facilities. Dux winners for both courses have been offered the opportunity to participate as associate judges at the Royal Adelaide Wine Show in 2014.

World Chardonnay and Pinot Noir showcased

Two themed tastings focused on World Chardonnay and Pinot Noir were delivered. The program consisted of eighty wines from across the world, with a large proportion sourced internationally, giving participants a unique opportunity to taste wines not commercially available in Australia.

Tool to manage refrigeration demand launched

The AWRI Refrigeration Demand Calculator is a spreadsheet-based tool that allows wine producers to model, analyse, understand, and better manage their refrigeration demand with a view to reducing electricity use. This new tool is now available to all Australian wine producers as a free download from the AWRI website.

Helpdesk queries answered

Project team members responded to 1,953 technical queries on a range of winemaking, viticulture and regulatory topics, with more than 80% answered within 24 hours. Weather-related issues including smoke taint, frost, heatwaves and uneven ripening were common query topics during vintage 2014.

Winemaking investigations

Over 1,000 samples were submitted and analysed as part of 201 investigations carried out during the year. A high proportion of the investigations were related to hazes and deposits in wine, followed by investigations of taints and contaminations.

Extension via the Greater Victoria node

The AWRI's Victorian node delivered extension events across Greater Victoria over and above the current national AWRI grape and wine roadshows. A particular highlight for 2013/2014 was the delivery of the cooler climate Shiraz Symposium in Melbourne on 11 June 2014 which was attended by 99 delegates. The Victorian node's extension events were delivered in partnership with Wine Victoria and the regional grape and wine industry associations across Victoria.

Mobile library catalogue available

A mobile version of the AWRI library catalogue was launched in June 2014, enabling users to search and order items using mobile devices.

Information packs added

Library staff have collated reference lists and fact sheets into 'information packs' on specific topics relating to oenology, viticulture, and sustainability. The information packs are available from the AWRI website and users can browse and order articles online. This type of packaging of relevant information together makes it much easier for library users to find the information they need. Approximately 50,000 visitors accessed the AWRI website during the year, resulting in around 255,000 page views. (These numbers cannot be directly compared to previous years due to a change in tracking methodology.)


Eveline Bartowsky

Webinar series continues to grow

The AWRI's third webinar series was held during the year, featuring 25 webinars with more than 375 attendees. Approximately half of the webinars were delivered by AWRI staff and the remainder by invited researchers and industry experts.

Face-to-face interactions

Throughout the year AWRI staff gave 393 external presentations, coordinated 78 workshops, conducted 41 media interviews, authored 65 posters, presented 24 lectures to university students and supervised/co-supervised 8 students.

Publications for industry

Grape and wine producers received relevant information through six AWRI reports and six columns on alternative varieties 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. Producers were alerted to topical issues in 15 *eBulletins* issued through the year. Updates of AWRI activities were provided in six issues of *eNews*, which were emailed to producers.

Social media engagement increased

The AWRI's presence on Twitter grew significantly to an audience of more than 2,300.

Service capabilities and foundational datasets

New methods applied to understanding wine texture and stability

New methods have been established to study colloids in wine (aggregates of tannins, proteins and polysaccharides). Isothermal titration calorimetry (ITC), small angle x-ray scattering (SAXS) and dynamic light scattering (DLS) techniques are all now in use.

New sensory techniques applied

The sensory team applied three new techniques to research and industry samples: 'napping', 'difference from control' and the 'tetrad test'. 'Napping' involves physically grouping samples on a two-dimensional space, based on sensory differences, and is useful for samples with limited volume or where full profiling is not needed. The method of 'difference from control', where several samples in a set are directly rated for degree of difference from a reference wine is a cost-effective method for large sample numbers. The 'tetrad test' is an alternative to existing difference tests, requiring fewer tasters. Results indicate, however, that it may be less powerful for wine samples than for other foods or beverages, due to greater sensory fatigue.

Key compounds synthesised

Compounds were synthesised for projects investigating 'stone fruit' flavour, formation of sulfur off-flavours, in-mouth flavour release studies, and off-flavours related to grape fungal diseases.

Metabolomics service delivering results

During 2013/2014, the AWRI's South Australian node of Metabolomics Australia provided approximately 10,000 analyses for over 2,400 samples to a diverse range of clients from the environmental, biomedical and agri-food sectors.

Busy vintage for WIC Winemaking

A total of 197 ferments were completed during vintage 2014; 73 ferments more than the previous vintage. New processes implemented during the year have boosted efficiency and improved services.

Culture collection services provided to researchers and industry

The AWRI wine microorganism culture collection (AWMCC) received 220 yeast and bacterial strains from researchers and wineries, all of which were checked for purity, had their identity determined and were prepared for cryogenic storage. In addition, 110 uncharacterised microbial strains currently in the collection were identified. During the year the AWMCC distributed more than 800 microbial strains to researchers and industry.

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

Acknowledgements

Edited by Ella Robinson, Dan Johnson and Chris Day

Compilation assistance from Annette Freeman, Kate Beames, Shiralee Dodd and Alfons Cuijvers

Design by Geoffrey Reed Communications

Photography by Angie Clements Photography and Jacqui Way Photography

Staff

The actual number of AWRI staff employed in a full-time, part-time and casual capacity as at 30 June 2014 was 115 (91.65 full-time equivalents). When the number of AWRI-based students (both from Australia and overseas) and visiting researchers is added, the total increases to 117. Of these, 70% were funded by the GWRDC in 2013/2014.

Office of the Managing Director

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

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

Rae Blair, CertAppMgt (Mkting) *AIM*, GAICD, Communication Manager (concluded 31 July 2013)

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

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

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

Kate Beames, AWITC Conference Manager

Sandra Davis, BaRTS *UniCanb*, AWITC Admin Assistant (concluded 18 July 2013)

Corporate Services

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

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

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

Linda Halse, BA, PostGradDip (Ind Rel) *UniNatal*, HR Manager (concluded 17 October 2013)

Alfons Cuijvers, MLaw *UniAntwerp*, Human Resources Coordinator

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

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

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

Deborah Thornton-Wakeford, Receptionist

Jennifer O'Mahony, Receptionist

Research

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

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

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

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

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

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

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

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

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

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

Matteo Marangon, BSc (Hons), PhD *UniPadua*, Senior Research Scientist (concluded 31 December 2013)

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

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

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

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

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

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

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

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

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

Helen Holt, BAgSc (Hons), PhD *LaTrobe*, Grad Cert Appl Sensory Sci and Consumer Testing *UC Davis*, Research Scientist (concluded 31 December 2013)

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

Agnieszka Mierczynska-Vasilev, MSc, PhD, *Uni-Lodz*, Research Scientist (started 3 February 2014)

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

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

Christine Mayr, State Examination (Pharm) *LMUMunich*, PhD (Chem), Post Doctoral Research Fellow (concluded 31 December 2013)

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

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

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

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

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

15th AWITC audience

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

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

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

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

Peter Sternes, BBiotech (Hons), PhD *UniQld*, Bioinformatician (started 28 April 2014)

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

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

Amanda Agius, BApplSc *UniSA*, Technical Officer (started 17 March 2014)

Alice Barker, BAppSc (Hons), *UniOtago*, Technical Officer (started 4 February 2014)

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

Radka Kolouchova, AssDip *TechCollFoodTech*, Technical Officer

Danna Li, BSc (Mol Biol), BSc (Hons) *UniAdel*, Technical Officer

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

Jelena Jovanovic, Laboratory Assistant

Heather Donnell, Administrator

South Australian Metabolomics Facility

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

Jeremy Hack, Bioinformatician

Esther Kristianto, BSc (ApplChem) *UniTechSydney*, Technical Officer

Casual Sensory Panel

Peter Baldwinson, Brian Beggs, Penelope Elliot (started 9 October 2013), Jaqueline Gould (concluded 28 August 2013), Philippa Hall, Sonya Henderson, Brad Hocking (started 9 October 2013), Gurinder Khera, Lynette Lee, Mary Likos, Catherine Milne, Ralph Osborne, Vivianne Rees, Sue Robinson (started 9 October 2013), Loretta Royal (started 9 October 2013), Heather Smith, Mark Werner (concluded 30 June 2014)

Industry Development and Support

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

Peter Dry, BAgSc, MAgSc, PhD *UniAdel*, Viticulture Consultant

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

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

Mark Krstic, BAgSc (Hons), PhD *UniTas*, MBA *MelbBusSchool*, Extension Services Manager Victoria

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

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

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

Michael Coode, BAppSc (Wine Sci) *CSU/DeakinU*, MWineBus *UniAdel,* Winemaker

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

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

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

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

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

Michael Downie, GradDip (Library and Info Mgt) *UniSA*, Library and Information Services Coordinator

Virginia Phillips, Project Coordinator

Industry Applications

Peter Godden, BAppSc (Wine Sci) *UniAdel*, Group Manager – Industry Applications

Samantha Connew, BA, LLB *UniCanterbury,* GradDip (Vit and Oen) *Lincoln*, Manager Hunter Valley node

Bob Dambergs, BSc (Hons) *UniAdel*, PhD *UniQld*, Senior Research Scientist (concluded 19 September 2013)

Richard Muhlack, BE (Hons) (Chem), PhD *UniAdel*, Process and Environmental Engineer (concluded 17 January 2014)


Anthony Borneman

Commercial Services

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

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

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

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

Warren Roget, BE (Mechatronic) (Hons) *UniAdel*, Technical Manager (concluded 11 July 2013)

Karl Forsyth, BE (Hons) (Chem), BEc *UniAdel*, Senior Engineer

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

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

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

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

Heather Tosen, BSc *UniAdel*, Scientist

Tina Tran, BSc (Microbiol and Biotech), BSc (App Biol) (Hons), PhD *VicUni*, Scientist

Kieran Hirlam, BE (Hons) (Chem), BFin *UniAdel*, Project Technician (started 7 March 2014)

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

Daniel Tynan, DipAppSc (Chem Tech) *UniSA*, Laboratory Technician

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

Erin Kearsley, BTech *Flinders*, Laboratory Technician (started 22 July 2013)

Oliver Lovat, BTech (Foren and Analyt Chem) *Flinders*, Laboratory Technician (started 28 January 2014)

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

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

Andrea Francis, BSc *UniWA*, GradDip (EnvSci) *Murdoch*, Customer Service Officer

Robyn Gleeson, Customer Service Officer

Alana Spears, CertII (Hosp Op) *TAFE SA*, CertIV (Japanese Lang) *VLLC*, Customer Service Officer

Students

Bora Kang, *Duke, USA*, undergraduate student (24/06/13–02/08/13)

Gal Kreitman, *Pennsylvania State, USA*, PhD student (19/02/13–31/07/13)

Kerry Levett, *UniSA*, graduate student (03/03/14–15/06/14)

Yolanda Ruiz Garcia, *UniMurcia, Spain*, PhD student, (01/08/13–01/11/13)

Florian Sengler, undergraduate student, *Geisenheim, Germany*, (06/05/14–30/09/14)

Ella Thomson, *UniAdel*, Honours student (04/02/13–18/11/13)

Ryan Zeppel, *UniAdel*, PhD student

Visiting Researchers

Angela Contreras, PhD *UniSantiago, Chile*, Visiting Researcher (28/02/13–31/10/13)

Ulrich Fischer, BSc *Geisenheim, Germany*, MSc *UC Davis, USA*, PhD *UniHannover, Germany*, Visiting Researcher (16/05/14–15/08/14)

Staff activities

Dan Johnson is Chair of the Australian Wine Industry Technical Conference; a director on the National Wine Foundation Board; a member of the International Scientific Board of L'Institut des Sciences de la Vigne et du Vin (ISVV) Bordeaux (France), the Winemakers' Federation of Australia Innovation Policy Committee, the *Australian Journal of Grape and Wine Research* Advisory Committee, the *World of Fine Wine* Editorial Board, the Wine Innovation Cluster Leadership Group, the Waite Strategic Leadership Group and the National Wine Sector Research, Development and Extension Implementation Committee; and a graduate of the Harvard Business School Authentic Leadership Development program, the INSEAD Blue Ocean Strategy program and the Australian Wine Industry Future Leaders Program.

Chris Day is a director and treasurer of the Australian Wine Industry Technical Conference.

Peter Godden is an Ex-Officio Councillor of the Royal Agricultural and Horticultural Society of South Australia and participated as a Panel Chair at the Royal Adelaide Wine Show.

Markus Herderich is a director of the Australian Wine Industry Technical Conference; member of the Metabolomics Australia Executive Management Group; and Wine Innovation Cluster Research Group. He is also an Affiliate Associate Professor of the University of Adelaide; a member of the Advisory Board of the *Journal of Agricultural and Food Chemistry;* a member of the Winemakers' Federation of Australia Wine Industry Technical Advisory Committee; and a delegate and expert for the Organisation International de la Vigne et du Vin (OIV).

Vince O'Brien is a member of the Winery Engineering Association Conference Planning Committee; a member of the Winemakers' Federation of Australia Wine Industry Packaging Committee; a member of the National Livestock Methane Program Industry Advisory Committee and a member of the CSIRO's Adaptive Value Chains Project Advisory Group.

Con Simos is the Deputy Chair of the National Wine Extension and Innovation Network (NWEIN) and is a member of the NSW Wine Industry Association R&D Committee.

Eric Wilkes is a member of the Interwinery Analysis Group committee; the FIVS (International Federation of Wines and Spirits) Scientific and Technical Committee; Good Laboratory Practice Working Group; and the APEC Wine Regulatory Forum Enhanced Risk Controls Working Group.

Eveline Bartowsky serves on the Joint Editorial Board of the *Journal of Applied Microbiology* and *Letters in Applied Microbiology*. She is an Associate Editor of the *American Journal of Enology and Viticulture* and the *Australian Journal of Grape Wine Research* and an editor of *Annals of Microbiology*. She also serves on the Editorial Review Board of the *Journal International des Sciences de la Vigne et du Vin*, *Acetic Acid Bacteria*, and *Frontiers in MicroBioTechnology* journals and is an Affiliate Lecturer at the University of Adelaide.

Paul Chambers is coordinator of a national Bioplatforms Australia/AWRI Wine Yeast Systems Biology project, and is coordinator of the Australasian Yeast Group (through its homepage at www.ayeastgroup.org/). He is a member of the Editorial Board of *Microbial Cell*. Paul was also a member of the Yeast: Products and Discovery 2013 conference organising committee.

Samantha Connew participated as the Deputy Chair of the Sydney Royal Wine Show, and as a Panel Chair at the Royal Queensland Wine Show. She is a convenor at the Len Evans Tutorial.

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

Bob Dambergs is a member of the Wine Industry Tasmania Technical Committee and the National Wine Research Network (NWRN); Secretary and Board member of the ASVO; and an Honorary Associate of the University of Tasmania.

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

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

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

Jeremy Hack is a member of the Metabolomics Australia Analytical and Informatics working groups.

Paul Henschke is an Associate Editor of the *Australian Journal of Grape and Wine Research,* and is a member of the Editorial Review Boards of *Food Microbiology* and *Mitteilungen Klosterneuburg*. He is an affiliate professor of the University of Adelaide.

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

Mark Krstic is a Board member of the Australian Society of Viticulture and Oenology (ASVO); Chair of Horticulture Australia Limited's Industry Advisory Committee (IAC) for the Australian Table Grape Industry; member of National Wine Innovation and Extension Network (NWEIN); member of the National Wine Research Network (NWRN); Associate Editor of *Wine and Viticulture Journal*; Honorary Senior Fellow at the University of Melbourne; Coordinator of the Victorian Viticultural Association; and member of the Standards Australia Committee for the Australian Grapevine Propagation Material standard.

Mardi Longbottom is a Visiting Research Fellow of the University of Adelaide; Vice President of the Australian Society of Viticulture and Oenology (ASVO); a member of the Winemakers' Federation of Australia Wine Industry National Environment Committee (WINEC); Board member of the Limestone Coast Grape and Wine Council and member of the LCGWC Technical Subcommittee; a member of the Decision Support Network of the Wine Grape Growers Australia; and a member of the Technical Environmental Committee of Freshcare Australia.

Simon Schmidt is a member of the Australian Society of Biochemistry and Molecular Biology (ASBMB) and ASBMB liaison officer for the Adelaide Protein Group (APG) Organising Committee.

Creina Stockley is an Affiliate Senior Lecturer at the University of Adelaide and is the Coordinator of the Wine Science Course *Grape Industry Practice, Policy and Communication* for the School of Agriculture and Wine. She is a member of the Winemakers' Federation of Australia (WFA) Wine Industry Technical Advisory Committee, and the WFA Wine and Health Working Group. She is a delegate and expert for the Organisation International de la Vigne et du Vin (OIV) and is currently President of Commission IV Safety and Food and a member of the Steering Committee. Creina is also a member of the honorary editorial board of the *International Journal of Wine Research* and *International Journal of Food and Fermentation Technology*, as well as a charter member of the International Scientific Forum on Alcohol Research, a member of the Scientific Board of the (European) Wine Information Council and a member of the European Food Safety Authority Expert Database.

Status of projects in the AWRI's 5-year RD&E plan

	Project		Status at 30 June 2014
Theme 1: Environment and sustainability			
1.1	Reduce inputs and environmental footprint across the value chain	1.1.1 Improving winery energy efficiency	Active
		1.1.2 Capitalising on the carbon economy	Active
		1.1.3 Improving the environmental and economic performance of the Australian wine supply chain	Active
		1.1.4 Assisting industry to adopt renewable energy technologies	Inactive
1.2	Capture the full value of clonal resources for key Australian varieties	1.2.1 Assessing diversity and clonal variation of Australia's grapevine germplasm	Active
1.3	Reduce the economic and environmental impact of pests and diseases and the techniques used to manage them	1.3.1 Understanding genetic variation in grapevine diseases and the genetic basis for pesticide resistance	Active
		1.3.2 Improving the consistency of description and measurement of disease	Active
		1.3.3 Regional benchmarking of viticultural spraying practices	Inactive
Theme 2: Consumers, customers and markets			
2.1	Identify and secure new market opportunities through consumer insights	2.1.1 Identifying and securing new market opportunities through consumer insights	Active
		2.1.2 Genetics of odour perception and wine preferences	Inactive
2.2	Build and safeguard brand Australia	2.2.1 Collecting and disseminating information regarding agrochemicals registered for use and maximum residue limits in Australian viticulture	Active
		2.2.2 Origin verification and detection of counterfeit Australian wines	Inactive
		2.2.3 Informing wine consumers through understanding issues of wine consumption, health and nutrition	Active
		2.2.4 Increasing Australia's influence in market access, safety, regulatory and technical trade issues	Active
2.3	Improve market access through anticipation and removal of trade barriers and regulatory constraints	2.3.1 Emergency response capability	On hold
Theme 3: Improving products and processes			
3.1	Objective measurement and target setting of grape and wine style	3.1.1 Identification and origin of volatile compounds responsible for important sensory attributes	Active
		3.1.2 Assessment of relationships between grape chemical composition and grape allocation grade	Active
		3.1.3 Flavour precursors: contribution to wine aroma, in-mouth sensory properties and flavour release	Active
		3.1.4 Factors affecting wine texture, taste, clarity, stability and production efficiency	Active
3.2	Optimise primary and secondary fermentation for effective production of targeted wine style	3.2.1 Are there regional micro-organisms, and can they be harnessed to produce regionally distinct wine styles?	Active
		3.2.2 Enhanced winemaking outcomes and wine style diversification through provision of fit-for-purpose yeast starter cultures	Active
		3.2.3 Defining the nutritional drivers of yeast performance and matching yeast to must	Active
		3.2.4 Efficient and reliable malolactic fermentation to achieve specification wine style	Active
		3.2.5 Safeguarding and realising the potential of the Australian wine microbial germplasm collection	Active

	Project	Status at 30 June 2014
3.3 Novel products and effective processes	3.3.1 Technologies and strategies for the production of lower alcohol wine	Active
	3.3.2 Influencing wine style through management of oxygen during winemaking	Active
	3.3.3 Capturing and re-using aroma compounds entrained in fermentation gases	Inactive
	3.3.4 Developing simplified sparkling winemaking processes which reduce production costs while replicating the flavour and textural properties of wines produced using traditional methods	Inactive
	3.3.5 Development and application of process analytical technologies for effective winemaking process control	Active
	3.3.6 Producing less processed, allergen-label-free, wines	Inactive
3.4 Reduce cost of production	3.4.1 Novel products utilising existing winery capital equipment, surplus grapes and winery waste	Active
	3.4.2 Reducing wine movements during production	Active
	3.4.3 Evaluating alternatives to barrel maturation	Active
	3.4.4 Identifying cost reduction opportunities by mapping the grape and wine value stream	Active
3.5 Reduce the economic impact of taints and faults	3.5.1 Fault and taint remediation strategies and technologies	Inactive
	3.5.2 Ensuring the continued efficacy of *Brettanomyces* control strategies for avoidance of spoilage	Active
	3.5.3 Formation and fate of positive and negative sulfur compounds	Active
3.6 Deliver sound product to the marketplace	3.6.1 Maximising quality during bulk wine transport	Active
Theme 4: Extension and adoption		
4.1 Drive productivity, sustainability and profitability through facilitating rapid adoption of R&D outcomes	4.1.1 The staging and conduct of extension programs	Active
	4.1.2 Specialised technical troubleshooting and responsive helpdesk services for the Australian wine sector	Active
	4.1.3 Library service	Active
	4.1.4 Communication with stakeholders	Active
	4.1.5 Development of web and mobile-based extension tools	Active
4.2 Align supply chains with industry needs	4.2.1 Evaluating and enabling adoption of new technologies	Active
4.3 Enhance national outreach and promote regional engagement	4.3.1 Tailored regional research, development, adoption and extension through regional nodes	Active
4.4 Improve intellectual capital available to the Australian wine industry	4.4.1 Contributing to undergraduate and postgraduate education programs of relevance to the Australian wine industry	Active
Theme 5: Service capabilities and foundational datasets		
5.1 Service capabilities and foundational datasets	5.1.1 Enhancing data capture and integration for re-use and data mining	Active
	5.1.2 Chemistry, sensory, chemometrics and development capacity	Active
	5.1.3 Efficient management and administration	Active
	5.1.4 International scientific exchange program	Active

Progress reports

Environment and sustainability

The future 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 and electricity, fuel, refrigeration, and waste disposal are all major costs in winemaking. Projects under this theme aim to assist producers to improve environmental and economic performance; to make the most of the grapevine clonal resources available; and to improve the management of pests and diseases.

Reduce inputs and environmental footprint across the value chain

Staff

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

Collaborators

AHA Viticulture (Ben Kantsler); Braemore Vineyard (Ken Bray); JA & ML Milne Investments Pty Ltd (Jeff Milne); Treasury Wine Estates (Amy Richards); Yalumba (Brooke Howell).

Capitalising on the carbon economy—Greenhouse gas abatement in viticulture

Background

Nitrous oxide (N_2O) is a potent greenhouse gas (GHG) emitted from agricultural soils when nitrogen-containing fertilisers are used. N_2O emissions have been measured from many agricultural crops; however, there is very little data from vineyards. The purpose of this project is to establish baseline levels of N_2O emissions from vineyards in a range of Australian wine regions and assess the potential of a range of vineyard floor treatments (including cover crops) to mitigate N_2O emissions and increase carbon sequestration in soil. The knowledge gained will allow Australian grapegrowers to adopt management practices that minimise N_2O emissions. This project is funded by the Department of Agriculture (DA) as part of the 'Action on the Ground' program. In addition to in-field evaluations, the project also includes significant extension activities including field demonstrations, publications and workshops, designed to raise the awareness of GHG mitigation strategies among grape and wine producers.

Vineyard trials

Five on-farm trial sites, in the Hunter Valley, Margaret River, Murray Darling, Eden Valley and McLaren Vale regions were established in 2012. The sites were chosen to cover a diverse range of climatic influences, soil types and vineyard practices. During the 2013 and 2014 growing seasons, fortnightly gas samples were collected from all field sites and analysed for methane, carbon dioxide and N_2O. The frequency of sampling was monthly over winter. Soil sampling was also conducted across some of these sites to establish the effects of soil treatment on carbon sequestration.

Preliminary data indicate that, in general, the level of N_2O emissions from the trial vineyards is very low compared to historical data from other horticultural crops. This is likely to be a result of the combination of low rainfall and soil moisture across the trial sites in 2012–2013 and also low nitrogen inputs relative to other crops.

Other observations include:

- A vineyard where chicken manure had been applied over a long period showed significantly higher N_2O emissions than all other vineyard sites.
- When undervine compost treatments were applied, a significant spike of N_2O was observed compared to the bare undervine area.
- No differences in emissions were observed between organic and conventionally treated vineyard management regimes in the Eden Valley.
- In a comparison between two mid-row cover crop species (wallaby and rye grass), lower emissions were observed from the wallaby grass treatment.
- Sites with higher water and nitrogen fertiliser inputs generally had higher observed emissions.

These preliminary results have been presented at a range of extension events across Australia. Work is continuing to develop recommendations for vineyard management practices that minimise N_2O emissions.

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

Background

Efforts are under way across a range of industries to reduce GHG emissions. To effectively achieve emissions reductions, industries need relevant and up-to-date technical and policy information. This project, funded by the DA as part of the 'Extension and Outreach' program, aims to deliver technical information about GHG emissions, carbon storage and the Carbon Farming Initiative (CFI) to the Australian grape and wine sector. It will provide access to technology, skills and decision support. The project will also enhance the adaptability of the grape and wine sector as it faces a variable climate and competition for natural resources.

Extension delivery

A dedicated project webpage has been created (www.awri.com.au/industry_support/new_climate/) with links, fact sheets and resources related to GHG emissions and the wine sector. As the project progresses, more and more resources will be added, making the page the 'go-to' source for information on GHGs and the grape and wine industry. Online resources will be complemented by face-to-face interactions at a comprehensive series of workshops to be delivered across Australia. Uptake of the information delivered will result in practice change which will ultimately ensure Australia has a sustainable, globally competitive and resilient wine sector.

The project team has been working closely with a group of 'soil stewards' from the Limestone Coast to assist them to establish a strategic plan for the sustainable management of soil in that region. A study tour of Margaret River, Barossa Valley, McLaren Vale and Langhorne Creek regions has been planned for this group to take place in 2014/2015.

The project team has also been collaborating with the Winemakers' Federation of Australia (WFA) to review and develop a web-based platform for the Australian Grape and Wine Carbon Calculator that will be linked to the WFA Entwine database. This will streamline the collection of Entwine environmental indicators and provide a benchmarking capability. It is expected that this will be completed in 2014/2015.

Capture the full value of clonal resources for key Australian varieties

Staff

Dr Anthony Borneman, Dr Peter Dry, Dr Simon Schmidt.

Collaborators

BC Genome Sciences Centre (Prof. Steven J.M. Jones, Justin Chu); Macquarie University (Prof. Sakkie Pretorius); SARDI (Dr Michael McCarthy); University of British Columbia (Prof. Hendrik J.J. van Vuuren, Prof. Jörg Bohlmann, Samantha Turner); University of Western Australia (Assoc. Prof. Michael Considine); Yalumba (Nick Dry).

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

Background

Chardonnay is one of the dominant grapevine cultivars used for winemaking in Australia. There are now many clones of this variety, some of which have only recently become available in Australia. These clones exhibit variation in a number of viticultural and oenological traits including fruit composition, flavour and aroma profile, ripening time, flower morphology (leading to seedless grapes), bunch morphology, yield and grape colour. This project aims to assess the genetic variation among clones of Chardonnay available in Australia, and evaluate how this variation contributes to chemical and sensory variation in grapes and wines derived from the different clones.

Comparative genomic approaches to understand genetic variation in Chardonnay

DNA from 15 Chardonnay clones has been extracted from young leaves collected from vines in the Riverland (Oxford Landing), Barossa Valley (SARDI research station) and Okanagan Valley (Canada). A reference sequence is being created from one of the clones (I10V1). Sequence data for the remaining 14 clones will be mapped onto the reference genome in order to identify variant bases, insertions and deletions. Until the completion of the reference genome, the existing Pinot Noir genome has been used as a reference. Pinot Noir is one of the parents of Chardonnay and is the only genome for which there is a relatively complete *de novo* assembly. To date 453 Single Nucleotide Polymorphism (SNPs), 67 indels and 33 transposons have been identified that are unique to a specific Chardonnay clone or are partially shared between clones. The identification of unique SNPs may lead to clone-specific markers that could be deployed in the field for the verification of clones prior to sale or the identification of clones in existing vineyards.

In addition to genomic characterisation, the project is also comparing the characteristics of grapes, juices and wines from different Chardonnay clones. Wines were made in the 2012 vintage from a subset of the clones used for the sequencing work. Grapes were hand-picked from ten clones growing on a single block at Oxford Landing (Yalumba). Small lot wines (24 kg) were made in triplicate from each clone. Sensory evaluation of the wines and chemical evaluation of the grapes and wines was carried out to assign the clones an oenological phenotype and to define chemical differences between the clones. Sensory descriptors such as 'stone fruit', 'citrus' and 'viscosity' were important drivers of oenological variation, enabling a classification of clones into three groups. Descriptors such as 'fruity' were associated with high linalool concentration in one of the clones. The chemical and sensory analysis of these juices and wines is now complete.

Marcel Essling

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

Staff

Dr Anthony Borneman, Dr Markus Herderich.

Collaborators

SARDI (Dr Barbara Hall, Dr Suzanne McKay).

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

Background

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

Quantifying potentially resistant strains

The AWRI is a partner in the SARDI-led project *Understanding fungicide resistance in powdery mildew, downy mildew and Botrytis*; other partners include the University of Adelaide, Charles Sturt University and Curtin University. The AWRI will contribute a genomics study aiming to quantify potentially resistant strains on a population basis with the help of next-generation sequencing.

Consumers, customers and markets

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

Build and safeguard brand Australia

Staff

Marcel Essling, Dr Markus Herderich, Dr Mardi Longbottom, Anne Lord, Creina Stockley.

Collaborators

Bayer CropScience (Hugh Armstrong); Department of Agriculture (John Power); Department of Colorectal Medicine and Genetics at the Royal Melbourne Hospital (Prof. Finlay Macrae); Fondazione Edmund Mach, San Michele all'Adige, Italy (Prof. Fulvio Mattivi); National Wine Foundation (Mitchell Taylor and Peter Gniel); Nufarm Australia Ltd (Ben Coombe and Doug Wilson); Wine Australia (Andreas Clark, Steve Guy); Wine Grape Growers Australia (Lawrie Stanford); Winemakers' Federation of Australia (Tony Battaglene, Paul Evans).

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

Background

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

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

Up-to-date information

During the year the project team reviewed 205 Sanitary and Phytosanitary notifications from the World Trade Organization and 26 gazettes issued by the Australian Pesticides and Veterinary Medicines Authority (APVMA). The outcomes of these reviews included changes to MRLs applicable to numerous markets including Canada, China, the European Union and the United States.

Every year, post-harvest, a process of identifying and incorporating the latest agrochemical information is undertaken. The project team obtains information from regulators, chemical manufacturers, suppliers and end-users. Best practice recommendations are then incorporated into the 'Dog book'. In total, 10,500 copies of the 2014/2015 'Dog book' were produced and distributed by direct mail to levy payers, via regional association networks, AWRI roadshow events, chemical retailers and an insert in the *Australian & New Zealand Grapegrower & Winemaker*. Updates were also made to the online search portal, the smart phone agrochemical app and an electronic pdf version which is available from the AWRI website. The 2014/2015 version of the 'Dog book' was expanded to include information on active constituents and new products in addition to a table of grapevine growth stages.

The project team also produced five *eBulletins* providing agrochemical updates (Table 7).

Improving grape sector practices and spray options

The AWRI collaborated with SARDI and Bayer CropScience to seek a permit for the use of tebuconazole as a post-pruning spray for *Eutypa* control. Existing registered pruning wound treatments for *Eutypa* prevention are uneconomical and impractical because they require manual application to the wound at the time of pruning. The APVMA is in the process of evaluating this application.

The AWRI is actively supporting the establishment of a MRL for phosphorous acid (phos acid) in key export markets and is collaborating with Wine Grape Growers Australia (WGGA), key regional associations and Nufarm Australia Ltd to prepare and submit an application to the Codex Alimentarius Commission (Codex). A number of key export markets default to Codex regulations in the absence of an established MRL, so this initiative is expected to substantially increase the number of countries that allow the presence of phos acid residues in wine.

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

Background

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

WineHealth 2013 International Wine and Health Conference

The seventh in the series of WineHealth International Wine and Health Conferences was held in Sydney from 18 to 20 July 2013, with significant involvement from AWRI staff. Eight sessions were held, comprising 28 presentations. A common message was that light to moderate wine consumption combined with a healthy diet and lifestyle can help promote healthy ageing. The science of wine and health is still in its infancy; targeted clinical and epidemiological studies are required to better understand the effects of wine and its core components on human health. The conference proceedings were published in the peer reviewed journal *Nutrition and Aging*. Among the many outcomes has been the formation of a working group to examine the risk and impact of conflicts that might arise through the conduct and publication of industry-funded health and nutrition research related to alcohol consumption.

National Wine Foundation projects

The AWRI first established a capability in understanding the health effects of wine in 1991. The National Wine Foundation allowed this capability to be retained in 2013/2014 by commissioning two projects. The first of these aims to investigate the price sensitivity of at-risk alcohol consumers and to establish whether price is an appropriate lever to use in strategies aimed at reducing harmful or risky consumption levels and alcohol-associated health and social harms in Australia. The focus is on the 14–25 and 50+ year age groups, which were identified as being at higher risk in the 2010 *National Drug Strategy Household Survey*. A review of the published literature found that there is a lack of robust Australian data concerning the broader link between price and levels of alcohol consumption. From a subsequent survey of approximately 3,000 South Australian households, initial trends have been identified which suggest that the main levers for change in alcohol consumption in the at-risk groups are peers and culture (family and friends) and health. The latter factor is particularly important in the older age group.

The second project is a literature review and critical analysis of the health and social impacts of moderate wine consumption as defined by the NHMRC guidelines of 2009. Its primary aim is to provide evidence-based information to inform consumption choices and reduce the risk of abusive alcohol patterns. Evaluation of the health impacts focuses on, but is not limited to, the areas already identified by the World Health Organization, namely cardiovascular disease and diabetes, as well as some cancers and dementia.

Other projects

The project entitled *Resveratrol in the chemoprevention of colorectal neoplasia* funded by Cancer Australia has continued, in collaboration with Prof. Finlay Macrae, at the Royal Melbourne Hospital. The project is investigating whether grape-derived resveratrol, administered in a moderate amount of red wine, reduces the risk of developing bowel cancer in human subjects. Now that the project has established that resveratrol is absorbed into the blood stream in measureable amounts, its effect on proteins and cell mechanisms involved in controlling cell growth and thus cancer potential is being measured from tissue samples taken from the bowel.

The project entitled *Tracking the metabolome of grapes into wine* has continued, in collaboration with Prof. Fulvio Mattivi of the Fondazione Edmund Mach and University of Trento, Italy. This project aims to identify, quantify and potentially characterise compounds in grapes that are transferred from grapes to wine which may have therapeutic effects in humans. A total of 749 compounds were found to be present in both grapes and wine; 17 were present in grapes but not wine and 427 were present in wine but not grapes. A review of the literature suggested that anthocyanins (found in both grapes and wine) may be important dietary compounds in the prevention of chronic diseases, such as cardiovascular disease, some cancers, dementia and diabetes. A review paper has been prepared and published on this class of compounds.

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

Background

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

Technical advice

Scientific and technical advice was provided for a number of issues including residual manganese in wine, which is a potential barrier to trade with China. The presence of phthalates in wine was also investigated and the AWRI participated in an Organisation International de la Vigne et du Vin (OIV)-led inter-laboratory ring test that evaluated methods for the analysis of phthalates in wines. Other market access issues investigated included sorbates, phos acid and copper sulfate. The AWRI also participated in a review of the Codex Alimentarius Commission's *Proposals for New and/or Revision of Food Additive Provisions,* the preparation of a product information declaration for wine industry suppliers, revisions of the Australian wine industry's policy and position statement on genetically modified (GM) organisms and a cost-benefit analysis for energy labelling on alcoholic beverages for the Wine Industry Technical Advisory Committee (WITAC).

International engagement

At the international level, the project team continued to participate at the OIV as members of the DA-led Australian delegation, together with representatives of WFA. Creina Stockley is President of the OIV's Health and Safety Commission IV and serves as a member of several OIV expert groups and two OIV working groups—*taskforce on additives and processing aids*, and *taskforce on allergens*.

The *taskforce on additives and processing aids* is currently preparing scientific and technical dossiers on additives and processing aids not currently permitted for winemaking in China and hence not permitted to be present in Australian wine exported to China. If unresolved, this could potentially result in restrictions on exports of wine into China. Six dossiers have been submitted to the Chinese government by WFA with scientific and technical input from the AWRI.

The role of the *taskforce on allergens* is to coordinate analytical and clinical research on the potential for residual protein in protein-fined wine and its significance for human health, which has been undertaken by Australia, France, Germany and Italy. During 2013/2014, the *taskforce on allergens* finalised the code *Good fining practice for wine to be applied after the use of proteinaceous [allergenic] wine fining agents [casein and egg white],* which is at step 7 of the OIV's 8-step resolution system for adoption at the 2014 General Assembly. If approved, it will then be considered for incorporation into European Commission regulations.

Draft resolutions and dossiers on agar, dimethylpolysiloxane, potassium carbonate and protease enzymes have been prepared and presented to the OIV expert groups as these processing

Creina Stockley

aids are not yet permitted for winemaking in the European Union. An application to enable use of protease enzymes such as Proctase in Australian winemaking was lodged with Food Standards Australia New Zealand and is awaiting formal approval. In addition, a report was prepared on the relevant definitions and legislation in place in the 45 OIV member countries in relation to nutrition labelling and ingredient listing, which will form the basis of an OIV study on the effectiveness of such labelling in influencing consumer behaviour. This is important as reviews of the marketing and medical literature from the past 20 years provide little insight into how labelling information is, or might be, used in real-world shopping situations and how it affects and influences consumer behaviour.


Brian Schmidt

Improving products and processes

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

Objective measurement and target setting of grape and wine style

Staff

Amanda Aguis, Alice Barker, Sheridan Barter, Dr Keren Bindon, Dr Cory Black, Dr Dimitra Capone, Dr Leigh Francis, Richard Gawel, Dr Yoji Hayasaka, Dr Markus Herderich, Stella Kassara, Dr Christine Mayr (until 31/12/13), Dr Jacqui McRae, Dr Agnieszka Mierczynska-Vasilev, Mango Parker, Wes Pearson, Alex Schulkin, Tracey Siebert, Dr Paul Smith, Mark Solomon, Patricia Williamson.

Visiting students

Yolanda Ruiz Garcia (University of Murcia, Spain).

Collaborators

Aarhus University (Dr Simone Mueller-Loose); Accolade Wines (Alex Sas, Warren Birchmore, Chris Bevin, James Wilson); Angove Family Winemakers (Richard Angove); Australian Vintage (Nick Yap, Jakub Rys); Bay of Fires (Peter Dredge); Brokenwood Wines (Simon Steel); Casella Wines (James Wilson); Chapel Hill (Michael Fragos); CSIRO (Dr Rob Bramley, Dr Shane Seabrook); De Bortoli Wines (Steve Webber); Institut Francais de la Vigne et du Vin Sud-Ouest (Olivier Geffroy); Joseph Chromy (Jeremy Dineen); Lion Nathan (Brooke Halkett); McWilliams' Wines (Andrew Higgins, Adrian Sparks, Anna Lawrence); Medhurst Wines (Matt Steel); Mt Langi Ghiran (Damien Sheehan, Nathan Scarlett); Mt Majura (Dr Frank van de Loo); Penney Vineyards (Gary Penney); Pernod Ricard (Dan Everitt, Kate Lattey, Sladjan Maksimovic); Pfeiffer Wines (Jen Pfeiffer); Plantagenet (Cath Oates); Printhie Wines (Drew Tuckwell); SARDI (Lee Bartlett, Dr Barbara Hall); Shaw and Smith Wines (Adam Wadewitz); Stonier (Michael Symons); The Lane Vineyard (Michael Schreurs); Treasury Wine Estates (Clare Flintoff, Melanie Chester, Dr Anthony Robinson, Dr Alison Soden); Tyrrell's Wines (Tom Lynar); University of Adelaide (Dr David Jeffery); University of Bordeaux Institut des Sciences de la Vigne et du Vin (Prof. Philippe Darriet, Dr Panagiotis Stamatopoulos); University of Melbourne (Prof. Snow Barlow, Dr Kate Howell, Pangzhen Zhang); University of Queensland (Dr Zyta Ziora); University of South Australia (Dr Miguel de Barros Lopes, Prof. Larry Lockshin, Dr Armando Corsi, Ava Huang, Dr Svetlana Bogomolova, Dr Peter Majewski, Dr Beatriz Simon); University of Tasmania/Tasmanian Institute of Agriculture (Dr Robert Shellie, Dr Dugald Close, Caroline Claye); Vasse Felix (Michael Langridge); Wine Australia (James Gosper, Willa Yang); Wines by Geoff Hardy (Shane Harris); Yalumba (Louisa Rose, Brooke Howell).

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

Background

Volatile chemical compounds are responsible for many important sensory attributes in wine and influence the quality and value of a wine in the eyes of many winemakers and consumers. This project aims to expand existing knowledge about key volatile chemical compounds in wine. It will focus on 'greenness' in red wines, and 'stone fruit' ('apricot'/'peach') which is common in Chardonnay and other white varieties such as Viognier. This project has a strong discovery element to identify the volatile compounds imparting these important flavour attributes. The project is also investigating the origin of volatile chemical compounds and factors which influence their concentrations in wine, including work on *Botrytis cinerea* and the peppery compound rotundone; leaves and stems and their effect on 'green' aroma; and volatiles from the local environment. The response of consumers to different levels of the flavour compounds is also being determined. Investigations into preferences of consumers in China for wines of differing composition and how those preferences might be influenced also feature in this project.

Volatile compounds causing important flavour characteristics

In order to identify the compounds that cause 'apricot' or 'peach' flavour, wines were selected based on a sensory assessment of 60 candidate wines coordinated through the AWRI/Tasmanian Institute of Agriculture (TIA) Tasmania node. The panel of experienced judges used to assess the wines included a group of Tasmanian winemakers. A range of lactone compounds previously described as being important to the flavour of stone fruits and other key flavour compounds have been quantified in the selected wines by gas chromatography mass spectrometry (GC-MS) analysis. For the discovery of new aroma compounds a range of commercial white wines with and without 'apricot' and 'peach' aroma were studied using gas chromatography-olfactometry (GC-O) analysis, with assessors evaluating aromas from the many compounds separated by gas chromatography. Further studies with the University of Tasmania/TIA used comprehensive multidimensional GC-MS for the separation of closely similar compounds to compare the volatile fingerprints of high 'stone fruit' and low 'stone fruit' wines. In collaboration with the University of Bordeaux, experiments have been initiated to enrich and further purify aroma fractions for further sensory evaluation and chemical characterisation.

The so-called varietal or polyfunctional thiols are well-known important flavour compounds in Sauvignon Blanc, providing 'tropical fruit' and 'grapefruit' aroma, and can contribute to the

flavour of other varieties. In order to understand their role in Australian Chardonnay, these compounds and their precursors were surveyed in more than 80 commercial Chardonnay wines from across Australia, with a particular focus on cooler regions. In addition, a winemaking study was conducted on a set of 20 Chardonnay grape lots sourced from cool and warm climate vineyards, from New South Wales, Victoria, Western Australia, Tasmania and South Australia. This study will allow an assessment of the relationship between thiol precursors in grapes, the concentration of free thiols in wine, and wine sensory properties.

Studies into 'green' flavour in red wines have involved GC-O to find individual aroma compounds that give rise to 'grassy' or 'vegetative' aromas in some Cabernet Sauvignon and Shiraz wines. A number of regions of the chromatograms were found to be associated with 'vegetative' aromas, including a clear 'capsicum'/methoxypyrazine-like aroma in the Shiraz 'green' wine samples. This observation is of great interest, as to date methoxypyrazines have not been considered to be important to Shiraz wines, except in wines made via whole bunch fermentation. Specific known 'green' compounds in the wines, including C6 compounds such as Z-3-hexenol, cineole and methoxypyrazines have been quantified. Several C6 compounds were clearly evident in the GC-O assessments. Related to these studies, grapes from a premium cool climate Shiraz vineyard have been sampled and used to make research wines with the addition of grape leaves or grape stalks, to assess whether 'vegetative' or other important flavour compounds are extracted into the must from these materials.

Factors that affect the concentration of the 'black pepper' compound rotundone, a key flavour compound in Shiraz from cooler regions, have been studied. As rotundone levels have been found to be higher in grapes from cooler (and sometimes wetter) seasons where *Botrytis cinerea* may be evident, it was considered possible that *Botrytis* might have a role in the biosynthesis of this grape metabolite. Following two separate experiments, infection of grape berries with *Botrytis* was found to have no effect on rotundone concentration between control and inoculated treatments, providing strong evidence that *Botrytis* infection alone does not induce rotundone formation in Shiraz grapes. It is becoming increasingly apparent from other, recent data that degree of ripeness and either ambient temperature or solar radiation are key factors in rotundone formation.

The effect of the taste experience and wine composition on re-purchase for Chinese consumers

In a collaborative project with the University of South Australia (UniSA) and Aarhus University, a shelf simulation online choice test was conducted with 1,670 Chinese consumers of imported red wine. The results revealed that reading an article about Australia considerably increased the choice of Australian wines over French, Italian or Chinese wines, especially when the article indicated that Chinese consumers prefer the taste of Australian wine compared to other countries, or the article reinforced the message that Australian foods and beverages are clean and unpolluted. Interestingly, the effect of the messages was found to continue when consumers were tested again more than a week after reading the article. As part of the study it was also confirmed that ratings by wine experts or stores are very important factors for Chinese consumers when choosing a wine. An in-store rating was the most important attribute influencing purchasing decisions, while the presence of a medal and closure type were the least important.

Following this shelf simulation study, 304 Chinese consumers completed a preference taste test and an online choice experiment, with half of the consumers tasting under blind conditions, and the other half tasting under informed conditions, where the price and brand were known to them while tasting. These same 304 consumers completed a subsequent repeated online choice test. The consumers were from Shanghai and Beijing and were regular buyers and drinkers of imported red wine. The 14 Australian, French and Chinese red wines assessed by the consumers were also profiled by a trained Chinese sensory panel in Shanghai using local Chinese descriptive terminology. In parallel, detailed chemical composition data were obtained on the wines. The preference mapping results of the wines tasted blind showed that a relatively small cluster of consumers (approximately 30%) liked the stronger flavoured wines while the largest group (approximately 50%) appreciated wines with attributes such as 'fermented bean curd' and did not like older wines. A further 20% of the consumers preferred the less flavourful wines. For each of the groups, the price of the wine was of little or no importance when it was not disclosed to them. In contrast, when tasting under informed conditions, price was very important for most consumers, with higher prices strongly correlated with higher liking scores. In only one cluster liking scores were not influenced by price. Australian and French wines were significantly more liked than Chinese wines when tasted under informed conditions. The results show that if consumers are given the opportunity to taste Australian wines, they are well-liked under both blind and informed conditions. The descriptive terms used by the local sensory panel provide an insight into those attributes most associated with quality from a consumer perspective and are of interest in enhancing communication strategies with Chinese consumers.

Assessment of relationships between grape chemical composition and grape allocation grade

Background

Compounds derived from grapes that are responsible for appearance, aroma, texture and taste in wine are the primary contributors to the degree of fitness for purpose of wine-grapes. Many of these compounds are known and are measurable, have meaning in relation to the final sensory state of the wine and are able to be manipulated through viticultural and/or winemaking practices. Yet the application of objective chemical measures by Australian grapegrowers and winemakers tends to be at a fairly rudimentary level, with only one or two chemical measures implemented in many instances. Winemaking begins in the vineyard, which means decisions made at this point are crucial to achieving the desired wine style (Figure 1).

The properties and value of grapes are currently being assessed in a wide range of ways which are mainly subjective. Streaming decisions and/or payment to a grower can be affected by field-based assessment of, for example, the condition of the vines, flavour of the fruit, presence of disease, and some quantitative chemical measures such as colour, Brix, pH and TA. In some instances the price of grapes may be retrospectively based on the final value of the wine that was achieved using those grapes. For a winemaker, these assessments are critical to ensuring they have sufficient quantities of grapes available at the right time that are appropriate for the style of the wine they intend to make. The subjectivity of some current grape quality assessment practices contributes to uncertainty about the full potential and maximum value possible and whether these have been achieved. As such, many growers and winemakers are seeking support for grape grading processes from additional objective chemical measures of key grape compounds that are directly related to valued taste, aroma, texture and appearance attributes.

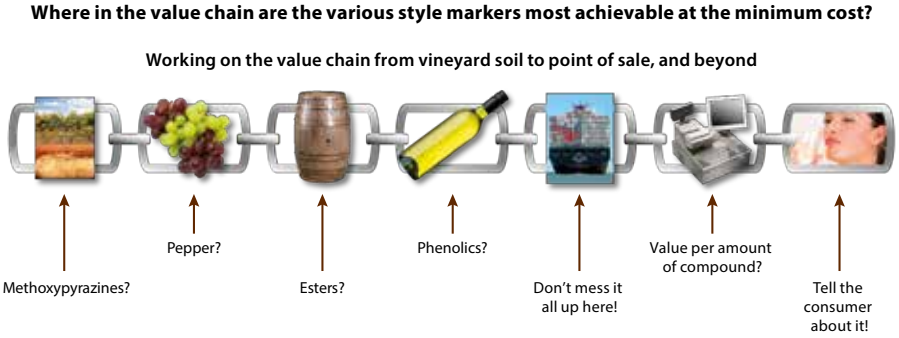


Figure 1. Where in the value chain are objective measures most beneficial?

By measuring a range of chemical compounds in multiple grape batches of different grades, this project aims to determine which grape compounds, independently or in combination, can differentiate between grape grades. The objectives are to determine how variable the chemical composition is across a wide range of fruit grades, if there is a relationship between grape composition and fruit grade, and if grape composition is clustered and grape lots can be batched together based on similarity in their chemical composition. A further aim of the project is to assess the practical application of already known key compounds for grape grading measurements and to support wine producers who intend to apply these measures.

Comparing analytical results with grape grade

The AWRI is collaborating with Accolade Wines to analyse key compounds in grapes that have been assessed by a standardised approach for grading. In 2013, 46 samples across grades 2 to 7 (2 = higher value, 7 = lower value) for Cabernet Sauvignon grapes were assessed. Nine geographical areas were covered: Swan Valley, south-western Western Australia, Riverland, McLaren Vale, Langhorne Creek, Clare Valley, Padthaway, Coonawarra and Wrattonbully. The trial was expanded in the 2014 vintage to include 182 samples across Cabernet Sauvignon, Shiraz and Chardonnay grapes from multiple regions.

A range of spectroscopy techniques have been used to measure the 'fingerprint' of the fruit. Results obtained so far suggest that, following data treatment, mid-infrared (MIR) spectra of grape homogenates provide an accurate way of predicting grape grade. The evaluation of potential specific grape quality markers is ongoing. Some 'lead' targets that will be validated with the 2014 sample set include Yeast Assimilable Nitrogen (YAN), total phenolics, absorbance at 420 and 520 nm and β-damascenone, which appear to be positively associated with higher value grades; and TA, cysteine, glutamate and glutathione, which appear to be negatively associated with higher value grades.

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

Background

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

This project has the overall goal of understanding the flavour of wine in the mouth that is due to precursor compounds and retronasal perception of volatiles (the aroma perceived when volatile compounds move from the mouth to the nose via the throat when foods or beverages are swallowed). Different aroma precursors will be investigated, as well as the breakdown of those compounds in-mouth and their sensory contribution to the flavour and aftertaste of wines. In addition, this research will provide insight into the consumer experience when drinking a wine, including the intensity of flavour and the persistence of aftertaste.

Isolation and sensory assessment of glycosides

Glycosides have been isolated from a wide range of wines and juices and the composition of the precursor isolates has been characterised. In tasting the crude glycosides, a sensory panel observed little flavour in glycosides from Chardonnay or Shiraz, but a clear, lingering 'fruity'/'floral' aftertaste was found in samples from floral varieties, especially Gewurztraminer. In several experiments it was confirmed that the flavour produced was derived from flavour precursors. A liquid chromatography-mass spectrometry (LC-MS) method was developed to quantify monoterpene glycosides, and a method to trap volatiles released in-mouth has been established.

Formal sensory experiments have been completed to assess the flavour release and quantify and characterise the intensity of flavour perceived. These were conducted using time-intensity methodology, whereby a trained sensory panel rates the intensity of in-mouth flavour attributes continuously over a period of minutes, so that the progress of release can be tracked over time. Glycoside isolates obtained from wine and juice, as well as synthetic, pure monoterpene glycosides were tested in comparison to free volatile compounds alone, and a model wine control. Figure 2 shows the fruit flavour release over time for a wine glycoside precursor extract, together with a juice precursor extract, compared to a control sample. Glycoside precursor samples had significantly less fruit aroma, assessed before tasting, than the samples containing extracted volatiles (data not shown), and the panel data shown in Figure 2 confirm a lingering fruit flavour released from the precursors, continuing for more than 80 seconds after expectoration. In further work, variability across individuals will be assessed, as well as the relative importance of the flavour released from glycosides and other precursor types compared to the free volatiles present, for different wine types. The results may provide a new measure to distinguish wines with desirable lingering flavour from those with a short finish.

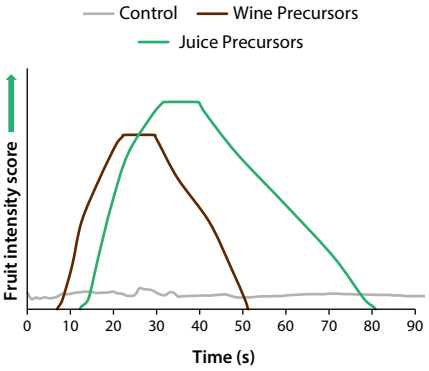


Figure 2. Mean time intensity curves for precursor samples in model wine assessed in triplicate for fruit flavour by a trained sensory panel. Also shown is data for a model wine control.

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

Background

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

The following specific aspects are being investigated in this project:

- the compositional drivers of texture, hotness and bitterness
- the role of macromolecules such as tannins, polysaccharides, proteins and their aggregate colloids in the expression of texture, stability, clarity and filterability
- the impact of other wine matrix components on macromolecule function and expression
- the source of these molecules or their precursors in grapes and yeast and the impact of winemaking processes such as clarification, flotation, vinification and filtration on their retention and/or transformation
- the impact of filtration on macromolecules

- strategies for modulation of specific compositional drivers through the use of grape-based fining agents
- alternative strategies for achieving protein stability
- practical methods for wineries to determine likely extractability of macromolecules during winemaking
- strategies for the stabilisation of colour independent of vintage effects.

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

Macromolecule and colour extraction, stability and retention and its influence on wine style and production practices

Research at the AWRI to date has shown that large differences in tannin and colour extractability exist both within and across grape varieties and vintages, dependent on factors including climate, maturity, winemaking and yeast selection. Results indicate that this variation may be due to the interaction between phenolic compounds and other macromolecules during fermentation. Insoluble cell wall material (fibre) can bind and thus trap tannin and anthocyanin during fermentation, and interactions between soluble polysaccharides and proteins may also result in a loss of soluble phenolics. These may be lost in marc or lees, or be sequestered in colloid complexes in red wines. Cell wall macromolecular composition may therefore influence anthocyanin as well as tannin extractability and retention. The AWRI's research has shown that biochemical changes occuring during grape ripening increase the extractability of grape skin tannins, but reduce the extractability of seed tannins. Notably, the magnitude of this effect differs markedly between grape varieties. Previous research on grape cell wall composition showed that differences in cell wall porosity may play a role, but techniques to directly measure this were not available. Various other factors may also affect grape cell wall porosity, namely pectin depolymerisation, deposition of extensins and highly polymerised tannins within cell wall components. As a result of this complexity, a method by which wine tannin and colour could be accurately predicted from grape analysis did not exist. This led to work developing a reliable and practical method to predict how extractable grape colour and tannin are likely to be during winemaking, as outlined below.

Keren Bindon

A practical method to determine extractable grape colour and tannin and the relationship of grape composition to final wine colour and tannin properties

The concentration of tannin and anthocyanin in red wine is an important determinant of wine colour and texture. Wine tannin and anthocyanin concentrations are dependent not only on the total concentration of these compounds in the grape, but also their relative extraction and retention during winemaking. Based on successful pilot studies described in the previous AWRI annual report (AWRI publication #1587), testing was conducted on the effectiveness of a simple extraction method to determine 'wine extractable' tannin and anthocyanin. Through collaboration with Accolade Wines, triplicate wines were made from 39 Shiraz and Cabernet Sauvignon grape samples sourced from different regions across South Australia. The 'wine-like' extraction method used gently crushed grapes, adjusted to 15% v/v ethanol, pH 3.4, in their own juice (Figure 3). To compare the effectiveness of the 'wine-like' extraction method against standard methods available to industry, the grapes were also homogenised and extracted in 50% v/v ethanol. Wines and extracts were analysed for tannin and anthocyanin, and colour density (wine only).

The results were very encouraging; it was found that the application of the 'wine-like' extraction method could provide a good indication of wine tannin (Figure 4) and anthocyanin concentrations extractable during fermentation, as well as predict wine colour density (AWRI publication #1617). Strong regional differences were found for both grape varieties. When considered on a varietal basis, the 'total' tannin concentrations measured using the grape homogenate method also correlated with those measured in the wines, but were noticeably higher than the actual concentrations achieved through vinification. The overestimation of tannin concentrations in grape homogenate extracts was greater for Cabernet Sauvignon samples than for Shiraz. Correlations between the grape anthocyanin, and wine anthocyanin, as well as wine colour density were strong, independent of grape variety or extraction method. In summary, the work demonstrated that the 'wine-like' extraction approach provides a useful prediction of wine tannin and colour.

Methods to characterise cell walls and their constituents

Previous work has shown that a significant amount of grape skin tannin is bound to cell walls, and is non-extractable even with a harsh solvent such as 70% v/v acetone in water (AWRI publication #1587).

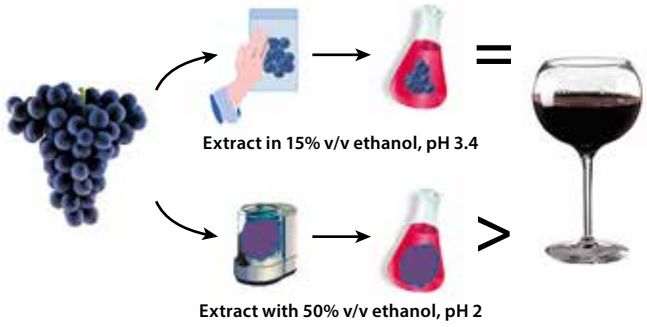


Figure 3. Comparison of 'wine-like' vs standard extraction protocols for tannin and colour analysis. The gentle 'wine-like' extraction in 15% ethanol (top) gives a good prediction of eventual wine tannin, while the standard protocol of grape homogenate extracted in 50% ethanol (bottom) overestimates the eventual wine tannin concentration.

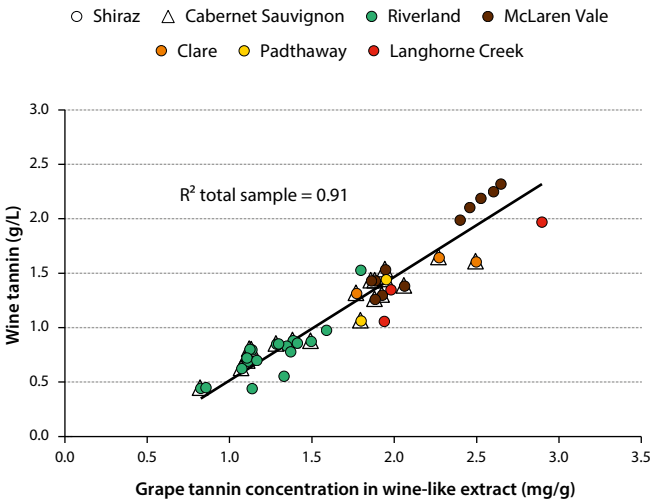


Figure 4. Correlation of grape tannin concentrations measured using the 'wine-like' extraction protocol with resulting wine tannin concentrations.

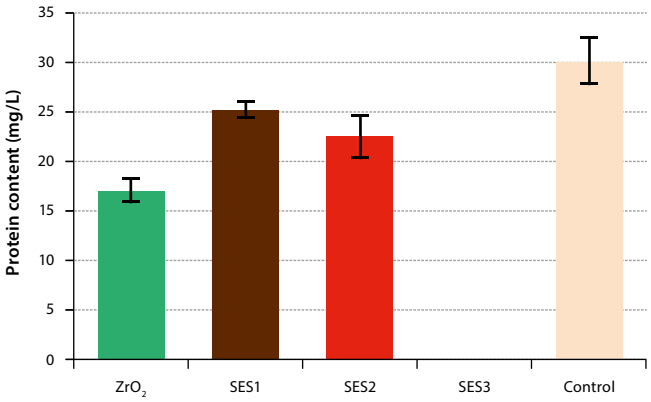


Figure 5. Protein concentration in Riesling wine after treatment with different surface-engineered silica (SES) gels at 10 g/L as compared with zirconium dioxide and the untreated control wine. SES3 removed all protein from the wine and therefore will be investigated further.

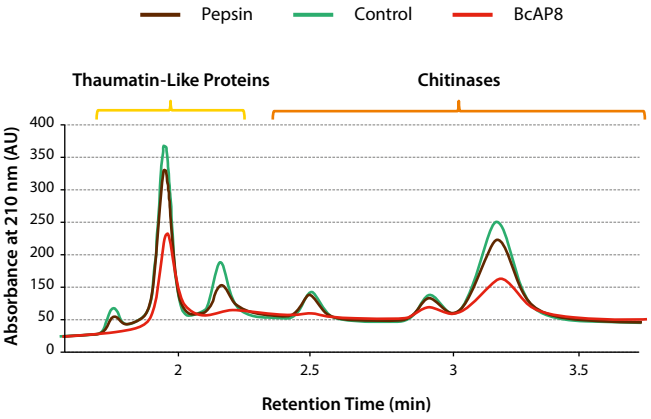


Figure 6. HPLC chromatograms of Muscat Gordo wines showing relative protein concentrations after protease treatment during fermentation (Pepsin and BcAP8) compared with a control wine without protease addition.

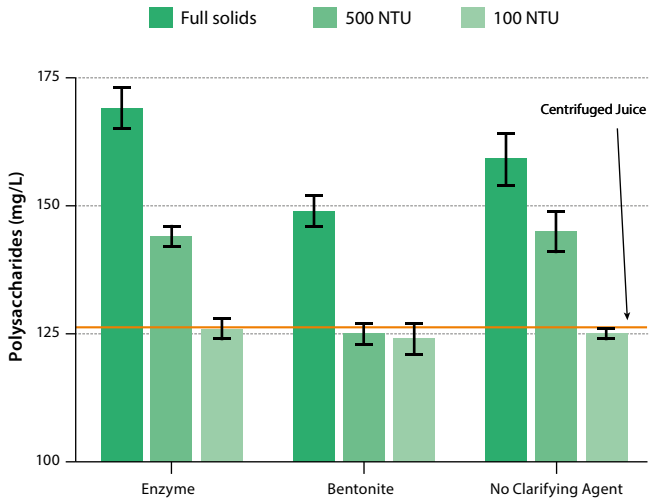


Figure 7. Effects of juice clarification on polysaccharides in white wine.

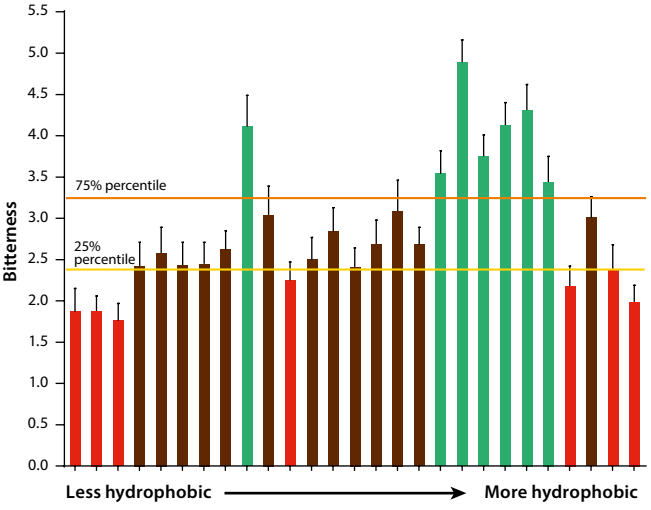


Figure 8. Perceived bitterness of compounds isolated from white wine.

Hence it is no surprise that under typical fermentation conditions only a fraction of total skin tannin is extracted into wine. To further address the role of cell wall composition in tannin release and back binding, the AWRI team was joined in 2013 by a visiting PhD student, Yolanda Ruiz Garcia from the University of Murcia in Spain, who was supported by a research scholarship from the Fundación Seneca. In this joint research project a sequential fractionation technique was employed to produce cell wall fractions of defined polysaccharide composition. More than 54% of cell wall-bound tannin was found to be associated with pectic polysaccharides in the cell wall (AWRI publication #1644). This observation was further corroborated by model adsorption experiments which confirmed that the removal of pectic polysaccharides most significantly reduced the adsorption capacity of cell walls for tannin. From these experiments it is evident that winemaking techniques which manipulate grape pectins may also affect the extraction of tannin into wine, and furthermore might limit tannin re-adsorption onto suspended cell wall material in the ferment.

New bentonite alternatives for removing protein haze in white wine

Consumer and market expectations drive the push for clarity and absence of bottle deposits in white wines. Wine haze can form when particular grape proteins – chitinases and thaumatins – are present in wine. The current practice of using bentonite to remove wine proteins is suboptimal largely due to the amount of wine lost with lees and the waste created. Alternatives for protein removal are therefore being investigated including new adsorbents for protein removal that are more selective, reusable and less wasteful, as well as protease enzymes with an ability to degrade proteins in wine. Other aspects of this project include research aiming to improve understanding of the proteins involved in haze and the development of better methods for measuring the haze potential of white wine.

In trialling new protein adsorbents, a collaboration has been set up with UniSA to assess the viability of different materials as bentonite alternatives. Preliminary investigations have indicated that some surface-engineered silica gels are selective for proteins in wines and research is continuing to evaluate these materials (Figure 5).

As an alternative to removing proteins from finished wines, the AWRI has previously reported on success in using a commercially available aspergillopepsin enzyme product known as Proctase to degrade wine proteins *in situ* (AWRI publication #1444). Successful Proctase use requires grape juice to be heated to 70°C for 1 minute; the heating step is required to both activate the enzyme and unfold the target proteins to make them susceptible to degradation, and this is a potential drawback to the industry adoption of this enzymatic process. Research is currently under way to find additional protease enzymes that are effective against wine proteins under winemaking conditions. A range of enzymes have been obtained for evaluation from natural sources including *Botrytis cinerea* and pineapples. Preliminary investigations have indicated that the *Botrytis* enzyme, BcAP8 (AWRI publication #1563), is active against wine proteins under winemaking conditions and further research is in progress to optimise this activity (Figure 6).

While the grape protein classes chitinases and thaumatins are the main wine components associated with haze in white wine, greater protein concentration in wine does not necessarily indicate a greater haze potential. To better understand the variability surrounding haze formation, an analytical method has been developed using high performance liquid chromatography (HPLC) to more rapidly identify and quantify specific proteins in white wine, reducing the analysis time from 60 minutes to 10 minutes per sample. Large-scale isolation of individual proteins from juice is also ongoing to obtain greater quantities of different proteins and other macromolecules for more detailed structure-function analysis of the haze-potential and aggregation behaviour of individual proteins, and their interplay with other wine compounds such as polyphenols.

Fundamental methods for understanding texture, taste, clarity, stability and filterability

Typical methods for investigating the formation and properties of colloids in wine (i.e. macromolecular aggregates with particle sizes in the nanometre range), are quite complicated and have mainly been developed for applications in areas other than wine science. They are, however, fundamental to determining how colloids influence the outcomes of many processes in wine production including extraction, settling, clarification, filtration and stability. To improve existing methods and tailor them to applications in the wine industry, new techniques of isothermal titration calorimetry (ITC), small angle x-ray scattering (SAXS) and dynamic light scattering (DLS) have recently been established. In addition, new methods for characterising particle size distributions in red wine and monitoring effects of filtration on the zeta-potential of a wine have been adopted. The zeta potential is a key indicator of the stability of colloidal dispersions. In a proof-of-concept study the zeta potential of a wine sample after filtration was found to be lower, possibly indicating an enhanced colloidal stability of the filtered wine. In a separate experiment, plasma polymerisation was used to create well-defined surfaces of varied properties (e.g. polarity, charge) to help characterise adsorption behaviour of wine molecules and colloids.

Impact of juice clarification on macromolecules and phenolics in white wine

Juice clarification prior to fermentation is an important part of the white winemaking process as excessive levels of juice turbidity can affect varietal expression and overall flavour quality. Although white juices will eventually clarify under the action of gravity, the process is inherently slow resulting in valuable tank space being tied up during busy vintage periods. The process of juice settling can be expedited by employing clarifying agents and pectolyic enzymes which facilitate flocculation and settling activity. Alternatively, solids may be separated from juice by centrifugation. The efficacy of these standard processes for wine production is well established. However, their impact on the macromolecular and colloid concentration and composition, and therefore on the mouth-feel of white wine, is not well understood. A broad scoping study has begun using laboratory-scale experiments to investigate the effects of different settling techniques (natural settling, centrifugation and clarification agents) on the macromolecular and phenolic composition of white wine. Results obtained so far suggest that fermenting juice containing higher levels of solids may result in wine with higher polysaccharide concentrations, which are also affected by the clarification method used (Figure 7). Juice clarity also significantly affected both wine total phenolics and phenolic profiles. Future work will involve characterising the molecular weight and monosaccharide distribution of the polysaccharides, the specific phenolic compounds associated with grape solids fermentation, and an evaluation of the sensory effects of changes in a wine's macromolecule composition.

Molecular drivers of texture and taste

Bitterness remains a significant negative influence on consumer preference in white wine. Formal sensory analysis of white wines made from three commercially relevant varieties and nine juice extraction and handling methods over two vintages showed that bitterness in these wines was associated with their total phenolic concentration (AWRI publication #1518). Further work established that low molecular weight hydrophobic phenolics were associated with white wine bitterness, and that two of the significant hydrophilic phenolics in white wine (grape reaction product and caftaric acid) did not contribute significantly to bitterness (AWRI publication #1596). Furthermore, sensory analysis has shown that interactions between the phenolic content and alcohol and acidity of white wine have significant effects on mouth-feel and bitterness, indicating that the wine matrix plays a significant role in the perception of bitterness induced by phenolics in white wine (AWRI publication #1552).

To understand the relative impact of the different types of phenolics on bitterness and mouth-feel, the total phenolic pool from bitter white wine was fractionated into hydrophilic and hydrophobic components using multilayer coil countercurrent chromatography, and the isolates were formally tasted in wine-like media at varying alcohol and acid levels. The perceived bitterness and hotness of the phenolic fractions depended on the acidity of the wine matrix. The hydrophilic phenolic fraction contributed to both bitterness and perceived acidity at all levels of acidity and alcohol. The hydrophobic


Jenny Bellon

isolate was further sub-fractionated using preparative-scale chromatography to obtain 27 fractions with defined phenolic composition and varying hydrophobicity. When tasted, these fractions varied significantly in perceived bitterness despite having the same total phenolic concentration (Figure 8). The phenolic composition of these fractions is now being investigated to identify the individual phenolic compounds most responsible for bitterness in white wine.

References

AWRI publication #1444. Marangon, M., Van Sluyter, S.C., Robinson, E.M.C., Muhlack, R.A., Holt, H.E., Haynes, P.A., Godden, P.W., Smith, P.A., Waters, E.J. Degradation of white wine haze proteins by Aspergillopepsin I and II during juice flash pasteurization. *Food Chem.* 135(3): 1157–1165; 2012.

AWRI publication #1518. Gawel, R., Day, M., Schulkin, A., Smith, P., Herderich, M., Johnson, D. The science of texture. *Wine Vitic. J.* 28(2): 30–34; 2013.

AWRI publication #1552. Gawel, R., Van Sluyter, S.C., Smith, P.A. and Waters, E.J. Effect of pH and alcohol on perception of phenolic character in white wine. *Am. J. Enol. Vitic.* 64: 425–429; 2013.

AWRI publication #1563. Van Sluyter, S.C., Warnock, N.I., Schmidt, S., Anderson, P., van Kan, J.A.L., Bacic, A., Waters, E.J. Aspartic acid protease from *Botrytis cinerea* removes haze-formation proteins during white winemaking. *J. Agric. Food Chem.* 61(40): 9705–9711; 2013.

AWRI publication #1587. Bindon, K.A., Madani, S.H., Pendleton, P., Smith, P.A., Kennedy, J.A. Factors affecting skin tannin extractability in ripening grapes. *J. Agric. Food Chem.* 62(5), 1130–1141; 2014.

AWRI publication #1596. Gawel, R., Schulkin, A., Smith, P.A., Waters, E.J. Taste and textural characters of mixtures of caftaric acid and Grape Reaction Product in model wine. *Aust. J. Grape Wine Res.* 20(1): 25–30; 2014.

AWRI publication #1617. Bindon, K.A., Kassara, S., Cynkar, W., Robinson, E.M.C., Scrimgeour, N., Smith, P.A. Comparison of Extraction Protocols to Determine Differences in Wine-Extractable Tannin and Anthocyanin in *Vitis vinifera* L. cv. Shiraz and Cabernet Sauvignon Grapes. *J. Agric. Food Chem.* 62(20): 4558–4576; 2014.

AWRI publication #1644. Ruiz-Garcia, Y., Smith, P.A., Bindon, K.A. Selective extraction of polysaccharide affects the adsorption of proanthocyanidin by grape cell walls. *Carbohyd. Polym.* 114: 102–114; 2014.

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

Staff

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

Collaborators

CCOVI, Brock University (Dr Debbie Inglis, Fei Yang); Stanford University (Prof. Mike Snyder, Dr Barbara Dunn, Assoc. Prof. Gavin Sherlock); University of Adelaide (Assoc. Prof. Chris Ford).

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

Background

Regional wine style expression has been identified as a key industry priority. An important aspect of regional expression, particularly where spontaneous fermentations are performed, may be due to regional wine microorganisms. It may be possible to exploit this geographical uniqueness in wine style if certain strains of yeast and bacteria can be shown to reside in specific vineyards, geographic or climatic zones. This potential genetic variation may also represent an opportunity to maximise the diversity and complexity of wines produced in different regions. This project will provide insights into the species commonly found during wild fermentation, and pave the way for a broader understanding of how the microbial dynamics of wild fermentation can be influenced by region or by viticultural and winemaking interventions.

Metagenomic analysis of wild ferments

Samples of uninoculated Chardonnay grape must were allowed to ferment and subjected to metagenomic analysis to determine the species composition present throughout the progression of fermentation. Initial results support the view that uninoculated ferments begin with a diverse ecosystem of yeast species (both *Saccharomyces* and non-*Saccharomyces*) but converge on the wine yeast *Saccharomyces cerevisiae* as the ferment progresses. Detailed analysis currently under way will define how the levels of both individual species and strains change during fermentation and whether regions, vineyards or wineries can be broadly defined by the resulting microbial composition of their wild ferments.

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

Background

It is common practice for winemakers to choose particular yeasts in pursuit of desired wine styles. Availability of new yeasts that impart novel flavour profiles or that accentuate specific varietal characters can provide winemakers with an expanding array of options to achieve stylistic flexibility. This project aims to facilitate the development of wine styles with distinctive flavour profiles and the production of existing wine styles with lower input costs, with a particular focus on the contribution of yeast to red wine flavour. A broad approach is being taken to microbial modulation of wine flavour, including harnessing the overall genetic diversity of yeast germplasm (both within and outside the *Saccharomyces cerevisiae* species) with the objective of establishing yeast 'flavour profiles' and accompanying genomic markers. Classical breeding, mutagenesis and interspecies hybridisation, guided by genomic insights into 'what each genome brings to a wine strain', are being applied to generate novel wine strains that modulate red wine flavour, display appropriate flocculation behaviour, produce low levels of off-flavours and exhibit stable performance.

Harnessing yeast diversity

A major objective has been to understand the potential value that can be derived from yeast genetic diversity to influence wine flavour profile and mouth-feel. The chemical compositions of fermentations conducted with a large number of yeast strains have been extensively

profiled, and flocculation behaviour of these strains also screened (Figure 9). A subset of strains was used to make Shiraz wines for sensory assessment. The resultant large multi-dimensional dataset is already in use for benchmarking novel strains, and will enable development of genomic markers for marker-assisted breeding. As part of this work a survey was conducted of available yeast strains for production of volatile compounds associated with 'rose' aromas. This has led to the development of novel strains that produce significantly higher levels of these 'rose' aroma compounds.

Protocols have also successfully been established for interspecies breeding between *Saccharomyces cerevisiae* wine yeasts and the recently described species *Saccharomyces arboricolus* and *Saccharomyces eubayanus*. Interspecies hybridisation has already proven to be an effective strategy to enhance genetic diversity and wine complexity, while maintaining fermentation efficiency. The new hybrids represent a promising opportunity to provide winemakers with additional tools in their pursuit of distinctive wines.

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

Background

From the AWRI's extensive experience in the rescue of suboptimal fermentations, it has become increasingly clear that the ability to predict problematic fermentations, beyond an understanding of the impacts of sugar and nitrogen, is extremely poor. Work is therefore in progress to develop a greater understanding of the interactions of yeast strains with their environment. The project aims to identify predictive factors of fermentation efficiency and reliability, and improve the tools available to winemakers to better manage fermentation through matching yeast strains to specific must conditions.

While currently over 200 yeast strains are available to the wine industry, there is limited detail available on how they perform in different contexts, both in terms of fermentation kinetics and flavour outcomes. This project aims to develop a knowledge base on how these different yeast strains perform under a range of environmental conditions (i.e. in grape juices of widely varying composition as used for a range of wine styles) and how winemakers can optimise fermentation efficiency and mitigate against the risks of suboptimal fermentations.

A multi-factorial approach

Recent technological developments have enabled the use of multi-factorial experimental designs to investigate environmental influences on yeast strain performance, making it possible to simultaneously evaluate hundreds of strains under many combinations of environmental conditions. This approach is being used to construct matrices that describe how individual yeast strains behave under different environmental conditions, identifying strain-specific limitations and essential requirements so that winemakers can reduce the risks of sub-optimal fermentations through strain selection or must amelioration. In parallel, detailed studies are under way to determine genetic factors that relate to, or cause variations in, wine yeast robustness and reliability.

Malolactic fermentation — understanding performance and identifying genetic markers of robust strains

Background

Malolactic fermentation (MLF) is an important but sometimes unreliable stage in the winemaking process, with the potential to impact significantly on wine quality. In recent years research at the AWRI has improved MLF efficiency by developing co-inoculation strategies (yeast and bacteria inoculated together) that have been demonstrated to reduce overall fermentation time. However, achieving a reliable MLF still provides winemakers with challenges from time to time. One contributing factor is the lack of MLF starter strains specifically suited to Australian winemaking conditions, as commercially available strains have largely been selected and developed for overseas markets. In addition, while MLF is primarily used for wine deacidification, there is a significant but largely hidden pool of latent grape and wine aroma compounds in wines that can be released during MLF to influence wine style and enhance complexity. In previous research the AWRI has identified compounds and potential enzymatic pathways that enable some *O. oeni* strains to enhance berry aromas in red wine. More recently, the genomes of 12 *O. oeni* strains sequenced at the AWRI revealed extreme genetic diversity across this group of bacteria. While this broad genetic diversity provides a promising opportunity to identify MLF strains with unique properties, there is currently little information available regarding genomic markers for wine-relevant phenotypes.

Comparative genomics and performance

The AWRI is building a knowledge base about MLF isolates through comparative genomics and phenomics (i.e. through characterising strain traits such as fermentation performance and potential for flavour release). With this information the AWRI aims to identify genetic markers for desirable traits, such as tolerance to low pH or alcohol. These markers can then be used to identify Australian isolates from the AWRI wine microorganism culture collection that are well suited to Australian winemaking conditions. In parallel with the identification of genetic markers, transcriptomic approaches are being developed for determining which genes are active (or inactive) and hence more likely to play an important role in performance during MLF. This will further enhance the strategies for marker-assisted selection of superior MLF strains for use in Australian winemaking.

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

Background

The AWRI Wine Microorganism Culture Collection (AWMCC) originates from early microbiological investigations in Australian wines by John Fornachon in the 1940s and the earliest days of the AWRI. Since that time ongoing additions to the AWMCC from wineries and researchers across Australia have led to the development of a repository that houses the Australian wine industry's microbial germplasm heritage. The AWMCC currently holds


Simon Schmidt

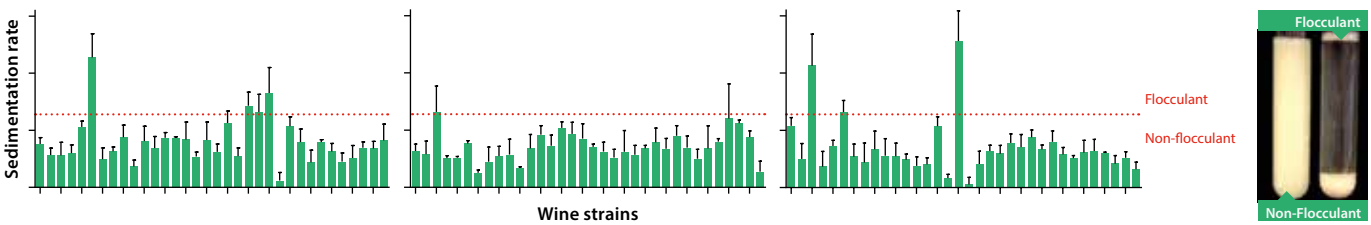


Figure 9. Flocculation behaviour of 102 wine yeast strains evaluated in a high-throughput microplate assay (left). Highly flocculant strains rapidly settle out of suspension in wine (right).

more than 2,000 yeast and more than 900 bacterial strains, with an electronic database used to record information about each strain and to manage their movement (deposition and supply) and intellectual property.

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

Identification, storage and distribution of microbial strains

In 2013/2014 220 yeast and bacterial strains were submitted to the AWMCC from researchers and wineries. All strains submitted were checked for purity, had their identity determined and were placed into cryogenic storage at -80°C. An additional 110 strains already present in the AWMCC were identified. During the year the AWMCC received a large number of requests for yeast and bacterial strains, resulting in 805 microbial samples being distributed from cryogenic stocks.

Novel products and effective processes

Staff

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

Collaborators

Australian Genome Research Facility (Prof. Sue Forrest, Dr John Stephen); Australian Proteome Analysis Facility (Prof. Mark Baker, Assoc. Prof. Peter Hoffman, Dr Alamgir Khan); Bioplatforms Australia (Andrew Gilbert); Oxford Landing Estates (Matt Zadow); Treasury Wine Estates (Dr Vanessa Stockdale); University of Melbourne (Prof. Tony Bacic, Assoc. Prof. Ute Roessner); University of New South Wales (Prof. Marc Wilkins, Dr Chi Pang); University of Queensland (Dr Jens Kroemer).

Technologies and strategies for the production of lower alcohol wine

Background

There is growing public and consumer interest in wines with lower alcohol concentration that maintain robust aroma and flavour profiles. Producers may also face financial penalties for higher alcohol wines in markets where taxes are levied on the basis of alcohol concentration. This project employs advanced 'systems biology' approaches to study the metabolism of *Saccharomyces cerevisiae* wine yeast strains modified to produce up to 2% less alcohol in a grape must with potential for 15% v/v alcohol, with the goal of harnessing this knowledge to develop non-GM strains.

The microbial biodiversity of spontaneous fermentations also contains great potential for shaping wine style, including the production of wine with reduced alcohol concentration. Harnessing this diversity in controlled, inoculated ferments may provide winemakers with simple, cost-effective and low risk strategies for tailoring wines to market demands.

Sequential inoculation

Sequential inoculation represents one approach to producing a wine with lower ethanol concentration. In this method, grape must is inoculated first with a selected non-*Saccharomyces* yeast which converts some fermentable sugar into compounds other than ethanol, but is unable to complete fermentation. Inoculation with *Saccharomyces cerevisiae* then follows to complete the fermentation with a lower final ethanol concentration than if the wine were produced by *Saccharomyces cerevisiae* alone.

Cristian Varela

Fifty different non-*Saccharomcyes* yeasts were screened and a strain of *Metschnikowia pulcherrima* was identified as a yeast suitable for producing lower ethanol wine via sequential inoculation. A proof-of-concept study of sequential inoculation with *M. pulcherrima* in a Shiraz fermentation showed a reduction in alcohol concentration of 1.6% v/v compared to wine produced by *S. cerevisiae* alone (Figure 10).

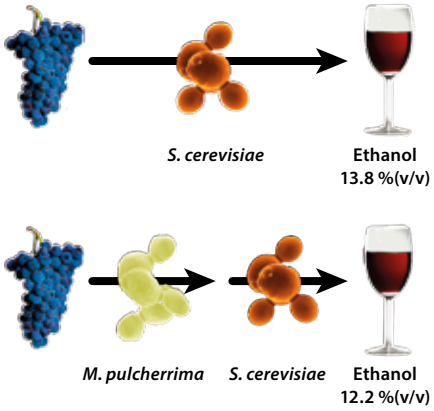


Figure 10. Shiraz grapes fermented by sequential inoculation with M. pulcherrima *AWRI1149 and* S. cerevisiae *produced wine with 1.6 % v/v lower alcohol concentration than that produced with* S. cerevisiae *alone.*

Influencing wine style through management of oxygen during winemaking

Background

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

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

Investigating extremes of oxygen exposure

The first stage of experiments has involved carrying out laboratory-scale ferments designed to represent the extremes of oxygen exposure that occur during standard white winemaking techniques. The first winery-scale experiments have involved using two pressing techniques on white fruit (inert and aerobic pressing) followed by two handling methods (reductive and oxidative), resulting in four very different final wines which reflect the extremes of oxygen use in their production.

Initial results from both the laboratory and pilot-scale projects have highlighted the impacts of oxygen treatments not only on reductive compounds, but also a range of other fermentation products capable of influencing final wine style. Valuable information has also been developed on the most appropriate equipment and processes to measure oxygen inputs during the winemaking process, as well as the quantities of oxygen introduced by various winemaking production techniques.

Reduce cost of production

Staff

Tadro Abbott, Dr Anthony Borneman, Karl Forsyth, Kieran Hirlam, Dr Josh Hixson, Dr Darek Kutyna, Danna Li, Dr Simon Nordestgaard, Dr Vince O'Brien, Dr Paul Smith, Dr Eric Wilkes.

Collaborators

Accolade Wines (Travis Haeft); Angove Family Winemakers (Tony Ingle); Coriole Vineyards (Mark Lloyd); Department of Environment and Primary Industries Victoria (Peter Moate, Joe Jacobs); SA State Government Department for Manufacturing, Innovation, Trade, Resources and Energy (Mark Ledson and Helen Bethell); Dowie Doole (Chris Thomas); Macquarie University (Prof. Sakkie Pretorius); McLaren Vale Grape Wine Tourism Association (Marc Allgrove); Pernod Ricard Winemakers (Dr Jean Macintrye, Vinjay Singh); Scholle Packaging (John Brooks); Tarac Technologies (Brenton Mengersen); University of Melbourne (Victoria Russo, Assoc. Prof. Brian Leury); University of New England (Prof. Roger Hegarty); University of Technology Sydney (Prof. Sam Bucolo); Wanderribby Cattle Feedlot (Ron Nankivell).

Understanding methane-reducing tannins in enteric fermentation using grape marc as a model tannin source

Background

Methane from ruminant animals contributes approximately 10% of Australia's GHG emissions. There is potential to reduce these emissions by supplementing livestock feed with tannins or tannin-containing feed, which have been


Peter Costello

shown to reduce the production of methane. Grape marc has been suggested as a possible source of tannin able to be used for this purpose. This project is applying the AWRI's existing expertise in tannin chemistry to gain a thorough understanding of the tannin in grape marc, and apply this knowledge to achieve reduced methane emissions and productivity improvements in the livestock industry. Funded by the DA through its 'Filling the Research Gap' program, this project is managed by Meat and Livestock Australia as part of the National Livestock Methane Program.

Grape marc analysis and application

A range of grape marc samples were obtained from across the wine production and processing chain and were analysed to determine their tannin concentration and composition. A diverse selection of tannin samples were then chosen for *in vitro* fermentation experiments to link tannin chemistry with methane reductions. Grape marc samples were also analysed for their content of fats and oils, carbohydrates, organic acids and minerals, to assess if these also affected methane emissions. Results showed that tannin concentration, tannin composition and overall fatty acid content were the most important factors influencing methane reductions. Other factors measured such as tartrate, copper and glycerol were not found to be significant.

Grape marc parcels were selected and used for *in vivo* feeding trials with dairy cattle. Initial results showed a reduction in both methane production and milk yield from the supplemented animals. Further *in vivo* trials with sheep are planned to take place at the University of Melbourne in 2014/2015, investigating two different dose rates of grape marc.

Using grape marc as a feed additive in commercial settings

Background

Grape marc has been identified as a potential feed additive for the livestock industry able to improve productivity and reduce methane emissions. In order for grape marc to be widely used in the livestock industry, some practical barriers regarding storage and distribution need to be overcome. This project commenced in September 2013, building on the work investigating grape marc tannin described earlier. Funded through the DA 'Action on the Ground' program, this project aims to address the practicalities of feeding grape marc to livestock. Specific areas of focus are: effective storage solutions that preserve tannin by restricting heat and oxygen exposure while allowing for year-round use; preventing mould formation during feeding; and addressing distribution restrictions arising from movement of a high moisture product.

Investigating storage methods

Following the completion of small-scale mini silo trials to investigate the effect of commercial additives on mould growth during anaerobic and aerobic storage, large-scale storage trials have been initiated and are continuing. Grape marc parcels from one tonne to several thousand tonnes have been stored using methods common to livestock feed (bunkering, bales, grain bags) and will be assessed over the course of a year for tannin content, nutritive value and mould formation.

Genomics innovation initiative

Background

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

The yeast *Saccharomyces cerevisiae* represents an obvious target for synthetic engineering. It is an established and prominent industrial microorganism, used to produce a diversity of high-value food, beverage and biotechnology products such as biofuels, pharmaceuticals, wine and beer. In addition, yeast is a key model organism for the development of new technologies in fundamental research, including genomics, transcriptomics, metabolomics and systems biology. The existing fundamental knowledge provides an extensive base on which to build a synthetic biology strategy that can be applied in an industrial setting to address key opportunities.

Specific objectives of this project are to engineer *Saccharomyces cerevisiae* with new metabolic pathways to enable biosynthesis of compounds such as monoterpenes, raspberry ketone, anthocyanins and lactic acid during fermentation.


Vince O'Brien

Engineering new metabolic pathways

This project is establishing the expertise, techniques and capacity to engineer complex genetic modules, taking advantage of recent improvements in commercial gene synthesis technologies. An area of focus is the engineering of biological pathways for the fermentation-derived production of compounds that are important to the wine industry. This year's work has concentrated on pathways in *Saccharomyces cerevisiae* that produce the monoterpenes linalool and geraniol, and raspberry ketone.

In addition, the AWRI has entered into a new synthetic biology partnership with Macquarie University. The partnership will focus on building skills and capability in synthetic biology, providing leadership in this field in the Asia-Pacific region and facilitating participation in international projects. The first project the partnership is involved in is the international collaboration to build a synthetic version of yeast, known as Sc2.0. Macquarie and the AWRI are jointly responsible for synthesising Chromosome XIV of the synthetic yeast's genome.

Reducing wine movements during production

Background

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

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

Investigating lees properties

The principal challenge inherent in reverse racking is that there will be some tendency for the clear product above to channel through the lees before all or much of the lees have been removed from the tank. The degree to which this will occur is likely to depend on the rheology of the lees (how easily they can flow) as well as tank design and pump settings. A key rheological property is known as 'yield stress' (the minimum stress that needs to be applied to make a structured fluid flow). As a general rule, lees samples with low yield stress values are likely to be better suited to reverse racking (experiencing less 'channelling') than samples with higher yield stress values.

As the first step in this project, a diverse range of lees samples were collected from wineries during and after the 2014 vintage and analysed. Of the samples collected so far, the overriding observation has been that with the exception of gross red lees (red ferment lees after draining/pressing and settling) winery lees are relatively thin – they have low/no yield stresses and low viscosities, suggesting that with correctly designed equipment, it may be possible to reverse rack the lees without too much of the clear juice/wine above channelling or bypassing through it.

The project will continue next year with laboratory-scale trials assessing a range of devices able to be retrofitted to existing winery tanks to facilitate reverse racking.

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

Background

As part of the its mission to support the profitability of the Australian wine sector, the AWRI, together with the South Australian Government, the McLaren Vale Grape Wine and Tourism Association and Scholle Packaging, established a 'Consumer Oriented Design' program in McLaren Vale. The goal of this program is to provide tools to enable the generation of innovative business initiatives and product concepts with emotive appeal to consumers, capable of engaging consumers via purchasing criteria other than price. After generating the new initiatives, the second project aim is to demonstrate them in action.

VALO—a unique business initiative

Key personnel from ten wineries in McLaren Vale attended a four-stage workshop program delivered by the University of Technology, Sydney. Attendees collaborated to develop three unique business initiatives. One of these initiatives – the VALO program – is now being commercialised.

The VALO program seeks to capitalise on the unique offerings of the McLaren Vale wine region for high net worth individuals who enjoy luxury experiences and have an interest in wine. The program will include:

- a pre-eminent wine made from the region's 'best of the best five barrels' for a given vintage
- South Australian designed and made bespoke packaging
- a series of unique events.

Reduce the economic impact of taints and faults

Staff

Caroline Abrahamse, Dr Anthony Borneman, Dr Toni Garcia Cordente, Dr Chris Curtin, Dr Mark Smith, Dr Paul Smith, Dr Cristian Varela, Dr Marlize Viviers, Dr Eric Wilkes.

Collaborators

University of Adelaide (Dr Paul Grbin, Dr Joan Kelly, Nick van Holst Pellekaan); University of New England (Dr Peter Lye); Yalumba (Dr Alana Seabrook).

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

Background

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


Marlize Viviers

Understanding adaptive mechanisms

The first year of this project has focused on developing knowledge about the mechanisms that enable *Brettanomyces* to adapt to environmental conditions, particularly in response to sulfite stress. This has included an investigation in collaboration with the University of Adelaide on whether *Brettanomyces* is able to enter a 'viable-but-non-culturable' (VBNC) state. *Brettanomyces* cultures have been established under conditions of continuous sulfite stress and next-generation sequencing methodologies have been developed to monitor them over time for changes in population structure. Detailed genomic maps of 40 *Brettanomyces* strains have been created, against which novel variants arising through the sulfite exposure experiments can be benchmarked to identify causal mutations.

To enhance the ability to monitor viability of *Brettanomyces* strains under various wine stresses, the University of Adelaide has implemented flow cytometry-based methods and optimised them for experiments conducted in model wine. Across multiple experiments discrepancies between estimations of how many cells are 'alive' have been noted for flow cytometry compared with conventional microbiological plating assays. This may mean that traditional methods underestimate the potential spoilage risk of a given wine, an aspect that will be investigated further over the coming year.

Formation and fate of positive and negative sulfur compounds

Background

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

Winemakers are familiar with the practice of adding copper sulfate to wines that exhibit 'rotten egg' or other 'reduced' characters when in tank. Many winemakers have also seen these 'reduced' characters disappear from their wines in the short term, only to see them return at a later date, sometimes after bottling. By exploring the chemistry of volatile sulfur compound 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.

A multi-metal experiment

To investigate the effects of metals on the formation of the 'reduced' aroma compounds methanethiol (MeSH), hydrogen sulfide (H_2S)

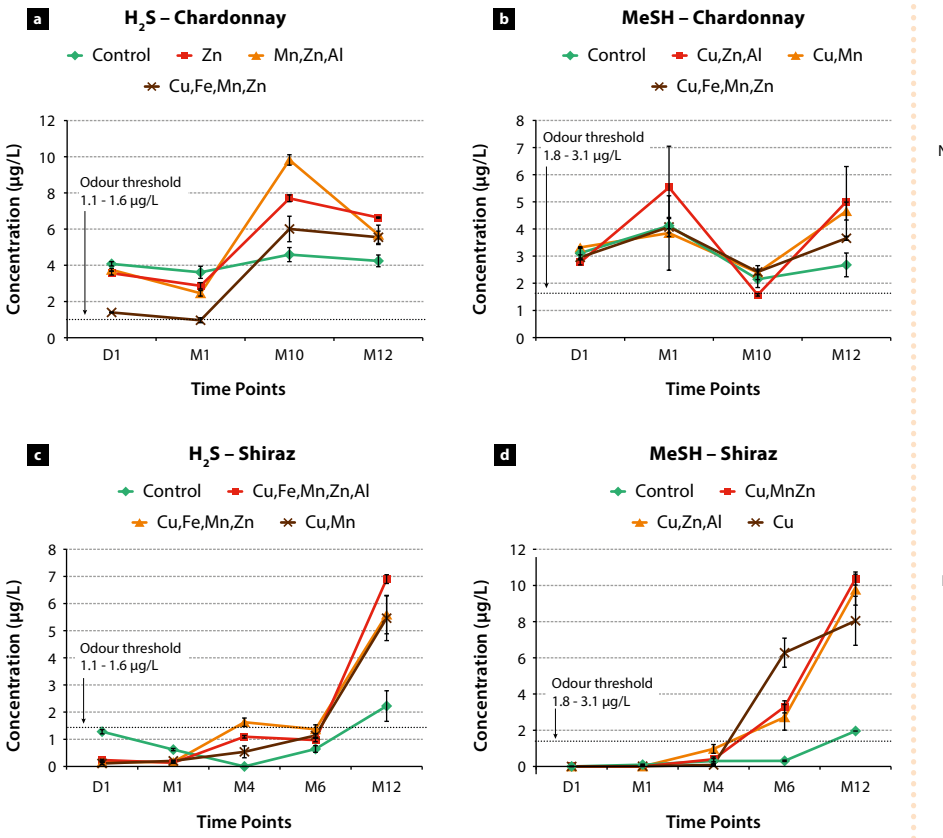


Figure 11. The impact of metals and metal combinations on the concentrations of H_2S and MeSH in Chardonnay and Shiraz wines over time (D=day, M=month).

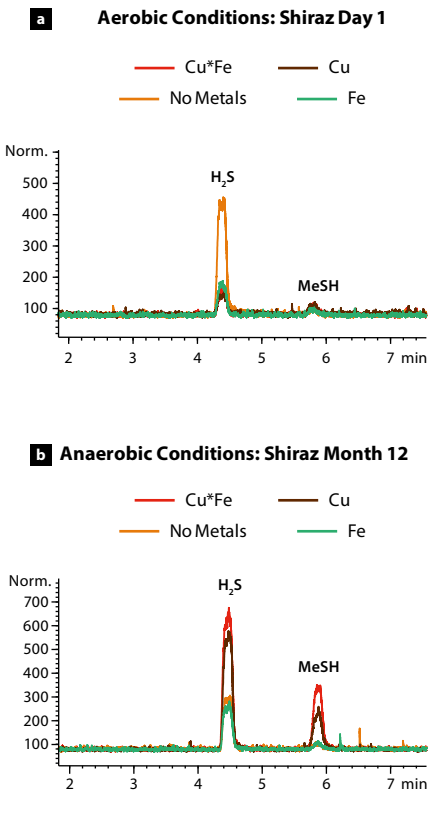


*Figure 12. Typical chromatograms for the analysis of H_2S and MeSH in Shiraz wine samples with added Cu, Fe and the metal combination Cu*Fe shown at (a) Day 1 and at (b) Month 12.*

and dimethylsulfide (DMS) during bottle ageing, a large experiment was designed in which five metals (Cu, Fe, Mn, Zn, Al) were added to Chardonnay and Shiraz wine samples in all possible combinations (resulting in 31 treatments and 1 control for each wine). The metals were present at either their native level in the base wine or at a high level spiked to approximately ten times that native concentration. The concentrations of volatile sulfur compounds were analysed over a 12-month period. At bottling, the wines contained oxygen at around the recommended level of 1 mg/L (Chardonnay 1.11 ± 0.34 mg/L; Shiraz 1.43 ± 0.35 mg/L) and after four months of anaerobic storage the dissolved oxygen (DO) of both Chardonnay and Shiraz samples decreased to undetectable levels. Significant changes in volatile sulfur compounds were observed over the 12-month period, with the Chardonnay samples showing increases in H_2S and DMS, and the Shiraz samples showing increases in H_2S and MeSH (Figure 11).

In this study, some metal treatments were initially associated with decreases in volatile sulfur compound concentrations; however these effects were shown to reverse after four months of anaerobic storage and this trend continued at the 12 month analysis point (Figure 12).

These observations are relevant to winemakers, particularly when considering routine additions of copper to remove unwanted sulfur aromas from wine. Copper additions are likely to be most effective if made early in a wine's life, preferably around the end of fermentation, when yeast cells are still available to help 'mop up' residual metals. If, however, copper is added later, significant amounts can remain in the final wine, greatly increasing the risk of developing 'reduced' aromas in bottle. This study has shown that metals can act singly or in combination to greatly influence evolution of undesirable 'reduced' aromas. Winemakers who wish to lower the risk of such characters should therefore take steps to monitor metal concentrations in wine.

Deliver sound product to the marketplace

Staff

Tadro Abbott, Dr Simon Nordestgaard, Dr Eric Wilkes.

Maximising quality during bulk wine transport

Background

Almost 60% of Australian wine exports by volume are now transported in bulk, up from less than 20% only ten years ago. Other New World wine-producing countries have made similar shifts towards bulk wine transport and packaging in-market. Given the volume of wine exported in this manner, there is considerable interest from wine producers in developing a rigorous understanding of the ways in which aspects of transportation impact upon bulk wine, in order to ensure that their wine always reaches export markets in optimal condition at the lowest cost.

Sampling and analysis across transport routes

The project has pursued this objective via a bulk wine transport sampling and analysis program. Chardonnay and Shiraz Cabernet wines have been sent from Australia to the United Kingdom (Australia's largest export market by volume) via three different shipping routes – direct, transhipped in Malaysia and transhipped in Colombia. Wine at nominally 5 or 15°C has been sent in both flexitanks (polyethylene tanks that convert a standard 20-foot shipping container into a 24,000 L liquid tank) and ISO tanks (stainless steel transport tanks).

Samples have been collected for chemical and sensory analysis from the winery (both from the winery tank and after filtration as the container is filled) and from the packaging centre (both on container emptying and after final packaging). Variables including wine temperature and container air temperature and humidity have been recorded throughout the transportation process. This sampling program is still in progress and will be completed early in 2015, with analysis to follow.

Extension and adoption

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

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

Staff

Gayle Baldock, Linda Bevin, Francesca Blefari, Rae Blair (until 31/07/13), Adrian Coulter, Geoff Cowey, Michael Downie, Dr Peter Dry, Marcel Essling, Dr Yoji Hayasaka, Dr Markus Herderich, Matt Holdstock, Dr Mardi Longbottom, Anne Lord, Virginia Phillips, Ella Robinson (from 01/10/13), Con Simos, Creina Stockley.

Collaborators

Institute of Masters of Wine (Jane Skilton, David LeMire, Peter Csizmadia-Honigh); NSW Department of Primary Industries (Assoc. Prof. Greg Dunn, Dr Deborah Hailstones); state and regional wine industry associations.

The staging and conduct of extension programs

Background

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

This year has been the AWRI's biggest ever in terms of the number of events delivered and number of participants at those events. When events of all types and funding sources are considered, for the first time the AWRI delivered on average more than one extension or education event every week during 2013/2014 (Figure 13).

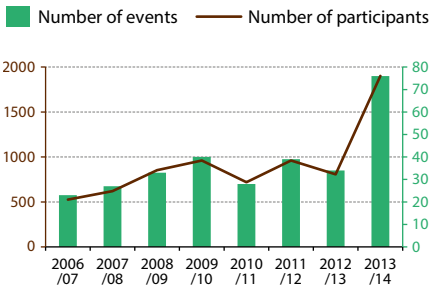


Figure 13. The evolution of the number of events delivered across all formats in the period 2006/2007 to 2013/2014 (excluding AWITC workshops, held in 2007, 2010 and 2013).

Roadshow seminars and workshops

Roadshow seminar content is prepared through various activities across the AWRI, augmented by presentations from Wine Innovation Cluster (WIC) partners and other research and development organisations. The AWRI, WIC members and other organisations annually submit topics on which they are able to present. Specific topics are selected by each regional association hosting a roadshow to form a program tailored to the needs of that region. This interaction provides an important indication of areas of interest or concern to specific regions, informing the development of future research, development and extension activities.

Roadshow workshops are presented by subject experts and are tailored to deliver practical advice to address current industry concerns, technical issues or challenges. The workshops are interactive in nature and involve tastings, diagnostic tests and practical exercises. The current workshop 'Adapting to difficult vintages' was developed following analysis of the calls received by the AWRI helpdesk and from feedback received at previous workshops. This workshop provides participants with strategies to adapt to weather extremes in a changing climate, and incorporates presentations delivered by the Bureau of Meteorology featuring the tools available to farmers and grapegrowers.

During the year, 16 days of roadshow seminars and 10 days of roadshow workshops were held in the following Australian winemaking zones and regions: Barossa Valley, Bendigo, Canberra District, Clare Valley, Eden Valley, Gippsland, Granite Belt, Great Southern, Hunter Valley, Limestone Coast, Margaret River, McLaren Vale, Mornington Peninsula, Mudgee, Orange, Pemberton, Pyrenees, Riverina, Riverland, Rutherglen, South Burnett, Swan District and Yarra Valley.

In order to maximise attendance, events are publicised via a range of mechanisms including the Australian Grape and Wine Events Calendar, Daily Wine News, the AWRI website, social media, state and regional association websites and local press. In addition, staff liaise with the local association(s) to coordinate local promotional efforts within the region(s), including discussion at local association meetings, direct email notification and often placements in print media. A total of 508 participants attended seminars across the 16 events, and a total of 243 participants attended the 10 workshops this year.

Electronic events and communications

The AWRI webinar series complements other extension events and is considered an effective method for disseminating information and knowledge to people located across multiple regions at one time. A comprehensive program of 25 webinars was presented by AWRI staff and external experts during 2013/2014.

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

The Advanced Wine Assessment Course

The Advanced Wine Assessment Course (AWAC) continues to be an important career development opportunity for those who wish to strengthen their knowledge of wine show judging and improve their sensory skills. The current program is offered in a four-day format with more than 40 hours of content. As part of the intensive program, participants evaluate a diverse range of more than 300 wines under simulated wine show conditions. Lectures are also presented by AWRI staff and the course features guidance from a range of prominent wine show judges, journalists and winemakers.

At each course, the top performing participant (based on statistical analysis of scores, verbal skills and group interaction) is named dux of the course and given the opportunity to participate as an associate judge at a national wine show. This year, the winners of the dux prize, Hwee Peng Lim (Wine Educator and Consultant from WineCraft, based in Singapore) and Rose Kentish (Winemaker from Ulithorne Wines in South Australia), have been offered judging places at the next Royal Adelaide Wine Show.

A number of operational changes have improved the delivery of the program. Following many of years of staging the event at a range of locations around Adelaide, including Penfolds Magill Estate and the Royal Adelaide Showgrounds, the course has now been held on-site at the AWRI commencing with consecutive courses staged in May and June 2014. These facilities are ideal, although the class size has been reduced from 30 to 15 participants. Demand for the course continues to be strong, with two further courses scheduled for September 2014.

Themed tastings

Over its many years conducting AWACs, the AWRI has solicited and received considerable feedback from course graduates. This feedback has indicated that graduates continue to seek additional education opportunities allowing them to stay in touch with new developments in world wine styles. To address this demand, the AWRI previously staged themed tastings, Wine of France (2011) and Sparkling Wines of the World (2012), which were followed this year by a World Chardonnay and Pinot Noir tasting event held in November 2013. This event was led by Iain Riggs of Brokenwood Wines and Tom Carson of Yabby Lake, and facilitated by Con Simos. The program consisted of 80 wines representing many countries, with a large proportion sourced internationally, giving participants a unique opportunity to taste wines not commercially available in Australia.

For the second consecutive year, the AWRI teamed up with the Barossa Grape and Wine Association to offer a 1.5-day 'Wine Assessment Tasting' in June 2014. The objective of this course is to train associate judges to take part in the Barossa Wine Show, and six participants were selected as judges for the 2014 Show. This initiative has shown itself to be an excellent opportunity to identify and develop talent at a regional level. A number of taints and faults clinics were delivered to cellar door sales staff including those at Penfolds Magill Estate and Rockford Wines, and an educational tasting was held at the Jacob's Creek Visitors centre for staff of Premium Wine Brands.

The State Government of Victoria, through the Department of State Development and Business Innovation, commissioned the AWRI to deliver a series of flavours and faults tasting workshops in Tianjin, Beijing and Shanghai (China) in October 2013. More than 90 trade, journalists, educators and government staff attended this initiative, part of a Victorian State Government 'Super Trade Mission' to China promoting Victorian wine.

Eric Wilkes

Savour Australia and Wine Australia

The AWRI continues to support the promotion of Australian wine, and was invited by Wine Australia to participate in the 'innovation lounge' at Savour Australia in September 2013. The AWRI showcased examples of innovation or technologies developed and used in Australia, and how these technological achievements underpin brand Australia, especially in export markets.

Savour Australia was well attended by a primarily non-technical audience, largely originating from the retail, marketing, buying and media segments, with strong international representation. The innovation lounge was staffed by the AWRI for the duration of the event and featured static displays as well as tastings based on key AWRI R&D outcomes.

Wine Australia officially launched Aussie Wine Month with 'Aussie Wine Unearthed' in Sydney during May 2014, featuring a tasting of more than 100 wines for an audience of media and around 600 wine lovers. The AWRI's participation in this event featured an 'aroma bar' showcasing a range of common taints, faults and flavours.

Institute of Masters of Wine

The AWRI's successful collaboration with the Institute of Masters of Wine (IMW) was extended for at least a further three years. As part of this arrangement, the AWRI hosted the IMW Australasian Seminar where students undertook classes and examinations guided by Masters of Wine instructors from around the world. The partnership with IMW includes an opportunity for AWRI staff to participate in IMW events in Europe and the USA. Geoff Cowey travelled to the UK in February 2014 to deliver a number of presentations including 'Trouble-free Winemaking' to students as part of the IMW international seminar. Peter Godden also presented at the IMW 8th Symposium in Florence, Italy in May 2014.

Research to Practice

The Research to Practice (RtP) training model provides practical, themed, user-pays training sessions for the wine sector. AWRI staff and external providers contribute to the design and delivery of the programs. Four modules, attended by 102 participants, were presented during 2013/2014 (see Appendix 2 for details). As part of this program a new workshop covering GHG emissions, carbon storage in viticulture and participation in the Carbon Farming Initiative is under development.

15th AWITC

The 15th AWITC was held in conjunction with ASVO in July 2013. AWRI staff members contributed to program planning and event management; were responsible for the workshop program and the poster display; and gave numerous presentations in both workshops and plenary sessions. A program of 43 workshops was presented (see Table 1 for a breakdown of themes) and the poster display included 163 posters.

In total, the 43 workshops attracted 1,236 attendees, with 80% of conference survey respondents indicating that the workshop program was considered to be either 'Important' or 'Extremely Important' to the overall event. Table 2 provides details of the organisations which convened workshops for the 15th AWITC.

An event of this magnitude requires a significant commitment from many people over an extended period. Special mention must be made to workshop convenors and presenters who volunteered their time to produce and deliver presentations; without their support a workshop program would not be possible.

NSW DPI Extension

Background

The NSW Department of Primary Industries (NSW DPI) has commissioned the AWRI to design, coordinate and deliver a Skills Development Program to the NSW wine-grape industry during 2014/2015 and, at the Department's option, for each of the four subsequent years. The objective of this program is to develop the skills of NSW wine-grape industry participants, empowering them to manage their vineyards autonomously. As such, the program is not focused on the extension of research outcomes or the provision of advisory services, but instead aims to build the capacity of industry to resolve issues and implement innovation. This will be achieved through programs which highlight practical management options (field days, videos), teach technical skills (biometrics workshops) and provide objective measures of performance (benchmarking).

Pest and disease early warning

An electronic pest and disease warning system is being developed across Mudgee and the Riverina. Fortnightly 'VineWatch' bulletins will be published throughout the growing season, providing timely and relevant information to wine-grape growers. The bulletins will combine information from a new network of weather stations in Mudgee and the Riverina with on-ground local weather conditions, vine phenology and pest and disease updates.

Table 1. Breakdown of workshops by theme at the 15th AWITC (held July 2013).

Theme	Number of workshops
Winemaking	22
Viticulture	13
Business	5
Regulatory and health	2
Engineering	1
Total	**43**

This network of ten weather stations is being installed across a range of vineyard sites in Mudgee and the Riverina, and is expected to be operational by July 2014. Data from these stations will be logged to a central server and accessible via the AWRI website. A detailed survey has been designed to collect information about the incidence and severity of pests and diseases in NSW wine-grape growing regions and the typical management practices used for their control.

Vineyard trials

Vineyard trials are being established in the Riverina and Mudgee to build on earlier work conducted in the Hunter Valley to evaluate alternative *Botrytis* controls including the 'biofungicide' *Trichoderma*. An existing trial investigating the effects of mulch on grapevine performance will also be continued in 2014/2015.

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

Background

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

Nearly 2,000 enquiries were received during 2013/2014 (Table 3). A database of all queries allows trends and spikes to be monitored, and appropriate responses coordinated and implemented as required. More than 80% of enquiries received during the year were answered within 24 hours.

Table 2. Organisations convening workshops at the 15th AWITC (held July 2013).

Organisation	Number of workshops
AWRI	23
Industry suppliers	8
Universities (Adelaide/ SA/Melbourne/Auckland/ Burgundy)	6
State Departments of Agriculture (TIA/SARDI/NSW DPI/DEPI Vic)	5
CSIRO	1
Total	**43**

Table 3. Enquiries received by the AWRI helpdesk in 2013/2014.

	Number of enquiries
Winemaking	1,309
Viticulture	466
Regulatory	178
Total	**1,953**

Winemaking enquiries

The majority of the winemaking enquiries received during the year were from wine companies and suppliers closely aligned with the wine industry, with the remaining queries originating from government organisations, students, legal practitioners and journalists. Approximately 20% of winemaking-related enquiries resulted in investigations, with samples requested and further analysis performed to identify the problem and recommend a process for remediation. The sources of winemaking enquiries received were generally aligned with the proportional volume of winegrape production by state (Figure 14).

The type and number of enquiries received by the helpdesk varied considerably, largely dependent on the time of year. Vintage 2014 was characterised by weather-related challenges across many wine regions, and this was reflected in the volume, timing and nature of enquiries received. During the early part of the 2014 vintage (January and February), spikes were observed in enquiries relating to smoke taint, fermentation advice, taints and contaminations and analysis methods. Queries were also received in relation to topical issues including 'fracking' (unconventional gas exploration and extraction) and *Metschnikowia pulcherrima* yeast (a yeast strain able to make lower alcohol wines identified by AWRI research), both of which were subject to considerable national and international media attention.

Winemakers in the Coonawarra region, and indeed agriculturalists in general, expressed concern that 'fracking' had the potential for detrimental impact to underground water reserves. The winemaker who contacted the helpdesk was concerned that contaminated water could potentially contaminate or taint wine during production. In order to gain further information regarding this issue, a team member attended a community information session organised by the South East Local Government Association (SELGA). From a question and answer session conducted at the meeting it became clear that the majority of the attendees were opposed to unconventional drilling in the area. Based on information presented during the meeting and the available literature on this subject, it is likely that there are potential taint and contamination risks for the wine industry associated with 'fracking'.

As vintage progressed, an unusually large number of enquiries relating to packaging issues emerged, combined with a low number relating to hazes and deposits. Taints and contaminant issues are routinely seen during vintage and 2014 was no exception, with a number of detailed investigations initiated based on such enquiries.

Towards the end of vintage there were a number of enquiries from and discussions with winemakers concerned about acidity levels and related adjustments. Unusual pH and titratable acidity (TA) relationships from the vintage were observed, attributed in part to the heatwaves experienced across the country earlier in 2014. Additionally, calcium-DL-tartrate precipitation issues were seen more commonly, thought to be a consequence of the cheaper racemic form of tartaric acid now allowed for use in Australian winemaking.

The 2012/2013 annual report discussed an increase in queries to the helpdesk relating to *Brettanomyces* spoilage. While numbers in 2013/2014 have not been as high, such queries still form a significant percentage of overall queries received, suggesting that control of this organism remains an important industry issue.

Viticultural enquiries

During the year, the viticulture team responded to 466 viticulture-related enquiries. More than 30% of the enquiries were agrochemical-related, with the remaining calls relating to general viticulture issues such as fungal and insect pest control, smoke taint, sustainability and alternative varieties.

A significant area of concern was the frosts that occurred in October 2013 in parts of WA (Great Southern), SA (Barossa Valley, Eden Valley, Clare Valley, Adelaide Hills), Victoria (Sunraysia, Rutherglen), ACT and NSW (Riverina, Tumbarumba). In response, the AWRI, at short notice, organised a frost management webinar presented by Sonja Needs (University of Melbourne). Vineyard management post-frost can represent a significant challenge, and these frost events caused yield losses of between 5 and 100% in affected areas. Another cause of low yield was identified to be the high incidence of both coulure and millerandage – consequences of the flowering of some varieties in certain regions coinciding with low minimum temperatures.

In contrast to the early season frost damage, three significant heatwaves occurred during January 2014: around New Year, mid-month and in the final days of the month continuing into early February (Adelaide had five days with 42°C or higher in January; Melbourne had four days with 41°C or higher). Growers were advised in advance of the hotter temperatures to increase irrigation to maintain canopies and leaf condition, with those able to irrigate in time able to limit bunch heat damage. For some variety/region combinations the heatwaves coincided with veraison, such as mid-January in the case of Barossa Shiraz. In these cases, the heat did not appear to cause significant yield losses, as bunches generally have low susceptibility to sunburn at this stage. It is possible, however, that such events contributed to the uneven ripening (also known as 'sweet and sour' condition) widely observed later in the season. An 'Ask the AWRI' article was written in response to reports of this condition.

Widespread thunderstorm events during February prompted an *eBulletin* warning of the potential for splitting and bunch rot. Across many regions, the season favoured the development of powdery mildew. Growers who were unable to control the disease early struggled later, by which time many otherwise effective chemicals were no longer permitted. Late season disease control situations are frequently problematic as many chemicals are no longer recommended for use, due to the need to avoid residues in harvested grapes. In addition, for resistance management purposes, the use of many chemical groups on existing infections is discouraged.

Health and regulatory enquiries

During the year 178 information requests were received on health and regulatory topics. An issue of particular significance related to the export of wines to China. In March 2014, Wine Australia issued a warning to wine exporters regarding increased scrutiny of manganese, iron and copper levels in wine by Chinese authorities. Maximum regulatory levels of 2 mg/L for manganese, 1 mg/L for copper and 8 mg/L for iron were being enforced in wines imported into China. While the regulatory levels set for copper and iron are consistent with other trading nations, the limit for manganese in wine appears to have caused concern across all wine-exporting countries. It is well established that there are natural background levels of this metal which vary significantly across vintages, regions and varieties. There is currently insufficient information to reliably predict whether any particular region, soil type or set of environmental conditions will be at higher risk of producing wines which exceed the 2 mg/L level, creating uncertainty for producers seeking to export their wines to this market. While manganese is not directly added during the winemaking process (as it is not a permitted winemaking additive or processing aid), evidence does suggest that certain viticultural and winemaking processes may contribute to the levels found in finished wines.

Since the introduction of the limit, the AWRI has analysed the manganese levels of more than 1,500 wines. A significant number of wines were found to exceed the 2 mg/L limit, with higher manganese levels seen in red wine than in white wine. Wines from the 2014 vintage have generally exhibited similar manganese levels to those of the 2012, 2011 and 2010 vintages, and lower than those from the 2013 vintage, 20–25% of which potentially exceed the 2 mg/L level. The AWRI has also tested a number of wine fining treatments to study their effects on manganese concentration. To date, none has been shown to exert a sufficient impact in reducing the manganese concentration of wines, although work continues to assess other possible processing and fining options. Consequently, the AWRI recommends

that all wines destined for export to China should be tested for copper, iron and manganese.

Other significant health and regulatory-related queries covered topics including:

- measurement and usage of permitted additives such as sorbates, organic acids, liquid tannin extracts, glutathione and carboxy methyl cellulose
- definitions of low and reduced alcohol wine, their production and health impacts
- ingredient and nutritional labelling
- the potential for toxicity from compounds sometimes found in wine
- adverse and allergenic effects from wine, its constituents and wine-related products such as balsamic vinegar
- the potential for transmission of human diseases through wine
- the effects of wine and its phenolic constituents on different diseases, relating to wine's role as part of a healthy diet and lifestyle.

Winemaking problem solving investigations

In 2013/2014 the AWRI conducted 201 investigations, arising from enquiries received by the helpdesk. This number of investigations is almost identical to the figure for previous years (Figure 15). Some of the investigations conducted related to disputes arising between levy payers or between levy payers and suppliers of materials or contract services. Consequently, staff often find themselves playing a mediation role in such disputes, and devote a considerable amount of time providing technical information to legal professionals who represent the interests of grapegrowers and wine producers. Fortunately however, the majority of disputes are settled before the initiation of formal court proceedings.

Full reports containing technical information relating to the problems investigated are prepared for clients when investigations are likely to result in litigation and/or insurance claims. Otherwise, clients are provided with summaries which seek to explain the underlying causes of the problems encountered, and often include links directing the client to relevant sections within the AWRI's website. Advice on how to prevent the reoccurrence of such problems is provided to clients and technical references relating to the area of investigation are also frequently supplied.

A summary of the number and type of investigations conducted by the helpdesk team over the past three financial years is presented in Table 4.

Considering the investigations conducted by state (Table 5), South Australia accounted for almost 50% of the investigations conducted, with New South Wales and Victoria respectively accounting for a further 19% and 17%. Only Victoria and Tasmania recorded fewer investigations this year compared to the previous year. The sources of winemaking investigations conducted were generally aligned with the proportional volume of wine-grape production by state (Figure 16).

The total number of investigations conducted on wines affected by hazes and deposits remained relatively high (Figure 17). More than 30% of deposits identified during 2013/2014 were crystalline, with approximately 50% of these being potassium hydrogen tartrate and 50% being calcium tartrate. The formation of calcium-based tartrates is generally more difficult to predict, as they often appear several months post-bottling. Such deposits are usually related to high calcium concentrations (either naturally or through additives and processing aids containing calcium such as skim milk, bentonites or calcium carbonate) or, in the case of calcium DL-tartrate deposits, the use of racemic tartaric acid or potassium hydrogen tartrate when cold stabilising.

The number of investigations conducted into microbiological instabilities increased slightly this year (Figure 18). The problems leading to such investigations were varied and included increasing volatile acidity (VA), refermentation, 'Brett'-related spoilage, stuck fermentations and post-bottling yeast growth. In some instances it is thought that the effects of the difficult 2011 vintage may be playing a continuing role, while cases of 'Brett' highlight the need for some wineries to be more vigilant in employing practices effective in controlling this spoilage yeast. Awareness regarding how to manage and avoid such issues continues to be raised at regional workshops.

Thirty-six sensory investigations were carried out in 2013/2014, down from 57 in the previous year (Figure 19). These included a number of microbial-related issues such as wines that were considered 'mousy', wines containing indole,

Geoff Cowey, Matt Holdstock, Virginia Phillips, Con Simos, Francesca Blefari, Michael Coode

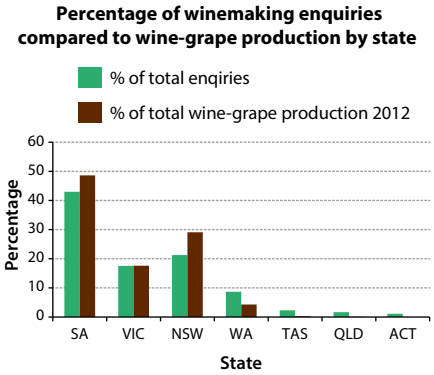


Figure 14. Winemaking enquiries received by the AWRI helpdesk in 2013/2014 by state, compared to wine-grape production.

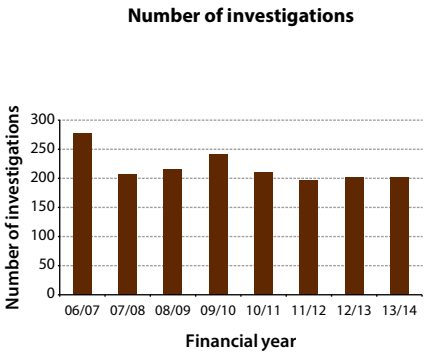


Figure 15. Investigations conducted by the AWRI helpdesk team between 2006/2007 and 2013/2014.

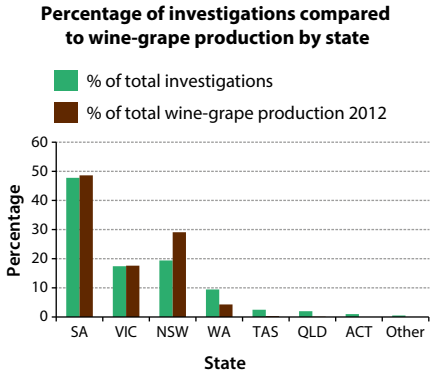


Figure 16. Investigations undertaken by the AWRI helpdesk team by state compared to wine-grape production.

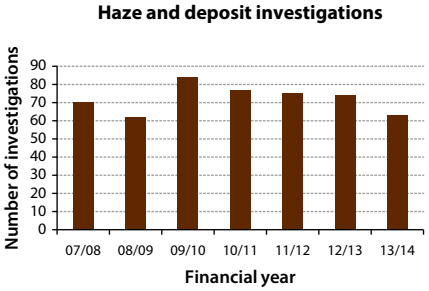


Figure 17. Haze and deposit investigations conducted by the AWRI helpdesk team between 2007/2008 and 2013/2014.

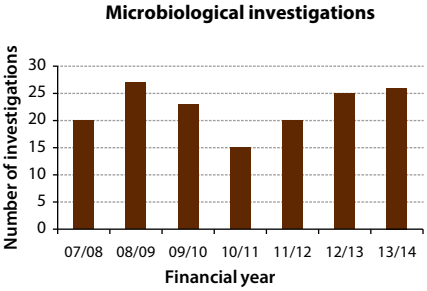


Figure 18. Microbiological investigations conducted by the AWRI helpdesk team between 2007/2008 and 2013/2014.

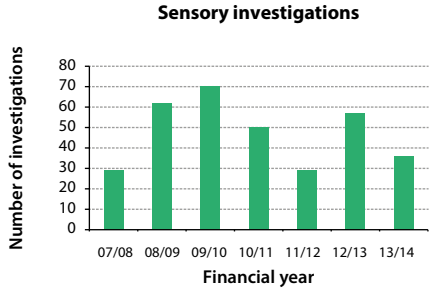


Figure 19. Investigations conducted on wines affected by sensory issues between 2007/2008 and 2013/2014.

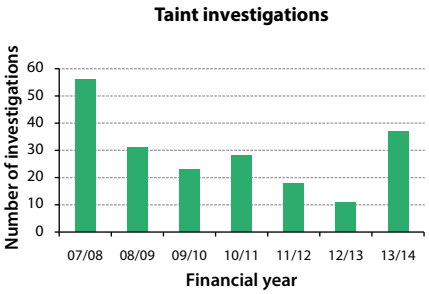


Figure 20. Investigations conducted on wines affected by taints between 2007/2008 and 2013/2014.

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

Type of investigation	2011/ 2012	2012/ 2013	2013/ 2014
Identification of hazes and deposits	75	74	63
Microbiological investigations	20	25	26
Sensory assessments	29	57	36
Taint and contamination problems	18	11	37
Other investigative analyses	53	35	31
Closure-related investigations	2	0	8
Total number of investigations	**197**	**202**	**201**
Total number of samples analysed	**816**	**914**	**1,059**

Table 5. Investigations conducted by state during the past three years.

State	2011/ 2012	2012/ 2013	2013/ 2014
SA	65	92	97
VIC	50	43	35
NSW	44	29	39
WA	11	17	19
ACT	0	4	5
TAS	20	16	4
QLD	7	1	2
Total	**197**	**202**	**201**

wines with 'Brett' and one case of volatile acidity. Other investigations examined reductive wines, wine assessed as salty and one case featuring suspected dilution of the product during bottling. Sensory evaluation is an important analytical and research tool, and is also commonly also employed in problem solving investigations classified under other categories such as 'microbiological investigations', 'taint problems' and 'other'.

During 2013/2014 eight investigations were conducted on sparkling wine or sparkling products, twice the number of such investigations conducted in each of the past two years. Investigations included stuck secondary ferments, a wine which developed indole during secondary fermentation, calcium tartrate instability, over-addition of sugar resulting in excessive carbon dioxide, filtration difficulties after sweetening and two investigations related to gushing.

In sparkling wines, gushing can be caused by the presence of particulate matter in the form of cork dust, yeast, potassium bitartrate, fibres and packaging material, which can obstruct very small air bubbles that act as nuclei for carbon dioxide to come out of solution with a release of pressure. Imperfections on the inside of glass bottles can also be responsible for gushing, however this is rare and has not been seen at the AWRI. In one of the gushing investigations it was apparent that the potentially dangerous 'random gushing' related to the wine not having been cold stabilised prior to carbonation. In this case the winemaker advised that the base wine had been checked for cold stability using a variation of the freeze-thaw cold stability test, which is known for providing inconsistent results and therefore not recommended by the AWRI. Subsequent analysis indicated that the wine was cold unstable, suggesting that this was the most likely cause of the gushing problem. The AWRI recommends that wineries confirm cold stability of products prior to bottling using the industry standard three-day brine test, which is conducted at -4°C.

A notable increase in the number of investigations relating to closures was observed during the past year, with eight investigations conducted, compared to none in 2012/2013 and two in 2011/2012. The types of issues observed included variation of a product which had been bottled at two different bottling facilities, excess cork coating material identified floating in products bottled under natural closures and assessment of two different wines for damage associated with poor screwcap application. Interestingly, in one such investigation where there was obvious damage to the top of the screwcaps and issues with the application, the wine had remained undamaged and at the time of the investigation showed no signs of oxidation or premature development.

Thirty-one 'other' investigations were conducted during 2013/2014, a high proportion of which related to wines to which excessive amounts of copper sulfate had been added that required potassium ferrocyanide (PFC) fining trials. All PFC trials were successful in reducing the copper to acceptable levels (< 0.5 mg/L). Other investigations included identifying a mite found under the cap and on the thread of a bottle, investigating pitting and corroding tin foil from a bottle under a natural cork closure and cases where the origin or authenticity of a wine was brought into question.

Thirty-seven 'taints and contaminations' investigations were carried out during 2013/2014 (Figure 20), a number much higher than the previous year (11) however still below the medium-term average (45). Accidental contamination of juice or wine represents a significant risk to wine quality and can pose human health issues. Minimising the risk of taints remains an important priority for the AWRI, which seeks to ensure that Australia maintains the highest standards possible in assuring product integrity.

A large percentage (~70%) of the taint-related investigations were carried out using GC-MS techniques and methods. Of these, seven investigations related to smoke taint, and others involved typical vintage-related issues including hydraulic oil, grapeseed oil, cleaning products, dimethyl dicarbonate overdose, plastic taints, mould, dilutions, brine contamination and a wine into which a battery had been dropped.

One of the more notable investigations conducted involved a wine undergoing MLF, which had been racked into a stainless steel tank with a submersible heater placed into it to generate heat and promote the passage of MLF. During this process the submersible heater ended up in the wine lees. Sensory assessment confirmed that the wine had developed a pungent taint described as 'burnt out pump', 'burnt plastic', 'wet campfire', 'barnyard', 'smoke', 'Band-Aid', 'toxic' and 'undrinkable'. GC-MS analysis was used to screen for aromatic hydrocarbons, which indicated the presence of various alkybenzenes and naphthalenes in the tainted wine, consistent with the sensory assessment which indicated that the wine was strongly tainted. These compounds are not found in sound grapes or wine and are not produced during normal fermentation, and were also not present in the GC-MS scans of a reference sample of wine supplied for comparison. The presence of o-, p- and m-cresols in the tainted wine and absence in the reference wine provided more evidence of a taint derived from the overheated lees, thought to contribute to the distinctive sensory character observed that rendered this wine commercially unacceptable.

Most unusual enquiry for the 2014 vintage

From time to time the AWRI helpdesk receives an unusual query that has not been previously encountered. That honour for vintage 2014 arose from a winemaker wishing to add blue colouring to a wine, raising some interesting issues relating to the difference between a wine and a wine product. While 'Brilliant Blue' food colouring is not a permitted additive under Standard 4.5.1 *Wine production requirements (Australia only)*, it is, however, permitted to be added to a product considered to be a wine-based beverage rather than a wine according to Standard 2.7.4 *Wine and wine products*. A wine product must be based on wine, but other permitted foods such as colourings and flavourings can be added, with 'Brilliant Blue' permitted under Standard 1.3.1 *Food additives*. If such an addition was to be made, the product in question could not be labelled as a wine, but rather would need to be labelled as a wine-based product.

Library service

Background

The John Fornachon Memorial Library holds the largest knowledge base of grape and wine technical resources in the southern hemisphere. The library continues to support the Australian grape and wine sector through strategic sourcing, management and dissemination of relevant and useful electronic and print resources covering 'vines to wines'. Over 76,000 items (including books, journals, article reprints, conference proceedings, reports, theses, standards and legislation, as well as a reference collection of directories, foreign dictionaries and atlases) are available to levy payers, industry organisations, students and AWRI staff.

Digital resources

While the John Fornachon Memorial Library's print collections continue to grow, an increasing emphasis is being placed on building collections of digital resources. Technologies are constantly evolving and changing the way grape and wine producers seek information, communicate, learn and apply knowledge in the workplace. Learning technologies are becoming social, collaborative and virtual. The library is continuing to seek innovative ways to deliver technical and scientific content and facilitate the use of that information and knowledge through digital technologies. This year, the library launched a mobile version of the library catalogue, enabling users to search and order items using mobile devices. An eBook platform is being trialled within the AWRI allowing users to download eBooks for reading on a computer or mobile device. Twenty new books were added to the eBook collection during the year, on subjects including winemaking, grape and wine biochemistry, wine chemistry, viticulture, wine economics and wine marketing. The next stage of the project will be to extend eBook access to industry users.

Staff publications database

Accessible from the AWRI website, the AWRI staff publications database contains citations of publications authored by AWRI staff. This tool was accessed more than 6,900 times this year, with 788 unique staff publications requested. The database is updated on a regular basis, ensuring that the latest publications are available for access.

Online information packs

Providing timely and relevant information is a key mission of the library. With so much content available online, it can be time-consuming for users to search and locate the specific information that they require. To assist grape and wine producers, the library packages reference lists and fact sheets into 'information packs' about current topics of interest. These information packs are available from the AWRI website, and enable users to browse and order articles from the library. Currently, information packs are available on fermentation, wine chemistry, packaging, emerging varieties and sustainability, and more topics will be added in the future.

Library reference and information requests

This year, the library received 1,330 requests for information and these included articles or book requests (document delivery services), literature search and reference enquiries. Over 82% of requests were received by email or via the AWRI website.

Document delivery services entail the supply of journal articles, books or other library items to customers upon request via the AWRI website, email, phone or in person. A total of 2,593 articles were supplied with the majority of requests completed within one business day. Table 6 outlines the types of articles requested.

Specialised information services

The online library catalogue, information packs and other online databases facilitate self-help through the AWRI website. In addition, the AWRI offers specialised information services such as literature searches for in-depth search and retrieval of information. This year, 43 literature search requests were conducted involving searches across in-house databases as well as external resources.

Table 6. Articles supplied from AWRI library collections during 2013/2014.

Article type	Number of articles supplied
AWRI staff publications	788
Technical Review current literature	882
Library reprint collection	923
Total	**2,593**

Communication with stakeholders

Background

This project focuses on written and electronic communication to Australian grape and wine producers, with aims including: keeping industry up to date with current research; providing advice to grapegrowers and winemakers; sharing news, events and ideas; and seeking feedback or interaction. Content is derived from across the AWRI's research and extension projects, and delivered through a variety of different channels. The AWRI communicates directly with stakeholders via its *eNews*, *eBulletins*, webinars and social media, publishes the bi-monthly *Technical Review* and contributes regularly to other industry publications. Activities within this project complement the communication objectives of all AWRI staff – the details of presentations delivered and articles published by AWRI staff in 2013/2014 can be found in the Appendices.

AWRI website

The AWRI website is a key mechanism for communicating with stakeholders, students, potential employees and the general public. Approximately 50,000 visitors accessed the AWRI website during the year resulting in around 255,000 page views. (These numbers cannot be directly compared to previous years due to a change in tracking methodology.) Updates to the website during the year focused on refreshing the 'Research topics' pages; adding new information packs and new collections of FAQs in the winemaking services area; and updating or providing two winemaking tools: the AWRI Ferment Simulator and the AWRI Refrigeration Demand Calculator.

eBulletins and *eNews*

Electronic delivery of information remains a priority as the grape and wine industry increasingly works online. Fifteen *eBulletins* were delivered during the year and are shown in Table 7. The *eBulletin* mailing list included more than 2,700 addresses by the end of the year.

The AWRI's electronic newsletter, *eNews*, continued to be distributed bi-monthly to around 2,600 email addresses. *eNews* provides information regarding events, updates on research projects and a general snapshot of the AWRI's activities. The distribution of *eNews* in alternate months to *Technical Review* means that information is communicated to stakeholders from the AWRI on at least a monthly basis.

Social media

The AWRI's Twitter presence grew significantly during 2013/2014, reaching more than 2,300 followers. Twitter has a high uptake within the wine industry and has proven to be an excellent avenue for interacting with stakeholders at an informal level. The AWRI's Facebook presence complements its Twitter account, with a focus on sharing images and visual stories.

Webinars

The AWRI webinar series continued during 2013/2014 with 25 webinar sessions and more than 375 participants. Approximately half were presented by AWRI staff, with the remainder delivered by guest presenters from a range of other research organisations. Webinars provide a convenient and cost-effective way to reach industry practitioners across the country in a single session. Participants have the opportunity to speak with subject experts, ask questions and share experiences.

Table 7. eBulletins *issued during 2013/2014.*

Date	Topic	Author
24/07/13	Winemaking calculators go mobile	Linda Bevin
08/10/13	Voting open in AWRI Board elections	Shiralee Dodd
21/10/13	*Technical Review* October 2013 issue available online	Linda Bevin
15/11/13	Support available in response to smoke taint and frost	Helpdesk team
04/12/13	Fermentation survey and *Technical Review* December 2013 issue	Peter Godden and Linda Bevin
13/12/13	Timely reminder about disease risk	Helpdesk team
09/01/14	Two current issues: heatwave warning and impact of elemental sulfur residues	Helpdesk team
06/02/14	*Technical Review* February 2014 issue available online	Linda Bevin
18/02/14	How should I deal with split fruit and disease pressure as harvest approaches?	Helpdesk team
24/02/14	Vineyard sprays – clarifying label directions	Marcel Essling
03/04/14	*Technical Review* April 2014 issue available online	Linda Bevin
10/06/14	*Technical Review* June 2014 issue available online	Linda Bevin
11/06/14	AWRI 2014 webinar series	Michael Downie
18/06/14	Opportunities in a new climate	Mardi Longbottom
26/06/14	Agrochemical update June 2014	Marcel Essling

Annual report

For the past 59 years, the AWRI has produced a printed annual report such as this one, as its formal report to Australian winemakers and grapegrowers. Since 1999, the annual reports have also been made available online via the AWRI's website. The AWRI also publishes a four-page supplement in the *Australian & New Zealand Grapegrower & Winemaker*, and approaches each major state-based winemaking body offering to deliver an annual presentation to their members. This formal activity complements the vast range of presentations and publications undertaken by AWRI staff members throughout the year (see Appendices).

Technical Review

Technical Review publishes abstracts of current technical literature on grape and wine-related topics. It also includes research updates from staff of the AWRI, as well as information about AWRI events. *Technical Review* is published six times a year, and is available to grape and wine producers via the AWRI website or in hard copy. A total of 882 articles featured in *Technical Review* were requested by and provided to readers.

Editorial support

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

Table 8. Media releases prepared and distributed during 2013/2014.

Announcement	Date distributed
New genomics partnership to shed light on mystery of wild wine ferments	28/11/13
Nobel Prize-winning scientist to join the Australian Wine Research Institute Board	13/12/13
International wine research partnership to benefit global wine industry	17/12/13
Louisa Rose to chair the Australian Wine Research Institute Board	25/02/14
Australian scientists to help create world's first synthetic complex organism	27/05/14

Media liaison

The AWRI is regularly approached for comment regarding wine technical matters from national and international media. This provides an excellent opportunity to ensure accurate information is published, and to generate further opportunities to communicate with the AWRI's stakeholders. Many requests from the media were handled during the year, with specific details provided in Appendix 6. Five media releases were prepared and distributed during the year, and are listed in Table 8.

Enhance national outreach and promote regional engagement

Staff

Samantha Connew, Dr Wies Cynkar, Dr Bob Dambergs (until 19/09/13), Peter Godden, Dr Mark Krstic, Dr Richard Muhlack (until 17/01/14).

Collaborators

Brokenwood (Simon Steele, Stuart Hordern, Lorrae St Vincent); Calabria Family Wines, formerly Westend Estate (Jeremy Nascambin); Casella Wines (Laura Malamace, Luke Edwards); Classic Oak (Peter Dunlop); De Bortoli Wines (John Coughlan, Sharon Adams, Henry Perez, Julie Mortlock, Rob Glastonbury, Tarek Heiland); De Iuliis Vineyards (Mike De Iuliis); Hunter Valley Wine and Tourism Association; Joseph Chromy Wines (Jeremy Dineen); Keith Tulloch Wine (Keith Tulloch, Amanda Tulloch); McWilliam's Wines (Jim Brayne, Simon Crook); Pressing Matters (Paul Smart); Robert Stein Wines (Jacob Stein); Riverina Institute of TAFE; State Government Victoria Department of Environment and Primary Industries (Dr Sze Flett, Jenny Treeby, Ricky James, Phil Haines); Tasmanian Institute of Agriculture (Dr Dugald Close, Dr Anna Carew, Angela Sparrow); University of Melbourne (Prof. Snow Barlow, Dr Kate Howell, Assoc. Prof. Angela Paladino); Vitibit (Liz Riley); Warburn Estate (Moreno Chiappin, Amba Goldsmith); Wine Tasmania (Sheralee Davies, David Sanderson); Wine Victoria (Damien Sheehan, Rachel Sweeney); Winegrapes Australia (Paula Edwards); Winemaking Tasmania (Julian Alcorso).

Tailored regional research, development, adoption and extension through regional nodes

Background

Regional areas of Australia have different research and development priorities which reflect their individual winemaking and viticultural challenges and requirements. This is recognised in the National Primary Industries RD&E Framework Wine Sector Strategy, upon which the formation of the AWRI's Regional node network was based. The AWRI established four regional nodes, in the Riverina, the Hunter Valley, Tasmania and Victoria, through which research, development and extension activities have successfully addressed regional priorities and technology adoption has been facilitated.

Improving refrigeration efficiency to reduce electricity use

Refrigeration is by far the largest user of electricity in the majority of wineries which means that improvements to refrigeration efficiency can be expected to result in an immediate improvement to the financial bottom line. In response to this opportunity, a practical spreadsheet-based software tool, the AWRI Refrigeration Demand Calculator, was developed and made available to all Australian wine producers as a free download via the AWRI website.

The calculator was developed using data accessed from three large wineries in the Riverina, and three medium-sized wineries in the Hunter Valley. Wine producers are able to enter grape intake and production data to simulate refrigeration demand across the entire annual production cycle, and assess the impact of factors such as cellar storage, cold stabilisation temperatures, fermentation conditions, climate, brine temperature, tank size and insulation on refrigeration demand and associated energy costs.

Adding to the functionality of the AWRI Ferment Simulator

The AWRI Ferment Simulator, developed through the Riverina node, was released last year. This tool allows winemakers to track and predict ferment trajectory, accounting for conditions such as temperature, yeast, wine type, nutrient levels, agitation regime and tank size. The simulator can also be used to monitor refrigeration and associated electricity demand, as well as identifying problem ferment behaviour early so that corrective action can be taken. A 'what if?' analysis function allows alternative fermentation management strategies to be evaluated.

During the year, and in response to feedback received from industry, the functionality of the simulator was enhanced to accommodate indigenous yeast ferments and 'cool climate' ferments of juices with very low pH and high TA. Fermentation records were sourced from a number of collaborating wineries, particularly via the AWRI/TIA Tasmania node, and changes made to the simulator source codes which were shown to accurately predict the fermentation trajectories for the newly added fermentation types.

The AWRI Ferment Simulator, either as a 'Full' or 'Lite' version, can be downloaded for free via the AWRI website. More than 700 page views of the simulator webpage were tracked during the year.

Understanding the pathways to adoption of technologies

While feedback from wineries that have used the AWRI Ferment Simulator has been overwhelmingly positive, the AWRI wishes to understand the process within wine companies which leads to such technologies being adopted, in order to remove any potential barriers to adoption. A number of initiatives were implemented, including direct survey interviews with wine producers in the Hunter Valley

and Riverina; working one-on-one with targeted wine producers during vintage to gain firsthand knowledge of how the Ferment Simulator is used in a winery setting; and an online survey which was widely distributed to industry via an AWRI *eBulletin* and the Interwinery Analysis Group.

Consistent results were obtained through each survey method. While respondents saw great value in the tool and found that it performed its intended functions well, there were three other key findings:

- There was a perception amongst small wineries in particular that the tool may be overly complicated.
- 60% of respondents said that they would be more likely to adopt the tool if they had attended a seminar or workshop on how to download and use it.
- Wine producers of all sizes indicated that they would prefer a more user-friendly web-based interface which was compatible with mobile devices. As a result of this industry feedback, a 'Lite' version of the simulator was developed with small wineries in mind, with a simplified user interface and basic fermentation simulation capability.

Workshops that provided a hands-on demonstration of both versions of the simulator were also presented in six regions and via a webinar, which is available for viewing on demand from the AWRI website. User guides for both versions and a case study showing its application to a full tank farm were also developed, and an article describing its use was published in the November/December 2013 issue of *Wine and Viticulture Journal*. Similarly, seven workshops providing practical demonstrations of the AWRI Refrigeration Demand Calculator were presented in three states and via a webinar, also available through the AWRI website.

Helping growers to work smarter, not harder

The projects pursued by each AWRI regional node were developed following extensive consultation with the local industry. The node strategy has been to address regional R&D priorities, through the development of concepts that also have applicability to the wider industry. Through this process, the AWRI Hunter Valley node addressed a regionally expressed priority to make new 'smart' technology platforms more accessible to grapegrowers through the creation of a workshop *Working smarter not harder – making the most of your smart phone and tablet*. This workshop was developed in collaboration with a number of leading viticulturists and vineyard managers who have already embedded the use of these technologies into the way they do business, and presented nine times across three states.

Addressing regional winemaking issues in NSW

The Hunter Valley node allowed the AWRI to stage a series of additional practical winemaking workshops through NSW and the ACT. The content chosen by each region varied widely, and included tasting and discussion of wines fermented using indigenous yeasts; practical understanding and management of phenolics in red wines; the avoidance of potential off-flavours from sources such as bushfire smoke and *Brettanomyces*; and tasting and discussion of 2014 vintage wines made using novel winemaking techniques or with which winemakers had encountered difficulties.

Linking sensory characteristics of iconic Hunter Valley Semillon wine to soil type

As reported last year, there is a common belief amongst Hunter Valley winemakers that the four main soil types in the region (Red, Sandy Alluvial, Pale Orange with Ironstone and Alluvial Loam) produce fruit and wines with different flavour, style and phenolic profiles. Developing scientific understanding of any such relationships was identified as a regional priority, with broad applicability to other regions and wine types. During the 2013 vintage fruit samples were collected from more than 20 different vineyards, and the resultant juices were assessed using phenolically important UV-Vis wavelengths (265, 280 and 330 nm).

This initial dataset indicated the existence of correlations between soil types and juice phenolics, and that hydroxycinnamates could potentially be a class of compounds responsible for the differences observed among the resultant wines. Prior to the 2014 harvest, 31 different Semillon vineyards were sampled and analysed for soil colour, texture and chemical composition, and the results combined with the vintage 2013 juice and wine samples. Encouraging results were obtained, with juices separating according to soil type during principal component analysis. This preliminary work provides promise that an objective link between soil and wine characteristics might be made with further study.

Using the AWRI WineCloud to gain insights into the evolution of red wine phenolic profiles during barrel maturation

The AWRI WineCloud is a tool which allows rapid analysis of the phenolic profiles of red grapes and wines. The availability and ease of use of the tool prompted a study by the AWRI Hunter Valley node to examine the evolution of the phenolic profile of a 2013 vintage Hunter Valley Shiraz, stored in both old and new barrels. A commercial cooper supplied six new tight-grained, medium toast barriques for the trial, and a Hunter Valley wine producer supplied six four-year old barriques (with identical usage histories) of the same specifications and from the same cooper.

Measurements of tannins, total phenolics and colour (total pigments) were made three times in the grapes pre-harvest; daily during fermentation; at pressing; once during MLF; once at the completion of MLF; and then at least monthly for seven months. The results of this analysis revealed that in both treatments tannin and total phenolics tended to show a gradual increase over the length of the trial. While a more rapid increase in tannin, total phenolics and colour was seen in the wine stored in new oak (especially during the first six weeks after pressing), after six months there was no difference in these measurements between the wines stored in the two oak types. This trial highlighted the ease and practicality of conducting such industry-based trials using the WineCloud platform.

Pinot Noir – it's a wrap

A comprehensive extension program was also staged by the AWRI/TIA Tasmania node, culminating in a two-day event which brought together everything learned about Pinot Noir during the node' s four years of operation. The node manager, four PhD candidates and one post-doctoral research fellow presented their research findings which illustrate how to optimise wine quality using an integrated approach featuring vineyard manipulation, fermentation management, yeast effects, and novel cap management and must treatment techniques, for both sparkling and table wines. The second day of the workshop provided participants with an opportunity to taste wines made as part of three of the research trials, as well as a range of Tasmanian Pinot Noir table wines and highly rated wines of this variety from three other states. Full phenolic profiles of each wine were provided during the tastings. This event concluded the work of the most recent phase of the node, with two of its PhD candidates having secured funding to further develop technologies resulting from their research, for the benefit of the greater Australian wine industry.

Victorian node

Background

The establishment of the AWRI's Victorian node was made possible through funding and material support provided by the Victorian Department of Environment and Primary Industries (DEPI), Wine Victoria, the GWRDC via their regional program and the AWRI. Since its inception in 2012, the AWRI Victorian node has been managed by Dr Mark Krstic, who is responsible for the delivery of a number of outputs and extension activities to the wine industry of Greater Victoria. In April 2014, the GWRDC released an independent review into extension and adoption which highlighted the strength of the AWRI node model in Victoria, and recommended continued investment in this model. The AWRI remains committed to supporting the delivery of Wine Victoria's GWRDC regional program for Greater Victoria, and is working with its partners to extend current arrangements supporting the node for a further term.

Node activities

In 2013/2014 the key outcomes from the AWRI's Victorian node included the delivery of eight

extension events across Greater Victoria, in partnership with Wine Victoria and regional grape and wine industry associations. Details of the events are presented in Appendix 2.

The Victorian node continues to play a pivotal role in coordinating an emergency response to potential smoke taint problems, as observed during February 2014. It also continues to provide strategic and operational guidance to the DEPI Centre of Expertise in Smoke Taint Research program currently operating in Victoria.

The Victorian node also contributed to a number of established research programs during 2013/2014, including the GWRDC-funded project "The adoption of grape and wine R&D outputs. Who, why and what?" in partnership with DEPI, WGGA and the University of Melbourne, and the joint AWRI/ University of Melbourne-supervised PhD project studying rotundone (student Pangzhen Zhang).

Service capabilities and foundational datasets

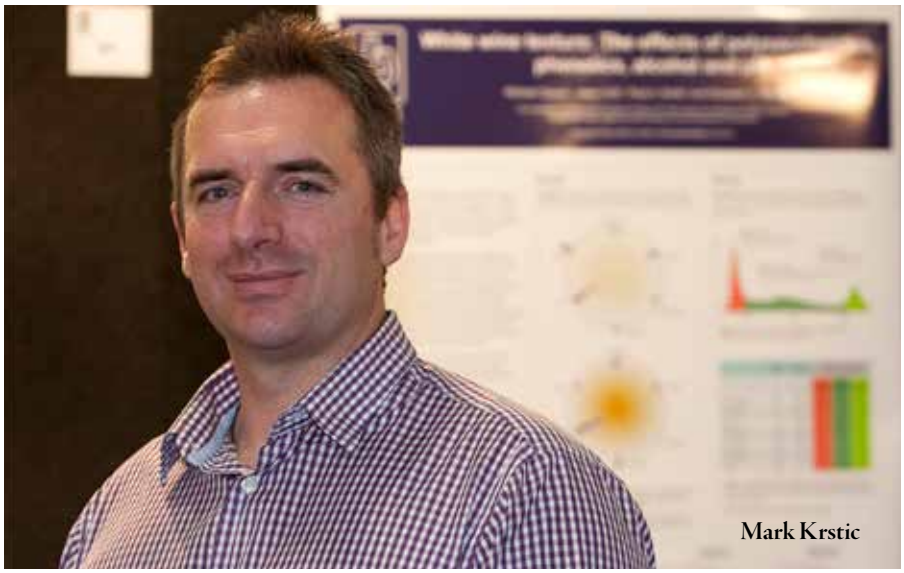
The research, development and extension activities of the AWRI are underpinned by an efficient service capacity that provides and supports infrastructure; provides technical support; manages governance, legal and financial affairs, information technology (IT) and workplace safety; and facilitates the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

Staff

Amanda Aguis, Alice Barker, Sheridan Barter, Dr Cory Black, Catherine Borneman, Mark Braybrook, Dr Dimitra Capone, Michael Coode, Alfons Cuijvers, Dr Chris Curtin, Dr Wies Cynkar, Chris Day, Shiralee Dodd, Annette Freeman, Dr Leigh Francis, Jeremy Hack, Dr Markus Herderich, Adam Holland, Dr Helen Holt (until 31/12/13), Dr Dan Johnson, Pauline Jorgensen, Esther Kristianto, Dr Mark Krstic, Dr Natoiya Lloyd, Dr Vince O'Brien, Jennifer O'Mahony, Wes Pearson, Con Simos, Tracey Siebert, Dr Mark Smith, Fang Tang, Deborah Thornton-Wakeford, Patricia Williamson.

Collaborators

CSIRO (Dr Rob Walker, Dr Peter Clingeleffer); Fondazione Edmund Mach, San Michele all'Adige, Italy (Prof. Fulvio Mattivi); Fraunhofer Institute for Process Engineering and Packaging, Freising, Germany (Prof. Andrea Buettner); HS Geisenheim, Germany (Prof. Manfred Grossmann, Prof. Hans Schulz, Dr Manfred Stoll); ISVV, Bordeaux, France (Dr Warren Albertin, Prof. Philippe Darriet, Prof. Serge Delrot, Prof. Isabelle Masneuf-Pomarède, Dr Takis Stamatopoulos); Medhurst Wines (Matt Steel); University of Adelaide (Stephen Clark); University of South Australia (Dr Armando Corsi, Prof. Larry Lockshin, Dr Justin Cohen); University of Tasmania/Tasmanian Institute of Agriculture (Angela Sparrow).


Mark Krstic

Chemistry, sensory, chemometrics and development capacity

Background

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

Sensory analysis

The sensory science team provides scientific leadership and supports research on the sensory properties of wines, including the acquisition and evaluation of consumer responses. Several panels of assessors are used on a routine basis to answer different researchable questions.

A technical quality panel evaluates wine as an expert group of judges, providing an indication of sensory characteristics, the presence of any off-flavours or taints and a quality score. The panel is used to provide data for the AWRI's helpdesk investigations, preliminary screenings for research studies and assessments for clients of AWRI Commercial Services. During 2013/2014, the panel evaluated 319 wines, in addition to numerous training and reference samples.

Many sensory descriptive analysis studies were also completed throughout the year, reported elsewhere in this document. The dedicated descriptive analysis panel is made up of highly trained and experienced assessors who work on a part-time basis, meeting generally throughout the year three times per week in two hour sessions. Five new assessors were recruited over the last year. Twelve separate descriptive studies were completed by the panel, rating defined descriptors over multiple replicated sessions. These included a large study to conclude a collaboration with CSIRO Plant Industry studying the effects of rootstocks which exclude salt in Shiraz and Chardonnay vines, by assessing the effects of rootstock on the sensory properties of the finished wines. A set of Pinot Noir wines produced as part of the PhD project of Angela Sparrow from TIA was profiled, investigating the impact of different cap management techniques. Two studies on a Shiraz wine bottled under different closures and stored under different temperature regimes were also completed, concluding 36 months after the wine was bottled.

The relatively new technique of 'napping' was applied to several sample sets, with the descriptive analysis panellists physically grouping samples within a two dimensional space based on their sensory differences. This method provides a rapid means of visualising similarities and differences in sensory properties among a set of wines, and circumvents the need to collect data over several weeks as required for conventional sensory descriptive analysis. This method has proven to be very useful for samples of limited volume or where full sensory profiling is not required. Sample sets studied using napping included a trial featuring the application of whole bunch fermentation to Pinot Noir fruit in assessing whether 'eucalyptus'/'mint' flavour could be masked, and a study involving novel malolactic bacterial strains.

Difference testing, using a screened and experienced set of judges recruited from AWRI staff, is also a valuable tool to determine relatively quickly

Shiralee Dodd, Kate Beames, Andrea Francis, Annette Freeman, Sandy Davis

whether two or more samples differ in their overall sensory properties. Aside from the routine testing of numerous sample sets, over the past year an evaluation has been conducted of a comparatively novel method known as the tetrad test, where four coded samples are presented in a random order to panellists, comprising two pairs of samples. The judges are asked to indicate which two samples belong to the same group. The tetrad test has been shown in other product types to have the potential to be more sensitive and statistically more powerful than duo-trio or triangle tests, with a smaller number of judges able to be used than normally required. However, evaluations so far have shown that the tetrad test may in fact be less powerful than the triangle test for wines, especially red wines where there is greater carry-over from sample to sample and sensory fatigue involved; further work is planned to confirm this. The method of difference from control, whereby several samples in a set are directly rated for degree of difference from a reference wine, has been applied extensively by the AWRI in recent times, and has proven to be a valuable and cost-effective method when many samples need to be examined.

Consumer testing continues to be an important element for a number of projects undertaken by the AWRI, for example confirming that a treatment has had an effect not only on a wine's sensory properties but also has been sufficient to affect consumers' preferences. Five sets of wines of widely divergent styles were characterised as part of a collaborative project undertaken in conjunction with UniSA, with the profiled wines subsequently assessed by consumers in China.

Spectral measures of grape and wine composition

The use of near infrared (NIR), ultraviolet (UV), visible and mid-infrared (MIR) spectroscopy to rapidly determine chemical composition and categorise or 'fingerprint' samples continues to be important across a range of projects. A study on the effects of long-term storage on a Shiraz wine has shown that Visible-NIR spectroscopy scanning unopened bottles using the BevScan™ instrument can non-destructively differentiate between storage conditions, with the results closely matching those obtained from sensory panel data. Spectral data have also been used to rapidly quantify measures such as yeast assimilable nitrogen in conjunction with industry partners to reduce reliance on slow and costly wet chemistry assays. The ability of spectroscopic methods to give a holistic multivariate snapshot of a grape or wine sample has been used to evaluate the extent of predictive relationships between grape composition and grape quality, in conjunction with a suite of individual chemical compositional variables.

Synthetic organic chemistry

The ability to synthesise complex chemical compounds in-house that are not commercially available brings considerable benefits to the AWRI's research efforts. Such compounds are used as analytical standards; for mechanistic and kinetic studies; for evaluation of sensory properties; and as reference standards to ensure correct identification is made of compounds which have been tentatively identified through literature data. Over the past year compounds required for projects investigating 'stone fruit' flavour, the formation of sulfur off-flavours, in-mouth flavour release studies and off-flavours relating to grape fungal diseases have been successfully synthesised, several of which required highly complex multi-step reactions.

Analytical chemistry

To ensure that high quality chemical analytical data are available for research studies and troubleshooting, state-of-the-art, carefully maintained instruments and accurate and precise quantitative methods have been extensively used across a wide range of projects. Important aroma compounds such as eucalyptol ('mint'/'eucalypt' flavour), thiols ('tropical fruit', 'grapefruit'), monoterpenes ('citrus', 'floral'), rotundone ('pepper') and C6 compounds ('grassy', 'vegetal') have been quantified in more than 600 samples.

Metabolomics (South Australian node of Metabolomics Australia)

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

During 2013/2014, the South Australian node of Metabolomics Australia provided approximately

10,000 analyses on more than 2,400 samples for a diverse range of clients from the environmental, biomedical and agri-food sectors. A total of 101 projects were completed; 97 for SA-based organisations and four for clients in Western Australia and Tasmania.

The AWRI's metabolomics group provided ongoing access for researchers and industry to three GC-MS systems with specialised autosamplers for the analysis of volatile trace metabolites and automated derivatisation of small non-volatile compounds, and two HPLC-MS instruments for the analysis of non-volatile metabolites by high resolution mass spectrometry and tandem mass spectrometry.

Wine Innovation Cluster Winemaking Services

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 established in 2010. Its location within the University of Adelaide's purpose built small-lot and pilot-scale winemaking facility enables the delivery of high quality research and small-scale commercial winemaking services.

Vintage 2014

WIC Winemaking Services was contracted to process a total of 197 (50–200 kg) ferments during the 2014 vintage, 73 more than the previous vintage. The customers of WIC Winemaking Services include all WIC partners and a number of other clients. During vintage 2014 grapes were sourced from all South Australian wine regions as well as a number from Victoria, Tasmania, Western Australia and New South Wales.

Improvements in standard operating procedures and updated IT have resulted in a significant improvement in WIC Winemaking processes, offering new ways to store, access and publish information. New technology has resulted in cost savings as well as more reliable data capture, with other improvements reflected in the quality and consistency of finished wines.

Efficient management and administration

Background

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

Finance

In October 2013 the Finance Manager, Chris Day, broadened his scope of responsibility and assumed the title of Group Manager – Corporate Services. In addition to fulfilling budgetary, reporting and financial management responsibilities, the finance team extensively revised the format of financial reporting in response to the requirements of new funding agreements, and continued to contribute to a range of funding submissions.

Human resources

In addition to his existing responsibilities relating to payroll, administration and WHS, Alfons Cuijvers assumed direct responsibility for all AWRI human resources matters in October 2013, taking on the role of Human Resources Coordinator. Alfons has drawn on his considerable corporate experience to ensure that the AWRI continues to be well served in this area, with a standout achievement being the renewal of the AWRI Employment Agreement which received the strong endorsement of staff. International recruitment, a key plank in the AWRI's talent attraction strategy, continues to present its inherent challenges particularly in the management of employer-sponsored visa nominations.

Operations

The Operations Manager, Mark Braybrook, manages and attends to all AWRI infrastructure, equipment and engineering requirements and represents the AWRI's interests, in partnership with the other occupants of the WIC building. Cost-effective custom designed and manufactured engineering solutions continue to be supplied throughout the organisation. Examples from this year include the installation of measuring and dosing equipment for 12 × 500 L fermenters required for the research project on oxygen and the installation of new equipment to generate hydrogen for use with the mass spectrometry and GC-O instruments. Considerable effort has been invested in addressing WHS requirements, including the installation of ducting, upgrading of gas connections and expansion of storage capabilities, while the organisation's WHS policy has been significantly revised and disseminated to all workers.

Corporate governance

The Company Secretary, Shiralee Dodd, has focused on changes to the process for electing directors to the AWRI Board, which will see the AWRI in future run its own elections. In addition to realising significant process efficiencies and cost savings, it is hoped that the associated transition to electronic ballots will encourage greater participation of levy payers in the voting process. These changes, which required extensive negotiations with the DA and amendments to the AWRI's constitution, will take effect in time for the upcoming 2014 AWRI director elections.

Information technology

The IT Coordinator, Adam Holland, further implemented the AWRI's strategy to standardise, centralise and virtualise its IT assets and environment, particularly through the rollout of a Virtual Desktop Infrastructure (VDI) platform. Improvements were also made through upgrading server and database platforms, while also assessing and implementing improvements to the organisation's intranet and management of third party devices. These efforts will continue to yield further improvements to productivity, and assist in the ongoing cost-effective delivery of IT solutions.

International scientific exchange program

Background

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

International exchanges and cooperation

Prof. Ulrich Fischer from DLR Rheinpfalz in Germany spent three months at the AWRI as a visiting scientist. During his sabbatical he presented four sensory workshops to Australian wine industry personnel: 'Unveiling the secrets of German Riesling and terroir' in the Clare and Barossa Valleys, and 'German Pinot Noir' in the Mornington Peninsula and Yarra Valley regions. He also presented scientific seminars to AWRI staff ('Flavour release from glycoside precursors during sparkling winemaking'), WIC researchers ('Terroir and sensory in German Riesling wine') and students and staff at the University of Adelaide ('Sensory impacts of process changes to make wine with reduced alcohol concentration').

This year saw the initiation of the first collaborative research projects conducted under the BAG (Bordeaux-Adelaide-Geisenheim) alliance. Florian Sengler, an employee and prospective student from Hochschule Geisenheim University, Germany, spent five months at the AWRI in 2014,


Neil Scrimgeour

The AWRI booth at the 15th AWITC trade exhibition

undertaking collaborative research alongside the AWRI's Brett project team as part of the BAG alliance project *Comparative and functional genomics of* Dekkera (Brettanomyces) bruxellensis *wine isolates from Australia, France and Germany*. Tracey Siebert of the AWRI's flavour chemistry team undertook a placement as a visiting scientist in Prof. Philippe Darriet's group at ISVV, Bordeaux, and studied target compounds thought to be responsible for 'stone fruit' aroma in white wine. Plans have been finalised for the first German-Australian Riesling trial (*heat berry project*) that aims to characterise and mitigate some of the effects of climate change – elevated temperature and radiation – through a comparison of metabolite profiles arising from parallel experiments in Riesling vineyards in both countries.

In another international project, the Metabolomics group has established comprehensive metabolite profiles for Australian and Italian grape and wine samples as part of a collaboration that seeks to characterise the relationships between grape metabolites and wine composition.

New partnerships

The AWRI has been invited to join the Innovative Training Network 'INDULGAROMA Indulgence-Inducing Aroma – just pleasure or treatment for body and soul?' as part of a funding application by a large European consortium under the Horizon2020 program. The AWRI has also signed an agreement to join the Oenoviti/Oenodoc International Network, an association of research and educational institutions involved in grape and wine science. This network fosters cooperation in teaching and research, conducting activities such as exchange programs, conferences, student placements and co-supervision arrangements.

Commercial Services

Staff

Tadro Abbott, Melissa Aitchison, Karl Forsyth, Andrea Francis, Robyn Gleeson, Kieran Hirlam, Leanne Hoxey, Erin Kearsley, Oliver Lovat, Bryan Newell, Dr Simon Nordestgaard, Dr Kerry Pinchbeck, Tim Reilly, Neil Scrimgeour, Pamela Solomon, Alana Spears, Randell Taylor, Heather Tosen, Dr Tina Tran, Daniel Tynan, Dr Eric Wilkes.

Commercial Services had an overwhelmingly positive year in 2013/2014, enjoying strong demand for its services as well as continued close working relationships with wine industry peak bodies and wine and grape producers. The growing success of these relationships is evidenced by the continued increase in sample numbers submitted, with the laboratory exceeding its historical average sample numbers in 9 out of 12 months and receiving overall sample numbers 31% above average. This strong demand necessitated investment in additional capital equipment (an autotitrator and a liquid chromatography mass spectrometer) to increase analytical capacity. The new equipment has allowed the group to continue to provide the high levels of service and responsive turnaround times required by the Australian grape and wine industry.

The strengths of collaboration

The advantages and importance of close relationships with stakeholders were highlighted by the group's involvement in the industry response to the enforcement by the Chinese government of new limits for the metals iron, copper and manganese in wine, as reported earlier. Commercial Services worked closely with Wine Australia and the AWRI's Industry Development and Support group to assess the potential impact of these new limits, and develop an industry response. This collaboration enabled the timely development of an affordable testing service for manganese, complementing those already in place for copper and iron, to meet industry's analytical demand once the new limits were enforced. More than 1,500 wine samples have been tested for manganese and 1,300 for copper since the recommendation in March 2014 by Wine Australia that all wines intended for export to China be checked prior to shipment.

The availability of this significant in-house testing capability within an industry-focused body delivers the added benefit of insightful aggregated data being available to help prioritise industry's responses to emerging and continuing issues. Recent analytical data for metals show that 25% of wines tested exceed the Chinese limit for manganese, while less than 1% of samples exceed the limit for copper. The data also demonstrate that manganese levels are higher for red wines than whites and are essentially independent of variety, with the greatest influences being region

and vintage environmental conditions. This valuable and previously absent understanding is now helping to direct industry strategies for research and mitigation. Similarly, examining other analytical trends shows that the spoilage yeast *Brettanomyces* continues to be an issue for the Australian industry, requiring the ongoing attention of producers.

Ensuring the best outcomes for the Australian industry

The AWRI continues to be recognised for its expertise and impartiality in the area of closure and package design and performance assessment. A range of novel closures have been submitted to Commercial Services for independent assessment. This testing assists producers in ensuring that their products meet the stringent requirements of the wine market, while also providing industry end-users with confidence that performance data presented to them come from a technically sound and impartial source with a focus on the requirements of the wine industry. The group's expertise has not only been applied to the testing of finished products, but has also seen Commercial Services consulting in the development phase of a number of new closures and packages for wine industry applications, helping to ensure that new technologies reach end-users as quickly as possible in a form optimised for wine products.

The breadth of the group's expertise in this and other areas has also contributed to the provision of extension services. Commercial Services staff continued to provide presentations and support for extension activities conducted during the year, including a range of workshops on refrigeration and fermentation simulation. The group also led and contributed to a number of research projects, as reported elsewhere.

The past year also saw significant additions to the AWRI WineCloud. Previously known as the Tannin Portal, this online service gives users the ability to measure and benchmark tannin content of wine through simple spectral measurements. The ability to measure grape tannins has been added to the WineCloud in 2013/2014, significantly expanding its capabilities and value to users. The interface has also been significantly improved to increase its ease of use as well as introducing the abilities to store, trend and profile other analytical values for samples, providing contextual information for analytical results.

Looking forward, Commercial Services has also secured funding for the next financial year for a project evaluating the viability of process sensor technologies to measure sugar levels during fermentation. Starting in July 2014, this project will assess the available sensors for fermentation management and their ability to automate processes during this critical part of the winemaking process.

Other unique competencies contributed by Commercial Services include the provision of environmental services to the wine industry, both through consulting in the areas of waste water, energy and refrigeration and by leading two major research projects investigating the potential for grape marc to be used as a feed supplement to reduce livestock methane emissions (reported in detail elsewhere).

Collaborations have also continued between Commercial Services and commercial suppliers of yeast and bacteria. The past year's work focused mainly on the development and characterisation of commercial strains of yeast with lower tendencies to produce wine faults such as volatile acidity and reductive characters. The group's recognised expertise in commercial wine microbiology also saw a steady growth in on-site services in the area. In particular, packaging line and winery microbiological audits services have proven to be popular, both in Australia and New Zealand. Packaging line microbiological audits focus on hygiene, filtration and sanitation, providing a valuable troubleshooting service to assist wineries in managing the risks associated with post-packaging spoilage issues. Winery microbiological audits focus on the mitigation and elimination of spoilage organisms such as *Brettanomyces,* providing important information about their occurrence as well as on the efficacy of control practices employed in the winery.

Financial statements – directors' report

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 2014.

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**
Mr Peter J. Dawson (Chair to 24 Feb 2014)	31 Jan 2002	24 Feb 2014	2	2
Mr John C. Angove	1 Jan 2010	–	4	4
Mr Toby J. Bekkers	1 Jan 2014	–	1	2
Mr James F. Brayne	1 Jan 2009	–	4	4
Mr Paul D. Conroy	2 May 2006	–	3	4
Dr John S. Harvey	1 Jan 2012	–	4	4
Dr Daniel L. Johnson	1 Dec 2011	–	4	4
Mr Brett M. McKinnon	1 Jan 2008	–	4	4
Ms Elizabeth A. Riley	1 Jan 2012	–	4	4
Ms Louisa E. Rose (Chair from 25 Feb 2014)	1 Jan 2011	–	3	4
Prof Brian P. Schmidt	25 Feb 2014	–	2	2
Mr Mark R. Watson	24 Jun 2008	–	4	4
Alternate directors				
Mr Michael R. DeGaris	17 Sep 2012	12 Aug 2013	–	–
Mr Neil A. McGuigan	22 Mar 2011	30 Jul 2013	–	–
Mr Alexander N. Sas	25 May 2004	30 Jul 2013	–	–

A – Number of meetings attended
B – Number of meetings held during the time the director held office during the year, or number of meetings held that the alternate director was eligible to attend 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 2014 the organisation recorded a surplus of $506,101 (2013: surplus of $36,405). This surplus is primarily due to the recognition of $600,873 in funding for the purchase of capital equipment (2013: $281,480), with $572,796 provided by the Grape and Wine Research and Development Corporation (2013: $229,968) and $28,077 by other funding bodies (2013: $51,512), and requiring recognition as income within the reported upon period in accordance with applicable accounting standards. It should be noted that corresponding capital expenditure, funded through this capital income in addition to internal sources, totalling $1,150,453 (2013: $292,716) was incurred during the year, with such expenditure to be expensed primarily in future periods over the assets' useful lives in accordance with applicable accounting standards.

Objectives and strategy

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

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

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

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

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

The Company's activities are implemented through a 10 Year Business Plan which is subject to periodic review. To achieve the Company's objectives, this plan articulates the following strategies:

- Advance the competitive edge of the Australian wine industry through the delivery of world class research and development activities
- Provide integrated solutions to proactively manage industry problems
- Deliver high value information and outcomes to the Australian wine industry
- Ensure the AWRI is 'top of mind' in wine innovation knowledge for all stakeholders of the Australian wine industry

The 5 Year Research, Development and Extension Plan *The AWRI 2013-2018* and an executive summary of the Business Plan are both 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. In addition problem solving services and an online search capacity across a range of technical websites are also provided

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 the 10 Year Business Plan, enabling the achievement of the long- and short-term objectives of the organisation as articulated above.

Performance measures

The Company measures its performance through considering the number, quality and impact of the AWRI's scientific publications; its research and development outcomes; the extent to which those outcomes have been adopted by industry practitioners to improve the quality and consistency of wine produced in Australia; and the extent to which that new knowledge has enabled the Australian wine industry to be successful in new and emerging markets. Progress against specific objectives is monitored though the achievement of specific milestones, outputs and performance targets as articulated in the 10 Year Business Plan, 5 Year Research, Development and Extension Plan and individual project plans, combined with measures of use of the AWRI's extension platforms and feedback provided through surveys distributed to service end-users. Financial performance measures include the value of funding and grants received, demand for the organisation's commercial services and contract research capabilities and performance relative to budget. From time to time the Company or parts of its operations are subject to independent review against externally established criteria, with the outcome of such reviews contributing to the Company's assessment of its own performance.

Information on directors

Ms Louisa E. Rose
Chair (non-executive) (from 25 February 2014)
Qualifications: BAppSc (Oenology) BSc GAICD
Experience: Head of Winemaking The Yalumba Wine Company and Hill-Smith Family Vineyards, Co-Chair of the South Australian Wine Industry Council, Chair of the Australian Alternative Varieties Wine Show, member of the Alumni Council of the University of Adelaide, member of the Council of Barons of Barossa, former director of the Barossa Grape and Wine Association and member of Wine Barossa, national wine show judge, 23 years' technical, winemaking, viticultural and commercial experience in the Australian wine industry.
Special Responsibilities: Ms Rose is the Chair of the Personnel committee.

Mr Peter J. Dawson
Chair (non-executive) (to 24 February 2014)
Qualifications: BSc BAppSc (Wine Science)
Experience: Principal Peter Dawson Consulting, Chair and Managing Director of Taransaud Australasia, director of Dawson and James, formerly Senior Vice President Group Operations and Technical Constellation Wines, Adjunct Professor of the Faculty of Science and Technology Deakin University, national wine show judge, 36 years' technical and winemaking experience in the Australian wine industry.

Mr John C. Angove
Non-executive director
Qualifications: BSc
Experience: Chair and Managing Director of Angove Family Winemakers, founding member of WFA in 1988. Immediate past Chair of WFA/AWBC Wine Industry Technical Advisory Committee, member WFA Medium Winemakers Membership Committee and member of WFA Executive.

Mr Toby Bekkers
Non-executive director
Qualifications: BAppSc (Ag) (Hons) GCertMgt
Experience: Principal of Bekkers Consulting and Bekkers Wine. Active as a viticulture and wine business consultant across Australia. Twenty 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.

Mr James F. Brayne
Non-executive director
Qualifications: BAppSc (Wine Science)
Experience: Production Director/Chief Winemaker McWilliams Wines Pty Ltd, national wine show judge, 40 years' technical and winemaking experience in the Australian wine industry.
Special Responsibilities: Mr Brayne is a member of the Personnel committee.

Mr Paul D. Conroy
Non-executive director
Qualifications: LLB (Hons) BComm
Experience: Chief Legal Officer and Company Secretary Treasury Wine Estates Ltd, admitted as a solicitor in the Supreme Courts of NSW, Victoria and the High Court of Australia, more than 20 years' legal and management experience working in Australia, Asia, United Kingdom and the USA.
Special Responsibilities: Mr Conroy is a member of the Audit committee.

Dr John S. Harvey
Non-executive director
Qualifications: BSc (Hons) PhD MBA GAICD
Experience: Managing Director and owner of Bathe Wines Pty Ltd, President of the Adelaide Hills Wine Region, member of the South Australian Wine Industry Association Executive and formerly Executive Director of the Grape and Wine Research and Development Corporation. Fourteen years of wine industry research, research and development management and commercial experience. Director of Business Development at BioInnovation SA, non-executive director of Studio Nine Architects, Rural Business Support, the Can:Do 4 Kids Group of Charities and external appointed member of the Programs Committee of the Adelaide Women's and Children's Hospital Foundation.
Special Responsibilities: Dr Harvey is a member of the Audit committee.

Dr Daniel L. Johnson
Managing Director
Qualifications: BSc (Hons) PhD MBA GAICD
Experience: Chair of the Australian Wine Industry Technical Conference, director of the National Wine Foundation, member of the International Scientific Council of L'Institut des Sciences de la Vigne et du Vin (ISVV) Bordeaux (France), member of the WFA Innovation Policy Committee, member of the Australian Journal of Grape and Wine Research Journal Advisory Committee, member of the World of Fine Wine Editorial Board, member of the Wine Innovation Cluster Leadership Group, member of the Waite Strategic Leadership Group, graduate of the Harvard Business School Authentic Leadership Development Program, graduate of the INSEAD Blue Ocean Strategy Program, graduate of the Australian Wine Industry Future Leaders Program, 17 years' experience in research, development and innovation.

Mr Brett M. McKinnon
Non-executive director
Qualifications: BAgSc (Oenology) (Hons)
Experience: Managing Director Orlando Wines, 26 years' technical, winemaking, viticulture and commercial experience, member WFA Innovation Policy Committee, director Barossa Grape and Wine Association, presiding member of the Phylloxera and Grape Industry Board Selection Committee, professional member of the ASVO, graduate of the Leadership in Innovation Program INSEAD (France).
Special Responsibilities: Mr McKinnon is a member of the Personnel committee.

Ms Elizabeth A. Riley
Non-executive director
Qualifications: BAppSc (Wine Science)
Experience: Nuffield Farming Scholar, Managing Director and Viticulturist Vitibit Pty Ltd, independent expert for the Wine Industry Code of Conduct – Wine Australia, professional member of the ASVO, associate member of the Hunter Valley Wine and Tourism Association and member of the Viticulture Subcommittee. Member of the Decision Support Network for Wine Grape Growers Australia. Previously a Viticulturist with Southcorp Wines between 1993 and 1999 in national and NSW-based roles, 22 years' experience in the Australian wine industry.

Prof. Brian P. Schmidt
Non-executive director
Qualifications: BS BS AM PhD
Experience: Owner and operator of Maipenrai Vineyard and Winery, Australian Research Council Laureate Professor and Distinguished Professor the Australian National University, Chair of Astronomy Australia Limited, member of the Commonwealth Science Council, member of Questacon Advisory Board, member of Australian Academy of Science Council, member of 1 Disease at a Time Advisory Board, member of the Canberra District Vignerons Association. Recipient of the 2011 Nobel Prize in Physics.

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

Alternate directors

Mr Michael R. DeGaris
Non-executive alternate director (for Mr Brayne) (to 12 August 2013)
Qualifications: BAppSc (Oenology) FACBS
Experience: Wine consultant, domestic and international wine show judging experience, previously winemaking positions at Tyrrells and Cellarmaster Wines, General Manager/Chief Winemaker of Cardmember Wines (NZ) and Rothbury Wines, over 30 years' experience in the Australian wine industry.

Mr Neil A. McGuigan
Non-executive alternate director (for Mr McKinnon) (to 30 July 2013)
Qualifications: BAppSc (Oenology)
Experience: CEO Australian Vintage Ltd, domestic and international wine show judging experience, over 35 years' technical, winemaking and management experience in the Australian wine industry.

Mr Alexander N. Sas
Non-executive alternate director (for Mr Dawson) (to 30 July 2013)
Qualifications: BSc Agric (Hons)
Experience: Chief Viticulturist Accolade Wines, 25 years' experience in viticultural research and development and grape supply management.

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, members of the organising committee of the WineHealth 2013 conference 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 as such 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 (2013: $20).

Auditor's independence

The auditor's independence declaration under section 307C of the Corporations Act 2001 is attached and forms part of the directors' report for the financial year ended 30 June 2014.

Dated at Urrbrae on this the 16th day of September 2014.

This directors' report is signed in accordance with a resolution of the directors made pursuant to s.298(2) of the Corporations Act 2001.

Louisa E. Rose
Chair

Daniel L. Johnson
Managing Director

Declaration of independence of Paul Gosnold

To the directors of the Australian Wine Research Institute Limited

As lead auditor of the Australian Wine Research Institute Limited for the year ended 30 June 2014, I declare that, to the best of my knowledge and belief, there have been:

1 No contraventions of the auditor independence requirements of the *Corporations Act 2001* 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, 16 September 2014

Financial statements

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 2014

	Note	2014	2013
Revenue from operating activities			
Grape and Wine Research and Development Corporation			
Investment agreement project funding		5,950,000	9,316,593
Investment agreement capital funding		50,000	136,973
Other project funding		2,164,918	20,207
Other capital funding		522,796	92,995
Capital specific grant funding		28,077	51,512
Other grant funding		836,686	718,628
Commercial services analytical and consulting income		2,822,271	2,343,726
Contract research and other commercial income		1,116,252	1,078,217
Other revenue		284,125	296,362
Total revenue		13,775,125	14,055,213
Other income	*2*	(1,692)	2,089
Expenses from operating activities			
Personnel expenses	*3*	8,893,976	9,641,361
Analytical and project operating expenses		1,927,167	1,958,155
Infrastructure and general services expenses		1,349,234	1,335,181
Depreciation and amortisation expense	*8, 9*	1,059,744	1,171,150
Travel expenses		397,489	362,306
Total expenses		13,627,610	14,468,153
Results from operating activities		145,823	(410,851)
Finance income		360,278	447,256
Profit for the period		506,101	36,405
Other comprehensive income		–	–
Total comprehensive income for the period		506,101	36,405

The notes on pages 55 to 60 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 2014

	Retained Earnings	Total Equity
Balance at 1 July 2012	13,341,927	13,341,927
Total comprehensive income for the period		
Profit or loss	36,405	36,405
Other comprehensive income	–	–
Total comprehensive income for the period	36,405	36,405
Balance at 30 June 2013	13,378,332	13,378,332
Balance at 1 July 2013	13,378,332	13,378,332
Total comprehensive income for the period		
Profit or loss	506,101	506,101
Other comprehensive income	–	–
Total comprehensive income for the period	506,101	506,101
Balance at 30 June 2014	13,884,433	13,884,433

The notes on pages 55 to 60 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 2014

	Note	2014	2013
Assets			
Cash and cash equivalents	4	2,102,532	3,092,752
Other investments	5	8,058,812	7,250,000
Trade and other receivables	6	2,378,947	1,447,382
Inventories	7	75,980	79,705
Prepayments		242,040	236,693
Total current assets		12,858,311	12,106,532
Property, plant and equipment	8	2,288,656	2,006,613
Interest in WIC Building	9	4,962,627	5,165,965
Total non-current assets		7,251,283	7,172,578
Total assets		20,109,594	19,279,110
Liabilities			
Payables and accruals	10	4,146,241	3,253,666
Project funds not expended	11	357,570	653,828
Provisions	12	1,463,390	1,626,060
Total current liabilities		5,967,201	5,533,554
Payables and accruals	10	–	101,000
Provisions	12	257,960	266,224
Total non-current liabilities		257,960	367,224
Total liabilities		6,225,161	5,900,778
Net assets		13,884,433	13,378,332
Equity			
Retained earnings		13,884,433	13,378,332
Total equity		13,884,433	13,378,332

The notes on pages 55 to 60 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 2014

	Note	2014	2013
Cash flows from operating activities			
Cash receipts from project grants and other income		12,513,956	12,236,069
Cash paid to suppliers and employees		(12,249,328)	(13,509,116)
Net cash from operating activities		264,628	(1,273,047)
Cash flows from investing activities			
Cash receipts from capital specific funding		251,262	292,544
Interest received		437,586	692,994
Proceeds from sale of property, plant and equipment		10,314	4,026
Acquisition of property, plant and equipment		(1,145,198)	(309,856)
Acquisition of other investments		(808,812)	(750,000)
Net cash used in investing activities		(1,254,848)	(70,292)
Cash flows from financing activities			
Payment of finance lease liabilities		–	–
Net cash used in financing activities		–	–
Net increase (decrease) in cash and cash equivalents		(990,220)	(1,343,339)
Cash and cash equivalents at 1 July		3,092,752	4,436,091
Cash and cash equivalents at 30 June	4	2,102,532	3,092,752

The notes on pages 55 to 60 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 domiciled in Australia. 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 16th day of September 2014.

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 Company applies Australian Accounting Standards – Reduced Disclosure Requirements as set out in AASB 1053 *Application of Tiers of Australian Accounting Standards* and AASB 2010-02 *Amendments to Australian Standards arising from Reduced Disclosure Requirements*.

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 *Corporations Act 2001*. The Company is a not-for-profit entity for financial reporting purposes under Australian Accounting Standards.

(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, 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 Class Order 98/100 dated 10 July 1988 and in accordance with that Class Order, 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 AASBs 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. Actual results may differ from these estimates.

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 and in any future periods affected.

(v) Changes in accounting policies

The Company has not implemented any changes to its accounting policies for the year ended 30 June 2014 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 and loans and receivables.

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.

(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

Leases in terms of which the Company assumes substantially all the risks and rewards of ownership are classified as finance leases. Upon initial recognition, the leased asset is measured at an amount equal to the lower of its fair value and the present value of the minimum lease payments. Subsequent to initial recognition, the asset is accounted for in accordance with the accounting policy applicable to that asset.

Other leases are 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 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 and indications that a debtor or issuer will enter bankruptcy.

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.

(ii) Non-financial assets

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

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

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

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

(h) Employee benefits

(i) Defined contribution plans

A defined contribution plan is a post-employment benefit plan under which an entity pays fixed contributions into a separate entity and will have no legal or constructive obligation to pay further amounts. Obligations for contributions to defined contribution plans are recognised as an employee benefit expense in profit or loss in the periods during which services are rendered by employees. Prepaid contributions are recognised as an asset to the extent that a cash refund or reduction in future payments is available. Contributions to a defined contribution plan that are due more than 12 months after the end of the period in which the employees render the service are discounted to their present value.

(ii) Other long-term employee benefits

The Company's net obligation in respect of long-term employee benefits is the amount of future benefit that employees have earned in return for their service in the current and prior periods plus related on-costs. The liability is measured such that it is not materially different from the estimate determined by using the present value of the estimated future cash outflows, based on a discount rate that is the yield at the reporting date on AA credit-rated or government bonds that have maturity dates approximating the terms of the Company's obligations.

(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

Grants are recognised at their fair value when there is reasonable assurance that they will be received and that the Company will comply with the conditions associated with the grant.

(j) Finance income

Finance income comprises interest income on funds invested. Interest income is recognised as it accrues in profit or loss using the effective interest rate method.

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. Lease incentives are recognised as an integral part of the total lease expense, over the term of the lease.

Minimum lease payments made under finance leases are apportioned between the finance expense and the reduction of the outstanding liability. The finance expense is allocated to each period during the lease term so as to produce a constant periodic rate of interest on the remaining balance of the liability.

Contingent lease payments are accounted for by revising the minimum lease payments over the remaining term of the lease when the lease adjustment is confirmed.

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. If the Company concludes for a finance lease that it is impracticable to separate the payments reliably, an asset and a liability are recognised at an amount equal to the fair value of the underlying asset. Subsequently the liability is reduced as payments are made and an imputed finance charge on the liability is recognised using the Company's incremental borrowing rate.

(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

	2014	2013
Net gain/(loss) on sale of property, plant and equipment	(1,692)	2,089
	(1,692)	2,089

3. Personnel expenses

	2014	2013
Wages and salaries	7,576,826	8,096,379
Other associated personnel expenses	628,066	826,314
Contributions to defined contribution plans	689,084	718,668
	8,893,976	9,641,361

4. Cash and cash equivalents

	2014	2013
Cash on hand	500	500
Bank deposits at-call	2,102,032	3,092,252
Cash and cash equivalents in the statement of cash flows	2,102,532	3,092,752

5. Other investments

	2014	2013
Held-to-maturity investments	8,058,812	7,250,000
	8,058,812	7,250,000

Held-to-maturity investments consist of term deposits with interest rates between 3.56 and 3.97 percent (2013: between 4.07 and 4.45 percent) and mature within 6 months of balance date (2013: within 6 months of balance date).

6. Trade and other receivables

	2014	2013
Trade receivables due from those other than related parties	976,107	904,233
Trade receivables due from related parties	36,412	42,679
Other receivables	1,366,428	500,470
	2,378,947	1,447,382

Trade receivables are shown net of impairment losses amounting to $0 (2013: $769) 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:

	2014	2013
Balance at 1 July	769	12,925
Impairment charge for the year	–	769
Written off during the year	(769)	(12,925)
Balance at 30 June	–	769

7. Inventories

	2014	2013
Course materials on hand – wine	75,980	79,705
	75,980	79,705

8. Property, plant and equipment

	Plant and machinery	Office furniture and IT	Laboratory equipment	Capital WIP	Total
Cost					
Balance at 1 July 2013	391,043	1,067,271	8,054,336	–	9,512,650
Additions	541	105,373	997,882	46,657	1,150,453
Disposals	(32,505)	(128,721)	(310,970)	–	(472,196)
Balance at 30 June 2014	359,079	1,043,923	8,741,248	46,657	10,190,907
Depreciation and impairment losses					
Balance at 1 July 2013	201,171	720,624	6,584,242	–	7,506,037
Depreciation charge for the year	50,685	139,774	665,945	–	856,404
Disposals	(29,819)	(120,248)	(310,123)	–	(460,190)
Balance at 30 June 2014	222,037	740,150	6,940,064	–	7,902,251
Carrying amounts					
at 1 July 2013	189,872	346,647	1,470,094	–	2,006,613
at 30 June 2014	137,042	303,773	1,801,184	46,657	2,288,656

9. Interest in WIC building

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

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

Cost	
Balance at 1 July 2013	6,100,140
Balance at 30 June 2014	6,100,140
Amortisation and impairment losses	
Balance at 1 July 2013	934,175
Amortisation charge for the year	203,338
Balance at 30 June 2014	1,137,513
Carrying amounts	
at 1 July 2013	5,165,965
at 30 June 2014	4,962,627

10. Payables and accruals

	2014	2013
Current		
Trade payables due to those other than related parties	205,670	425,288
Trade payables due to related parties	–	835
Income received in advance	1,818,226	1,319,868
PAYG and GST	349,295	240,357
Non-trade payables and accrued expenses	1,773,050	1,267,318
	4,146,241	3,253,666
Non-current		
Other payables and accrued expenses	–	101,000
	–	101,000

11. Project funds not expended

Any unexpended GWRDC funding is reimbursable to GWRDC, except where GWRDC agrees that amounts can be retained by the AWRI for purposes approved by GWRDC, at which point such amounts are considered to be committed towards that purpose.

There were no unspent investment agreement funds for the current year (2013: $402,494). The unspent funds from other GWRDC contracts for the current year totalled $196,027 (2013: $4,480).

During the year GWRDC approved the retention by the Company of unspent prior years' funds totalling $365,050 for the purpose of specific capital purchases (2013: $50,000) and $122,755 for other purposes (2013: $26,972). During the year unspent prior years' funds relating to other GWRDC projects totalling $4,480 were returned to GWRDC (2013: $4,466).

	2014	2013
GWRDC current year's investment agreement funding unexpended	–	402,494
GWRDC current year's other contract funding unexpended	196,027	4,480
GWRDC prior years' funding unexpended and uncommitted	161,543	246,854
	357,570	653,828

12. Provisions

	2014	2013
Current		
Employee entitlements	1,463,390	1,626,060
Non-current		
Employee entitlements	257,960	266,224
Number of employees (FTEs)	91.7	94.3

13. Operating leases

Leases as lessee

Non-cancellable operating lease rentals are payable as follows:

	2014	2013
Within one year	24,913	20,532
One year or later and no later than five years	13,936	18,680
Later than five years	–	–
	38,849	39,212

During the year the Company entered into one new lease for a vehicle under an operating lease agreement. This lease runs for a period of two years with no option to renew or purchase at completion of this term.

During the year ended 30 June 2014 an amount of $21,409 was recognised as an expense in respect of operating leases (2013: $20,532).

14. Capital commitments

	2014	2013
Plant and equipment		
Contracted but not provided for and payable		
Within one year	37,605	69,934
One year or later and no later than five years	–	–
Later than five years	–	–
	37,605	69,934

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:

	2014	2013
Total remuneration	1,583,605	1,480,172

During the year non-executive directors became entitled to compensation totalling $86,333 (2013: $88,730). A number of directors voluntarily elected not to receive $37,000 of this entitlement (2013: $24,000), instead redirecting such amounts to support otherwise unfunded activities of the Company including the participation of a number of staff in the fifteenth Australian Wine Industry Technical Conference, held in Sydney during July 2013.

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:

Angove's Pty Ltd
Arrivo Wine
Bathe Wines Pty Ltd
Dawson and James
Peter Dawson Consulting
Vitibit Pty Ltd

Other related party transactions
During the year the Company purchased services from and provided services to a jointly controlled entity, The Australian Wine Industry Technical Conference Incorporated. The jointly controlled entity provided services encompassing conference and workshop activities to the Company, and the Company provided administrative services to the jointly controlled entity.

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	
	2014	**2013**	**2014**	**2013**
Services received from related parties	33,239	10,517	–	835
Services provided to related parties	260,954	178,703	36,412	42,679

16. Contingencies

In the opinion of the directors, there were no material or significant contingent liabilities at 30 June 2014 (2013: none).

17. Subsequent events

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

18. Limited liability

In accordance with the Company's constitution, each member (both during the time he or she is a member and within one year afterwards) is liable to contribute $2 in the event that the Company is wound up. The total amount members would contribute is $24 (2013: $20).

Directors' declaration

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

(a) the accompanying financial statement and notes that are contained on pages 55 to 60 are in accordance with the Corporations Act 2001, including:
- **(i)** giving a true and fair view of the Company's financial position as at 30 June 2014 and of its performance for the financial year ended on that date; and
- **(ii)** complying with Australian Accounting Standards – Reduced Disclosure Requirements and the Corporations Regulations 2001; and

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

Signed in accordance with a resolution of the directors of the Australian Wine Research Institute Limited.

Louisa E. Rose
Chair

Daniel L. Johnson
Managing Director
Dated at Urrbrae on this the 16th day of September 2014.

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

We have audited the accompanying financial report of the Australian Wine Research Institute Limited, which comprises the statement of financial position as at 30 June 2014, the statement of profit or loss and other comprehensive income, statement of changes in equity and statement of cash flows for the year then ended, notes comprising a summary of significant accounting policies and other explanatory information, and the directors' declaration.

Directors' responsibility for the financial report

The directors of the company are responsible for the preparation of the financial report that gives a true and fair view in accordance with Australian Accounting Standards – Reduced Disclosure Requirements and the *Corporations Act 2001* and for such internal control as the directors determine is necessary to enable the preparation of the financial report that gives a true and fair view and is free from material misstatement, whether due to fraud or error.

Auditor's responsibility

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

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

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

Independence

In conducting our audit, we have complied with the independence requirements of the *Corporations Act 2001.* We confirm that the independence declaration required by the *Corporations Act 2001,* which has been given to the directors of the Australian Wine Research Institute Limited, would be in the same terms if given to the directors as at the time of this auditor's report.

Opinion

In our opinion the financial report of the Australian Wine Research Institute Limited is in accordance with the *Corporations Act 2001,* including:

(a) giving a true and fair view of the company's financial position as at 30 June 2014 and of its performance for the year ended on that date; and

(b) complying with Australian Accounting Standards – Reduced Disclosure Requirements and the Corporations Regulations 2001.

BDO Audit (SA) Pty Ltd

Paul Gosnold
Director
Adelaide, 18 September 2014

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 2014; and

(ii) the Statements of financial position give a true and fair view of each Trust's state of affairs as at 30 June 2014.

(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 16th day of September 2014.

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 2014	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**
Income								
Interest	3,114	3,863	2,543	3,189	2,023	2,515	2,742	3,425
Donations and other income	–	–	–	–	–	–	–	–
Total income	3,114	3,863	2,543	3,189	2,023	2,515	2,742	3,425
Expenses								
Advertising	–	–	–	–	–	–	–	–
Audit fees	–	–	–	–	–	–	–	–
Bank charges	–	–	–	–	–	–	–	–
Technical Review contributions	–	–	–	–	–	–	–	–
Sponsorship	–	–	10,000	–	–	–	7,000	–
Total expenses	–	–	10,000	–	–	–	7,000	–
Profit/(loss) from ordinary activities	3,114	3,863	(7,457)	3,189	2,023	2,515	(4,258)	3,425
Other comprehensive income	–	–	–	–	–	–	–	–
Total comprehensive income for the period	3,114	3,863	(7,457)	3,189	2,023	2,515	(4,258)	3,425

STATEMENTS OF FINANCIAL POSITION								
As at 30 June 2014	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**
Assets								
Cash at bank	–	–	–	–	–	–	–	–
Investments	127,286	124,143	95,003	102,416	82,728	80,686	105,818	110,036
Receivables	252	281	188	232	163	182	208	248
Total current assets	127,538	124,424	95,191	102,648	82,891	80,868	106,026	110,284
Investments	–	–	–	–	–	–	–	–
Total non-current assets	–	–	–	–	–	–	–	–
Total assets	127,538	124,424	95,191	102,648	82,891	80,868	106,026	110,284
Liabilities								
Sundry creditors	–	–	–	–	–	–	–	–
Total current liabilities	–	–	–	–	–	–	–	–
Net assets	127,538	124,424	95,191	102,648	82,891	80,868	106,026	110,284
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	111,639	107,776	77,598	74,409	60,868	58,353	110,234	106,809
Profit/(loss) for the year	3,114	3,863	(7,457)	3,189	2,023	2,515	(4,258)	3,425
Closing balance	114,753	111,639	70,141	77,598	62,891	60,868	105,976	110,234
Total trust funds	127,538	124,424	95,191	102,648	82,891	80,868	106,026	110,284

Appendix 1 – External presentations and talks

Staff	Title of presentation	Presented to and where	Date
C.S. Stockley	Wine, health and social responsibility	South Australian Wine Industry Council, Adelaide, SA	5 Jul 13
M.P. Krstic	Welcome, introduction and setting the scene for the Pinot Noir workshop	15th Australian Wine Industry Technical Conference, Workshop Program, Sydney, NSW	13 Jul 13
	Summary and wrap up Pinot Noir workshop		
D.L. Capone	Aroma compounds important to Pinot Noir – an overview of recent eucalyptus/mint research		
	Varietal thiols and green characters		
	Eucalyptol		
R.G. Dambergs	Manipulating Pinot Noir expression in the winery through novel winemaking practices		
M.L. Longbottom	Organic vs conventional N_2O emissions		
I.L. Francis	Key wine aroma compounds: their origin, aroma properties and how to dial them up or down		
	Fermentation-derived aroma compounds and grape-derived monoterpenes		
	Pepper and spice in Shiraz: what influences rotundone levels in wines?		
C.M. Mayr	Reductive and oxidised characters		
C.A. Black	Managing wine faults and taints		
E. Wilkes	Copper adds never do any harm		
C.D. Curtin	Can 'Brett' be a good thing?		
P.R. Dry	Terroir, the deciding factor		
H.E. Holt	Small berries, good wine!		
P.A. Henschke	Wine: from the academic to the artisan		14 Jul 13
J.R.Bellon	Interspecific hybrids: new yeast for the New World		
C.A.Varela	Winemaking approaches to lower ethanol concentration in wine		
K.A. Bindon	Sequential harvest trial		
I.L. Francis	Tasting of commercially available low alcohol wines		
M.E. Smith	Reductive aromas – a review of fate and formation		
M.P. Day	Impact of oxygen during winemaking on wine style – introduction		
	Impact of oxygen during winemaking on wine style – results and implications		
M.Z. Viviers	Influence of metals on post-bottling reductive aroma formation		
P.A. Smith	Factors influencing wine style evolution in-bottle – Oxygen Transfer Rate (OTR) and closure selection		
N. Scrimgeour	Welcome and introduction to rapid analytical measurement tools		
	BevScan: non-invasive spectroscopic screening		
	Future developments and trends		
W.U. Cynkar	Measuring YAN for optimal juice composition		
R.A. Muhlack	The Ferment Simulator		

Staff	Title of presentation	Presented to and where	Date
R.G. Dambergs	The Wine Portal: applications for tannin measurement	15th Australian Wine Industry Technical Conference, Workshop Program, Sydney, NSW	14 Jul 13
M.L. Longbottom	Greenhouse gas abatement in viticulture		
K.K. Forsyth	Carbon accounting in the grape and wine sector		
C.D. Curtin	*Brettanomyces* research and practical management of 'Brett' in the winery		
H.E. Holt	Introduction to sensory evaluation		15 Jul 13
P.O. Williamson	Using sensory science to develop successful wines		
	Consumer sensory testing		
E. Wilkes	CMCs and other crystallisation inhibitors		
	Testing for protein stability, tips and downfalls		
	Testing for tartrate stability		
S. Nordestgaard	Refrigeration management		
K.K. Forsyth	Continuous stabilisation methods		
M. Marangon	Heat stability, what is it?		
	Proctase and other alternatives		
R.A. Muhlack	Bentonites aren't bentonites		
P.R. Dry	Update on emerging varieties in Australia, New Zealand and California		
	White wine varieties: description and tasting		
	Red wine varieties: description and tasting		
C.D. Curtin	Shaping wine style through choice of yeast		
A.D. Coulter	Improved tools: laccase assay		
M. Marangon	Proctase – a viable alternative to bentonite for protein stabilisation of white wines	15th Australian Wine Industry Technical Conference, Fresh Research Session, Sydney, NSW	
S.A. Schmidt	Chardonnay clonal variation – a comparative genomic and phenotypic evaluation		
K.A. Bindon	From grape to consumer: relationships between grape maturity, wine composition and wine sensory properties in Cabernet Sauvignon		
A. Contreras	Can non-conventional yeast be used for the production of wines with lower alcohol concentration?		
M.Z. Viviers	The effects of metals on the evolution of volatile sulfur compounds during wine maturation		
R.A. Muhlack	Creating value from by-products – an industry review and insights into practical case studies	15th Australian Wine Industry Technical Conference, Main Program, Sydney, NSW	16 Jul 13
S. Connew	The AWRI's Semillon project	15th Australian Wine Industry Technical Conference, Workshop Program, Sydney, NSW	
P.J. Costello	Expanding the Chardonnay sensory profile through malolactic fermentation		
E.J. Bartowsky, P.J. Costello	MLF options for flavour management		
M.P. Day	White wine phenolics – introduction		
	White wine phenolics – results and implications for winemaking		
P.A. Smith	Polysaccharides – what do we know about their effects on wine style?		
	Winemaking – what factors influence tannin in red wines?		
K.A. Bindon	What factors influence tannin extractability?		
J.M. McRae	Tannins and their effects on sensory		
C.S. Stockley	Where is allergen labelling at?		
L.M. Hoxey	Lean laboratory systems		
	QA systems, making sure it all works		
E. Wilkes	LIMS, it doesn't have to be complicated		
	Practical problem solving, how do we do it?		

Staff	Title of presentation	Presented to and where	Date
E. Wilkes, L.M. Hoxey	Common troubleshooting, some hard won notes	15th Australian Wine Industry Technical Conference, Workshop Program, Sydney, NSW	16 Jul 13
V.T. O'Brien	The need for Australian industry to sell on value not price		
P.A. Henschke, A.R. Borneman, C.D. Curtin	Meet the wild yeasts		
C.D. Curtin	Harnessing genomics to ensure a 'Brett'-free future for Australian wine	15th Australian Wine Industry Technical Conference, Main Program, Sydney, NSW	17 Jul 13
A.R. Borneman	Next-generation DNA sequencing and its application by the wine industry		
G.D. Cowey	Introduction to the world of tasting	15th Australian Wine Industry Technical Conference, Workshop Program, Sydney, NSW	18 Jul 13
	Basic flavours, taints and faults and thresholds		
C.A. Simos	The Advanced Wine Assessment Course and masterclasses		
S. Connew	The Australian wine show system		
M. Essling	Welcome and introduction to objective measures of quality workshop		
	Common vineyard measures – the theory		
R.G. Dambergs	Towards the prediction of wine outcomes from grape compositional measures		
C.S. Stockley	Translation of science into public health policy	WineHealth 2013 International Wine and Health Conference, Sydney, NSW	19 Jul 13
C.A. Varela	Strategies for reducing alcohol levels in wine	AWRI webinar	30 Jul 13
P.R. Dry	How can irrigation management strategies be used to manipulate wine quality?	Farmer Johns Viticulture Update, Barossa, SA	30 Jul 13
M.P. Krstic	Smoke taint update	State Government Victoria, Department of Environment and Primary Industries, Melbourne, Vic	31 Jul 13
E. Wilkes	The latest on CMCs	AWRI webinar	6 Aug 13
D.L. Johnson	The AWRI – introduction and 5-year RD&E Plan overview	AWRI roadshow seminar, Rutherglen, Vic	13 Aug 13
M.P. Krstic	Why do varieties respond differently to drought and heat stress and what does this mean for your irrigation management?		
	Vine balance – how does it affect yield and quality?		
	Features of the AWRI website		
	How can irrigation management strategies be used to manipulate wine quality?		
P.A. Henschke	Practical strategies for reducing alcohol levels in wine		
	Increasing red and white wine complexity with the AWRI's *Bayanus* yeast		
I.L. Francis	Pepper and spice in Shiraz: what influences rotundone levels in wine?		
R.A. Muhlack	Energy for the future: moving towards on-site renewable biomass and solar technology		
D.L. Johnson	The AWRI – introduction and 5-year RD&E Plan overview	AWRI roadshow seminar, Bendigo, Vic	14 Aug 13
M.P. Krstic	How can irrigation management strategies be used to manipulate wine quality?		
	Does soil and vine nutrient status affect wine quality?		
	Features of the AWRI website		
I.L. Francis	Pepper and spice in Shiraz: what influences rotundone levels in wine?		
E.J. Bartowsky	Using MLF to accentuate wine aroma and flavour		
	Using the timing of MLF inoculation to optimise your winemaking		
E. Wilkes	Carboxymethylcellulose – an important tool for white wine tartrate stabilisation		
P.A. Henschke	Causes and management of slow and stuck fermentations		

Staff	Title of presentation	Presented to and where	Date
D.L. Johnson	The AWRI – introduction and 5-year RD&E Plan overview	AWRI roadshow seminar, Avoca, Vic	15 Aug 13
P.A. Henschke	Did you know that DAP can strongly affect the flavour profile and style of wine?		
	Causes and management of slow and stuck fermentations		
E. Wilkes	Practical management of 'Brett' in the winery		
	Saving time and money: automated methods for juice and wine analysis		
E.J. Bartowsky	Strategies for a successful MLF		
	Using MLF to accentuate wine aroma and flavour		
I.L. Francis	Rotten egg, cabbage and rubber: compounds responsible for reductive off-flavours in wines		
M.P. Krstic	Features of the AWRI website		
S. Connew	The Hunter Valley Semillon project	Hunter Valley Wine Show Trade Familiarisation, Brokenwood Wines, Pokolbin, NSW	16 Aug 13
J. Hixson, K.K. Forsyth	Grape marc tannin – review of scientific rigour	Meat and Livestock Australia, External Science Review Panel, Brisbane, Qld	20 Aug 13
M.L. Longbottom	Building resilience and sustainability in the grape and wine sector	Western Australia Wine Industry Technical Committee, Curtin University, Margaret River, WA	22 Aug 13
M.P. Krstic	Smoke taint update	Avoca Information Centre, Avoca, Vic	28 Aug 13
M. Essling	Does soil and vine nutrient status affect wine quality?	AWRI roadshow seminar, McLaren Vale, SA	3 Sep 13
	Berry sensory assessment in the vineyard for fruit grading – does it work?		
M.P. Krstic	The AWRI – introduction and 5-year RD&E Plan overview		
	Vine balance – how does it affect yield and quality?		
	Importance of sampling for quality parameters in the vineyard		
	Features of the AWRI website		
T.E. Siebert	Spicing up Shiraz: viticultural and winemaking influences on the peppery aroma compound rotundone		
D.L. Capone	The origin of eucalyptus flavour in red wine		
J.R. Bellon	Hybrid yeast: new yeast for the New World	AWRI webinar	
C.A. Simos	The AWRI – introduction and 5-year RD&E Plan overview	AWRI roadshow workshop, McLaren Vale, SA	10 Sep 13
P.R. Dry	Why is harvest getting earlier and what can we do about it?		
	Hotter and drier in the vineyard		
	Salinity and sodicity in the vineyard		
	Growing grapes in wet seasons		
	Practical vineyard and winery group exercise		
	New varieties for a changing climate tasting		
A.D. Coulter	Hotter and drier – processing ripe fruit		
	Bushfires and smoke taint tasting		
	Efficiencies in the winery		
	Energy use and winery wastewater		
M.G. Holdstock	Salty juice and wine		
	Winemaking in wet seasons		
D.L. Johnson	'Mythbusting' session	Savour Australia 2013, Adelaide Convention Centre, Adelaide, SA	16 Sep 13
M.J. Herderich	Tannins in wine: development and application of methods for their quantitative analysis and the characterisation of physico-chemical properties.	42. Deutscher Lebensmittelchemikertag, Braunschweig, Germany	17 Sep 13
C.A. Simos	The AWRI – introduction and 5-year RD&E Plan overview	AWRI roadshow seminar, Clare, SA	25 Sep 13
	Features of the AWRI website		

Staff	Title of presentation	Presented to and where	Date
P.R. Dry	Terroir – separating fact from fiction	AWRI roadshow seminar, Clare, SA	25 Sep 13
	It's getting hotter – what does this mean for our vineyard management strategies?		
M. Essling	Does soil and vine nutrient status affect wine quality?		
C.S. Stockley	Health, nutrition and other warning labels		
D.L. Capone	The origin of eucalyptus flavour in red wine		
P.J. Costello	Using the timing of MLF inoculation to optimise your winemaking		
C.A. Simos	Welcome and introduction/overview of the AWRI	AWRI roadshow seminar, Barossa Valley, SA	3 Oct 13
	Features of the AWRI website and close		
M.L. Longbottom	Vine balance – how does it affect yield and quality?		
	Great wines from grafted vines		
	Improving water use efficiency with rootstocks		
M. Essling	How can irrigation management strategies be used to manipulate wine quality?		
	Does soil and vine nutrient status affect wine quality?		
N. Scrimgeour	Winery cost reduction strategies		
	How to significantly reduce your carbon footprint without spending any money		
P.A. Henschke	Causes and management of slow and stuck fermentations		
G.D. Cowey	A tasting of wine produced using AWRI innovations	National Livestock Methane Program (NLMP), AWRI, Urrbrae, SA	
J.M. McRae	Good wine texture starts in the grape	Wine Tasmania 2013 Field Day, Rosevears, Tas	
D.L. Johnson (presented by L.E. Rose)	2013 overview of the AWRI and alignment with SA Government strategic priority	South Australian Wine Industry Council, Adelaide, SA	
M.Z. Viviers	The effects of metals on the evolution of volatile sulfur compounds during wine maturation	AWRI webinar	8 Oct 13
E.J. Bartowsky	Waiter, there are bacteria in my wine! How bacteria help shape wine style	School of Molecular and Biomedical Science, University of Adelaide, Adelaide, SA	21 Oct 13
M.P. Krstic	Why is harvest getting earlier and what can we do about it?	AWRI roadshow workshop, Gippsland, Vic	29 Oct 13
	Hotter and drier in the vineyard		
	Salinity and sodicity in the vineyard		
	Growing grapes in wet seasons		
	Practical vineyard and winery group exercise		
	New varieties for a changing climate tasting		
A.D. Coulter	Hotter and drier – processing ripe fruit		
	Bushfires and smoke taint tasting		
	Efficiencies in the winery		
	Energy use and winery wastewater		
M.G. Holdstock	Salty juice and wine		
	Winemaking in wet seasons		
M.P. Krstic	Why is harvest getting earlier and what can we do about it?	AWRI roadshow workshop, Mornington, Vic	30 Oct 13
	Hotter and drier in the vineyard		
	Salinity and sodicity in the vineyard		
	Growing grapes in wet seasons		
	Practical vineyard and winery group exercise		
	New varieties for a changing climate tasting		
	N_2O – Greenhouse gas abatement in viticulture		
A.D. Coulter	Hotter and drier – processing ripe fruit		

Staff	Title of presentation	Presented to and where	Date
A.D. Coulter	Bushfires and smoke taint tasting	AWRI roadshow workshop, Mornington, Vic	30 Oct 13
	Efficiencies in the winery		
	Energy use and winery wastewater		
M.G. Holdstock	Salty juice and wine		
	Winemaking in wet seasons		
M.P. Krstic	Why is harvest getting earlier and what can we do about it?	AWRI roadshow workshop, Yarra Valley, Vic	31 Oct 13
	Hotter and drier in the vineyard		
	Salinity and sodicity in the vineyard		
	Growing grapes in wet seasons		
	Practical vineyard and winery group exercise		
A.D. Coulter	Hotter and drier – processing ripe fruit		
	Bushfires and smoke taint tasting		
	Efficiencies in the winery		
	Energy use and winery wastewater		
M.G. Holdstock	Salty juice and wine		
	Winemaking in wet seasons		
V.T. O'Brien	Consumer oriented design	McLaren Vale Grape Wine and Tourism Association Board, McLaren Vale, SA	
C.A. Simos	Welcome and introduction/overview of the AWRI	AWRI roadshow seminar, Griffith, NSW	5 Nov 13
	Features of the AWRI website and close		
K.A. Bindon	Tannin from grape to wine: new insights on a complex system		
	Grape ripeness and wine composition (Cabernet Sauvignon)		
C.D. Curtin	Choose the right yeast to achieve the red wine style you want		
	Wild ferments – what are the alternatives?		
	Did you know that DAP can strongly affect the flavour profile and style of wine?		
	Complex yeast nutrients – how do they fit into your fermentation management strategy?		
R.A. Muhlack	An update on the Griffith node activities		
C.A. Simos	Welcome and introduction/overview of the AWRI	AWRI roadshow seminar, Orange, NSW	6 Nov 13
	Why is managing dissolved oxygen at bottling so important?		
	Features of the AWRI website and close		
P.R. Dry	Why do we need new clones?		
	How can cultural practices be used to improve fruit set?		
K.A. Bindon	Viticultural management of grape and wine phenolics		
	Grape ripeness and wine composition (Cabernet Sauvignon)		
C.D. Curtin	Wild ferments – what are the alternatives?		
C.A. Simos	Welcome and introduction/overview of the AWRI	AWRI roadshow seminar, Mudgee, NSW	7 Nov 13
	Managing stuck fermentation and rescue procedures		
	Features of the AWRI website and close		
P.R. Dry	How can irrigation management strategies be used to manipulate wine quality?		
R.A. Muhlack	Doing more with less: sustainable process solutions for profitability		
K.A. Bindon	Viticultural management of grape and wine phenolics		
C.D. Curtin	Managing H_2S during fermentation – latest research		
	Practical management of 'Brett' in the winery		
C.A. Simos	Welcome and introduction/overview of the AWRI	AWRI roadshow seminar, Canberra, ACT	8 Nov 13
	Features of the AWRI website and close		

Staff	Title of presentation	Presented to and where	Date
P.R. Dry	Does soil and vine nutrient status affect wine quality?	AWRI roadshow seminar, Canberra, ACT	8 Nov 13
	Terroir – separating fact from fiction		
K.A. Bindon	Viticultural management of grape and wine phenolics		
J.R. Bellon	Wild ferments – what are the alternatives?		
E. Wilkes	Pepper and spice in Shiraz: what influences rotundone levels in wines?		
	Copper in winemaking, the good and the bad		
M.P. Day	Post-bottling effects of early oxygen exposure during red winemaking	AWRI webinar	12 Nov 13
V.T. O'Brien	Consumer oriented design briefing presentation	AWRI/SA State Government Department for Manufacturing, Innovation, Trade, Resources and Energy joint briefing, Adelaide, SA	14 Nov 13
G.D. Cowey	Sensory evaluation wine aromas, flavours, faults and taints: Australian wine show tasting	Premium Wine Brands, Barossa Valley, SA	
P.O. Williamson	Relationship between chemical composition and preferences of Western and Asian consumers	Beijing International Wine-Tech Forum, Beijing, China	16 Nov 13
D.L. Capone	Recent work on the impact of 1,8-cineole on Pinot Noir	Pinot Massif, Hepburn Springs, Vic	18 Nov 13
E. Wilkes	Optimising your laboratory for the best results	AWRI webinar	19 Nov 13
P.R. Dry	Terroir and wine typicity	Soil and Wine Symposium, Urrbrae, SA	21 Nov 13
P.J. Dawson	2013 AWRI annual report	Winemakers' Federation of Australia AGM, Adelaide, SA	26 Nov 13
C.S. Stockley	The evolution of Australia's alcohol drinking guidelines	Wine Information Council Second Conference – Wine in Moderation: From Science to Art de Vivre, Brussels, Belgium	27 Nov 13
J.R. Bellon	New yeast for the New World	Wine Innovation Cluster 2013 research update and end of year networking event, Adelaide, SA	
J.M. McRae	What the Synchrotron can tell us about wine tannins		
C.M. Mayr	Shiraz reconstitution		
C.A. Simos	World Chardonnay and Pinot Noir tasting	World Chardonnay and Pinot Noir Masterclass, Adelaide, SA	28 Nov 13
			29 Nov 13
P.O. Williamson	Thinking outside the bottle: insights on how Chinese consumers choose wine	AWRI webinar	3 Dec 13
G.D. Cowey, M. Essling, A.D. Coulter	Adapting to difficult vintages – welcome and introduction	AWRI roadshow workshop, Mt Barker, WA	
M. Essling	Why is harvest getting earlier and what can we do about it?		
	Hotter and drier in the vineyard		
	Practical vineyard and winery group exercise		
	Growing grapes in wet seasons		
G.D. Cowey	Hotter and drier – processing ripe fruit		
	New varieties for a changing climate tasting		
	Salty juice and wine		
	Salinity and sodicity in the vineyard		
A.D. Coulter	Winemaking in wet seasons		
	Bushfires and smoke taint tasting		
	Sustainability and efficiencies in the winery		
G.D. Cowey	Adapting to difficult vintages – welcome and introduction	AWRI roadshow workshop, Pemberton, WA	4 Dec 13
	New varieties for a changing climate tasting		
	Salty juice and wine		
	Salinity and sodicity in the vineyard		
	Hotter and drier – processing ripe fruit		

Staff	Title of presentation	Presented to and where	Date
M. Essling	Why is harvest getting earlier and what can we do about it?	AWRI roadshow workshop, Pemberton, WA	4 Dec 13
	Hotter and drier in the vineyard		
	Practical vineyard and winery group exercise		
	Growing grapes in wet seasons		
A.D. Coulter	Winemaking in wet seasons		
	Bushfires and smoke taint tasting		
	Sustainability and efficiencies in the winery		
G.D. Cowey	Adapting to difficult vintages – welcome and introduction	AWRI roadshow workshop, Margaret River, WA	5 Dec 13
	New varieties for a changing climate tasting		
	Salty juice and wine		
	Salinity and sodicity in the vineyard		
	Hotter and drier – processing ripe fruit		
M. Essling	Why is harvest getting earlier and what can we do about it?		
	Hotter and drier in the vineyard		
	Practical vineyard and winery group exercise		
	Growing grapes in wet seasons		
A.D. Coulter	Winemaking in wet seasons		
	Bushfires and smoke taint tasting		
	Sustainability and efficiencies in the winery		
G.D. Cowey	Adapting to difficult vintages – welcome and introduction	AWRI roadshow workshop, Swan Valley, WA	6 Dec 13
	New varieties for a changing climate tasting		
	Salty juice and wine		
	Salinity and sodicity in the vineyard		
	Hotter and drier – processing ripe fruit		
M. Essling	Why is harvest getting earlier and what can we do about it?		
	Hotter and drier in the vineyard		
	Practical vineyard and winery group exercise		
	Growing grapes in wet seasons		
A.D. Coulter	Winemaking in wet seasons		
	Bushfires and smoke taint tasting		
	Sustainability and efficiencies in the winery		
M.L. Longbottom	Greenhouse gas emissions in vineyards	AWRI webinar	10 Dec 13
W.U. Cynkar	Measuring YAN for optimal juice composition	2013 Interwinery Analysis Group Annual General Meeting, Clare, SA	13 Dec 13
D.L. Johnson	2013 AWRI annual report presentation and update	NSW Wine Industry Association, Sydney, NSW	20 Jan 14
R.G. Dambergs[1]	Copper – the good, the bad and the ugly	Improved winemaking practices workshop, Richmond, Tas	21 Jan 14
S. Connew	Getting the most from your smartphone and tablet		
P.W. Godden	Spontaneous fermentations		
R.G. Dambergs[1]	Copper – the good, the bad and the ugly	Improved winemaking practices workshop, Tamar Valley, Tas	22 Jan 14
S. Connew	Getting the most from your smartphone and tablet		
P.W. Godden	Spontaneous fermentations		
D.L. Johnson	2013 AWRI annual report presentation and update	Wines of WA Board meeting, Dardanup, WA	12 Feb 14
C.A. Simos	Welcome and introduction/overview of the AWRI	AWRI roadshow seminar, Coonawarra, SA	14 Feb 14
	Features of the AWRI website and close		
P.R. Dry	It's getting hotter – what does this mean for our vineyard management strategies?		
	Terroir – separating fact from fiction		
	How can cultural practices be used to improve fruit set?		

Staff	Title of presentation	Presented to and where	Date
M.P. Krstic	Importance of sampling for quality parameters in the vineyard	AWRI roadshow seminar, Coonawarra, SA	14 Feb 14
	Berry sensory assessment in the vineyard for fruit grading – does it work?		
C.D. Curtin	Complex yeast nutrients – how do they fit into your fermentation management strategy?		
E.J. Bartowsky	Strategies for a successful MLF		
C.S. Stockley	Health, nutrition and other warning labels		
G.D. Cowey	Trouble-free winemaking	Institute of Masters of Wine, Reading, UK	
D.L. Johnson	2013 AWRI annual report presentation and update	Wine Tasmania Board meeting, Campbell Town, Tas	20 Feb 14
P.W. Godden		SA Wine Industry Association, Adelaide, SA	
D.L. Johnson	Agriculture, Food, Water and Energy Nexus	Plant Genomics Centre, Urrbrae, SA	27 Mar 14
R.A. Muhlack[2], P.W. Godden	Refrigeration efficiency: a new tool to model refrigeration demand	Griffith, NSW	3 Apr 14
R.G. Dambergs[1]	Understanding and manipulating red wine phenolics for quality		
M.J. Herderich	The Australian wine sector and the Australian Wine Research Institute	Joint Research Centre - Institute for Reference Materials and Measurements, Geel, Belgium	7 Apr 2014
P.J. Chambers	Improving wine through yeast strain development	5th European Yeast Flavour Conference: Biotechnology for Natural Flavours Production, Montreux, Switzerland	5 May 14
C.A. Simos	Welcome and introduction/overview of the AWRI	AWRI roadshow seminar, Renmark, SA	8 May 14
	Features of the AWRI website and close		
P.R. Dry	How can irrigation management strategies be used to manipulate wine quality?		
	Why do we need clones?		
	How can cultural practices be used to improve fruit set?		
M.P. Krstic	Does soil and vine nutrient status affect wine quality?		
	Why do varieties respond differently to drought and heat stress – and what does this mean for your irrigation management?		
K.A. Bindon	Managing phenolic quality in the vineyard		
M.L. Longbottom	Nitrogen management in viticulture	Margaret River grapegrowers, Curtin University, Margaret River, WA	13 May 14
P.W. Godden	The wine science horizon	Institute of Masters of Wine 8th Symposium, Florence, Italy	16 May 14
D.L. Johnson	Sc2.0 Synthetic Yeast genome project launch and wine tasting	Synthetic Biology Symposium, Macquarie University, Sydney, NSW	27 May 14
M.L. Longbottom	Greenhouse gas abatement in viticulture	Hunter Valley grapegrowers, Pokolbin, NSW	
I.L. Francis, W.P. Pearson	Descriptive terminology	AWRI Advanced Wine Assessment Course, Urrbrae, SA	2 Jun 14
M.P. Krstic	Insights into smoke taint	Royal Australian Chemical Institute – Food Nutrition and Analytical Chemistry Group, Moorabbin, Vic	4 Jun 14
P.W. Godden	Getting to know wild yeasts tasting	Refrigeration and improved winemaking practices workshop, Canberra, ACT	6 Jun 14
R.A. Muhlack[2]	Refrigeration efficiency: a new tool to model refrigeration demand		
R.G. Dambergs[1]	Understanding and manipulating red wine phenolics for quality		
P.R. Dry	International Shiraz production and performance	Shiraz Symposium, Melbourne, Vic	11 Jun 14
I.L. Francis	Capturing the pepper character in Shiraz		
D.L. Capone	Managing the eucalyptus character in Shiraz		
R.A. Muhlack[2]	Refrigeration efficiency: a new tool to model refrigeration demand	Refrigeration and ferment simulation workshop, Rutherglen, Vic	13 Jun 14
	Automating fermentation control with computer simulation		

Staff	Title of presentation	Presented to and where	Date
S. Connew	Working smarter, not harder in the vineyard: making the most of your smart phone and tablet	AWRI webinar	17 Jun 14
G.D. Cowey	Adapting to difficult vintages – welcome and introduction	AWRI roadshow workshop, Murgon, Qld	
	Hotter and drier – processing ripe fruit		
	Salinity, sodicity and salty wine		
	New varieties for a changing climate tasting		
M. Essling	Hotter and drier in the vineyard		
	Growing grapes in wet seasons		
	Q&A session and case studies		
A.D. Coulter	Bushfires and smoke taint tasting		
	Winemaking in wet seasons		
	Sustainability and efficiencies in the winery		
S. Nordestgaard	Lees: rheology, reverse racking and recovery	Winery Engineering Association Conference, McLaren Vale, SA	18 Jun 14
S.A. Schmidt	What's under the hood? Genomic differences powering variation in primary fermentation		
J.M. McRae	Recent developments in removing protein haze from white wines		
G.D. Cowey	Adapting to difficult vintages – welcome and introduction	AWRI roadshow workshop, Stanthorpe, Qld	19 Jun 14
	Hotter and drier – processing ripe fruit		
	Salinity, sodicity and salty wine		
	New varieties for a changing climate tasting		
M. Essling	Hotter and drier in the vineyard		
	Growing grapes in wet seasons		
	Q&A session and case studies		
A.D. Coulter	Bushfires and smoke taint tasting		
	Winemaking in wet seasons		
	Sustainability and efficiencies in the winery		
C.A. Simos	Welcome and introduction/overview of the AWRI	AWRI roadshow seminar, Murgon, Qld	24 Jun 14
	Features of the AWRI website and close		
P.R. Dry	How can irrigation management strategies be used to manipulate wine quality		
	Why do bunches get hot and what does this mean for wine quality?		
	Why do we need new varieties for the future?		
K.A. Bindon	Viticultural management of grape and wine phenolics		
E. Wilkes	Cold stabilisation		
C.A. Simos	Welcome and introduction/overview of the AWRI	AWRI roadshow seminar, Stanthorpe, Qld	25 Jun 14
	Winemaking management strategies for *Botrytis* and Powdery Mildew		
	Features of the AWRI website and close		
P.R. Dry	How can cultural practices be used to improve fruit set?		
	Is it possible to control bunch rot without fungicides?		
K.A. Bindon	Viticultural management of grape and wine phenolics		
	Crafting diverse wine styles through an understanding of how grape composition affects wine composition		
E. Wilkes	Cold stabilisation		
T.J. Abbott, P.W. Godden	Automating fermentation control with computer simulation	Refrigeration and ferment simulation workshop, Mornington Peninsula, Vic	26 Jun 14
	Refrigeration efficiency: a new tool to model refrigeration demand		

Staff	Title of presentation	Presented to and where	Date
P.W. Godden	Working smarter not harder in the vineyard – making the most of your smart phone and tablet	Refrigeration and improved winemaking practices workshop, Orange, NSW	30 Jun 14
P.W. Godden, W.P. Pearson	Vintage benchmark tasting – challenging wines and trying new techniques		
R.A. Muhlack[2]	Refrigeration efficiency: a new tool to model refrigeration demand		

Affiliations: [1]Wine TQ, [2]University of Adelaide

Appendix 2 – Workshops organised by AWRI staff

Staff	Title of workshop	Held	Date
M.P. Krstic, D.L. Capone, R.G. Dambergs	Perfecting Pinot Noir – W01	15th Australian Wine Industry Technical Conference, Sydney, NSW	13 Jul 13
I.L. Francis, D.L. Capone	Key wine aroma compounds: their origin, aroma properties and how to dial them up or down – W07		
E. Wilkes, P.R. Dry, C.D. Curtin, H.E. Holt	Mythbusting: critically evaluating selected winemaking concepts – W08		14 Jul 13
J.R. Bellon, P.A. Henschke	The power of non-conventional yeast in fermentation – W13		
C.A.Varela, K.A. Bindon	How to make wine with lower alcohol concentration – W14		
P.A. Smith, M.E. Smith, M.P. Day, M.Z. Viviers	The effects of oxygen exposure during winemaking and packaging on wine style – W15		
M.L. Longbottom	Environmental sustainability – where are we now and what are the drivers? – W18		
N. Scrimgeour, W.U. Cynkar, R.A. Muhlack, R.G. Dambergs	Practical applications of rapid analytical measurement tools for grapes and wine – W21		
P.O. Williamson, H.E. Holt, I.L. Francis	Consumer-led wines: using sensory science to develop commercially successful wines – W23		15 Jul 13
E. Wilkes, S. Nordestgaard, K.K. Forsyth, M. Marangon, R.A. Muhlack	Heat and cold stability – W24		
P.R. Dry	Emerging varieties: what is the latest? – W25		
C.D. Curtin	Fermentation is in your hands: processes and oenological tools for quality, wine style and consistency – W28		
A.D. Coulter	Measuring and managing *Botrytis* and other bunch rots – W29		
S. Connew	The terroirs and tastes of Hunter Semillon – W31		16 Jul 13
E.J. Bartowsky, P.J. Costello	Malolactic fermentation – flavour and efficiency – W32		
C.D. Curtin	'Wild' wines (and winemakers) under the microscope – W33		
P.A. Smith, M.P. Day, K.A. Bindon, J.M. McRae,	Influences on texture and in-mouth sensory properties of red and white wines – W34		
C.S. Stockley	Winemaking, composition and labelling – what you need to know – W36		
E. Wilkes, L.M. Hoxey	Optimising your laboratory for the best results – W37		
V.T. O'Brien	Design, produce and market a product for a high value segment – W38		
S. Nordestgaard	Commercial innovations in grape and juice processing – W39		
G.D. Cowey, C.A. Simos, S. Connew	A taste of wine education. Guided tastings from the world's wine assessment courses – W41		18 Jul 13

Staff	Title of workshop	Held	Date
M. Essling, R.G. Dambergs	Measures of quality from the vineyard to the winery – W42	15th Australian Wine Industry Technical Conference, Sydney, NSW	18 Jul 13
C.S. Stockley	Addressing the white elephant in the room – W43		
I.L. Francis, S.R. Barter, J.M. McRae, J. Hixson, M.G. Holdstock, N.D.R. Lloyd	Visitor stand showcasing flavour chemistry of wine	Science Alive!, National Science Week, Wayville Showgrounds, Adelaide, SA	9-11 Aug 13
A.D. Coulter, P.R. Dry, M.G. Holdstock	AWRI roadshow workshop – Adapting to difficult vintages	McLaren Vale, SA	10 Sep 13
C.A. Simos	Victorian State Government super trade mission to China – wine flavours, faults and taints tasting	Tianjin, China	21 Oct 13
		Beijing, China	22 Oct 13
M. Essling, M.L. Longbottom	Research to practice workshop – Integrated pest management and Nutrition	Macedon Ranges, Vic	23 Oct 13
C.A. Simos	Victorian State Government super trade mission to China – wine flavours, faults and taints tasting	Shanghai, China	24 Oct 13
M.L. Longbottom	N_2O – Greenhouse gas abatement in viticulture	Adelaide, SA	25 Oct 13
M.P. Krstic, A.D. Coulter, M.G. Holdstock	AWRI roadshow workshop – Adapting to difficult vintages	Gippsland, Vic	29 Oct 13
		Mornington Peninsula, Vic	30 Oct 13
		Yarra Valley, Vic	31 Oct 13
M. Essling	Research to practice workshop – Organic, biodynamic and sustainable management	Granite Belt, Qld	6 Nov 13
M.P. Krstic, C.A. Simos	Smoke taint	Hunter Valley, NSW	13 Nov 13
V.T. O'Brien	HALO launch	Adelaide, SA	14 Nov 13
	HALO workshop	McLaren Vale, SA	26 Nov 13
C.A. Simos, F. Blefari, V.F. Phillips	Themed Tasting – World Chardonnay and Pinot Noir	AWRI, Urrbrae, SA	28 Nov 13
			29 Nov 13
M. Essling, A.D. Coulter, G.D. Cowey	AWRI roadshow workshop – Adapting to difficult vintages	Mt Barker, WA	3 Dec 13
		Pemberton, WA	4 Dec 13
V.T. O'Brien	HALO workshop	McLaren Vale, SA	
M. Essling, A.D. Coulter, G.D. Cowey	AWRI roadshow workshop – Adapting to difficult vintages	Margaret River, WA	5 Dec 13
		Swan Valley, WA	6 Dec 13
M.P. Krstic	Regional MLF	Yarra Valley, Vic	11 Dec 13
V.T. O'Brien	HALO workshop	Adelaide, SA	17 Dec 13
S. Nordestgaard, K.K. Forsyth	Winery operations workshop	Swan Valley, WA	14 Jan 14
S. Connew, P.W. Godden	Smartphone and tablet workshop	Tanunda, SA	15 Jan 14
		McLaren Vale, SA	16 Jan 14
S. Nordestgaard, K.K. Forsyth	Winery operations workshop	Margaret River, WA	
S. Connew, P.W. Godden, R.G. Dambergs[1]	Improving winemaking practices workshop	Richmond, Tas	21 Jan 14
S. Connew, P.W. Godden		Tamar Valley, Tas	22 Jan 14
V.T. O'Brien	HALO workshop	McLaren Vale, SA	23 Jan 14
C.A. Simos, M.P. Krstic	Smoke taint Q&A session	Eden Valley, SA	30 Jan 14
P.W. Godden, R.A. Muhlack[2], R.G. Dambergs[1]	Refrigeration and improved winemaking practices workshop	Griffith, NSW	3 Apr 14
S. Connew	Working smarter not harder in the vineyard – making the most of your smart phone and tablet	Hanwood, NSW	4 Apr 14
P.W. Godden	Understanding and managing 'Brett' in the winery	Mudgee, NSW	9 Apr 14
M.P. Krstic, C.A. Simos	Smoke taint update	Oxley, Vic	13 May 14
		Heathcote, Vic	14 May 14
		Yarra Valley, Vic	15 May 14
R.A. Muhlack[2], S. Connew	Refrigeration workshop	Mudgee, NSW	21 May 14
M.L. Longbottom	Research to practice workshop – Managing grapevine nutrition in a changing climate	McLaren Vale, SA	22 May 14

Staff	Title of workshop	Held	Date
S. Connew	Working smarter not harder in the vineyard – making the most of your smart phone and tablet	Pokolbin, NSW	27 May 14
R.A. Muhlack[2], P.W. Godden	AWRI Ferment Simulator demonstration	Coonawarra, SA	4 Jun 14
M.P. Krstic	Rootstock tasting workshop	Mornington Peninsula, Vic	5 Jun 14
P.W. Godden, R.A. Muhlack[2], R.G. Dambergs[1]	Refrigeration and improved winemaking practices workshop	Canberra, ACT	6 Jun 14
M.P. Krstic, P.R. Dry, I.L. Francis, D.L. Capone	Shiraz Symposium	Melbourne, Vic	11 Jun 14
P.W. Godden, R.A. Muhlack[2]	Refrigeration and ferment simulation workshop	Rutherglen, Vic	13 Jun 14
S. Connew	Working smarter not harder in the vineyard – making the most of your smart phone and tablet	Berri, SA	16 Jun 14
A.D. Coulter, G.D. Cowey, M. Essling	AWRI roadshow workshop – Adapting to difficult vintages	Murgon, Qld	17 Jun 14
M.G. Holdstock, F. Blefari	AWRI wine assessment tasting	Barossa Valley, SA	17-18 Jun 14
M.P. Krstic	Soils, soil management, climate and vineyard technology	Beechworth, Vic	18 Jun 14
A.D. Coulter, G.D. Cowey, M. Essling	AWRI roadshow workshop – Adapting to difficult vintages	Stanthorpe, Qld	19 Jun 14
M.P. Krstic	Season round-up and grapevine bunch potential workshop	Mornington Peninsula, Vic	20 Jun 14
P.W. Godden	A review of the AWRI/TIA Tasmania node's work on Pinot Noir	Relbia, Tas	24-25 Jun 14
T.J. Abbott, S. Connew	Refrigeration workshop	Hunter Valley, NSW	25 Jun 14
T.J. Abbott, P.W. Godden	Refrigeration efficiency and ferment simulation workshop	Mornington Peninsula, Vic	26 Jun 14
P.W. Godden, W.P. Pearson R.A. Muhlack[2]	Refrigeration efficiency and improved winemaking practices workshop	Orange, NSW	30 Jun 14

Affiliations: [1]Wine TQ, [2]University of Adelaide

Appendix 3 – Posters

Staff	Title of poster	Presented at	Date
N.D.R. Lloyd, J.C. Hack, M.R. Solomon, V. Hysenaj[1], T. Parker, M.J. Herderich	Targeted and non-targeted analysis of grape and wine metabolites	15th Australian Wine Industry Technical Conference, Sydney, NSW	13-18 Jul 13
E. Wilkes, T.T.M.T. Tran	A review of CMCs – carboxymethylcellulose as a cold stabilisation aid		
K.A. Bindon, R.F. Guerrero, P.A. Smith	Fibres from processing wastes as novel fining agents for wine tannin		
A. Contreras, C.D. Curtin, C.A. Varela, P.J. Chambers, P.A. Henschke, C. Hidalgo[2]	Can non-conventional yeast be used for the production of wines with lower alcohol concentration?		
S.A. Schmidt, J. Li[3], R. Kolouchova, A.R. Borneman, P.A. Henschke, P.J. Chambers	Understanding the genetic basis of tolerance and sensitivity to low pH in wine yeast		
J.R. Bellon, D.L. Capone, B.L. Dunn[4], P.J. Chambers	Introducing a new breed of wine yeast: interspecific hybrids between *Saccharomyces cerevisiae* and *Saccharomyces mikatae*		
C.A. Varela, S.A. Schmidt, A.R. Borneman, P.J. Chambers	Systems biology: a new approach to industrial yeast strain development		
C.D. Curtin, A.G. Cordente, G. Cordero-Bueso[5], I.S. Pretorius[6]	Novel wine yeasts with mutations in the regulatory gene YAP1 that produce less volatile acidity during fermentation		
C.D. Curtin, A. Ortiz-Julien[7], M. Mercurio, S. Odell	Effects of organic and inorganic nutrition on yeast – a metabolomic study of Chardonnay fermentation		
R.A. Muhlack, N. Scrimgeour, P.W. Godden	Automating fermentation control with computer simulation		
P.J. Costello, E.J. Bartowsky, I.L. Francis, S. Krieger-Weber[8]	Influence of malolactic fermentation on red wine fruity properties		

Staff	Title of poster	Presented at	Date
J.M. McCarthy, E.J. Bartowsky	The AWRI wine microorganism culture collection – a valuable resource for the Australian wine industry	15th Australian Wine Industry Technical Conference, Sydney, NSW	13-18 Jul 13
A.R. Borneman, J.M. McCarthy, E.J. Bartowsky, P.J. Chambers	The *Oenococcus oeni* genome is more diverse than originally thought – what does this mean for the development of improved MLF bacteria?		
C.D. Curtin, A.R. Borneman, P.J. Chambers, I.S. Pretorius[6]	Characterisation of intra-specific genomic diversity in industrial yeasts by whole-genome sequencing		
C.E. Abrahamse, E.J. Bartowsky	Development of a micro-scale microbiological screen for compatibility of yeast and bacterial strains in MLF		
A. Moncalvo[9], C.E. Abrahamse, E.J. Bartowsky	Screening of Australian *Lactobacillus* strains for wine stress tolerance and MLF performance		
S.A. Schmidt, R. Kolouchova, P.A. Henschke, P.J. Chambers	Management of fermentation performance in low pH juices – can fermentation nutrient additives help?		
P.A. Henschke, M. Ugliano[10], B. Fedrizzi[11], S.A. Schmidt, T.E. Siebert, R. Kalouchova, P.J. Chambers, G. Versini[12], I.L. Francis	DAP – a powerful wine aroma and style tool: case study with Shiraz		
P.A. Henschke, C.A. Varela, S.A. Schmidt, D. Torrea[13], M. Vilanova[14], T.E. Siebert, R. Kalouchova, M. Ugliano[10], C. Ancin-Azpilicueta[15], C.D. Curtin, P.J. Chambers, I.L. Francis	DAP – a powerful wine aroma and style tool: case studies with Albariño and Chardonnay		
K. Wilkinson[16], A. Prida[17], Y. Hayasaka	Evolution of oak lactone from glycoconjugate precursors during toasting and maturation		
K. Wilkinson[16], S. Li[16], A. Crump[16], P.Grbin[16], P. Warren[18], Y. Hayasaka	What is the flavour potential of oak battens made from old barrels?		
E. Wilkes, E.M.C. Robinson, N. Scrimgeour, M.E. Smith, P.A. Smith, M.Z. Viviers	The impacts of copper and iron on the reductive characteristics of a bottled Chardonnay		
E. Wilkes, W.U. Cynkar, N. Scrimgeour, P.W. Godden	The impacts of oak chip and dust additions during red wine fermentation on colour and phenolic profile		
G.A. Logan[19], T.E. Siebert, M.R. Solomon[2], P.A. Kilmartin[19]	Clonal impacts on rotundone concentration throughout ripening in New Zealand *Vitis vinifera* L. Syrah		
S.A. Schmidt, M.P. Day, R. Kolouchova, P.A. Smith, P.A. Henschke	Manipulation of wine volatile aroma profiles in white wine through the use of oxygen during grape processing and fermentation		
D.L. Capone, S. Anderson, M.A. Sefton[16], D.W. Jeffery[16], I.L. Francis	Origin and effects of matter other than grapes (MOG) on eucalyptol concentration in red wine		
M.Z. Viviers, M.E. Smith, E. Wilkes, P.A. Smith	The effects of metals on the evolution of volatile sulfur compounds during wine maturation		
C.M. Mayr, T. Parker, G.A. Baldock, C.A. Black, K.H. Pardon, P.O. Williamson, M.J. Herderich, I.L. Francis	Flavour and aftertaste of smoke affected wines: the role of glycoside precursors		
H.E. Holt, W.P. Pearson, I.L. Francis, D. Blackmore[20], P. Clingeleffer[20], R. Walker[20]	The effect of grapevine rootstock on the sensory properties of Chardonnay and Shiraz		
H.E. Holt, P.O. Williamson, W.P. Pearson, P. Deneulin[21], A. Corsi[22], I.L. Francis	Descriptive analysis and napping: understanding wine style using traditional and rapid methods		
N. Scrimgeour, A. Seabrook[23]	Monitoring the impact of pectolytic enzymes on autolysis characters in sparkling wine during bottle ageing		
K.A.Bindon, C.A. Varela, H.E. Holt, P.O. Williamson, J.A. Kennedy[24], I.L. Francis, M.J. Herderich	From grape to consumer: relationships between grape maturity, wine composition and wine sensory properties in Cabernet Sauvignon		
R. Gawel, H.E. Holt, E.J. Waters[25], P.A. Smith	The effect of polysaccharides, phenolics, pH and alcohol on the mouth-feel and flavour of white wine		
L.M. Bevin, A.D. Lord, M.L. Downie	Online information from the Australian Wine Research Institute		
	Library and information services for the Australian grape and wine industry		
C.D. Curtin, A.R. Borneman, P.J. Chambers	Comparative genomics of the spoilage yeast *Dekkera* (*Brettanomyces*) *bruxellensis*		

Staff	Title of poster	Presented at	Date
G. Hill[26], K. Evans[27], R. Beresford[26], R.G. Dambergs	Comparison of methods for quantification of *Botrytis* bunch rot in white wine grape varieties	15th Australian Wine Industry Technical Conference, Sydney, NSW	13-18 Jul 13
A.M. Sparrow[28], R.G. Dambergs, D.C. Close[28]	Cutting edge Pinot – reducing skin particle size early in fermentation is the key		
	Wine quality vs seediness: differential extraction of skin and seed tannins may optimise Pinot Noir wine quality		
	Waste not, want not: winery waste can be recycled to improve wine quality		
	Ever reliable Chardonnay? Co-fermentation of Pinot Noir must with Chardonnay pomace compromises colour stability		
A.L. Carew[28], N.D.R. Lloyd, D.C. Close[28], R.G. Dambergs	Microwave maceration of Pinot Noir: phenolically equivalent, aromatically distinct		
R.I. Chittenden[28], R.G. Dambergs	Shining the light on wine shows – rapid spectral wine analysis linked with show performance		
A.L. Carew[28], S. Connew, D.C. Close[28], R.G. Dambergs	Microwave maceration for control of laccase and enhanced phenolic outcomes in Shiraz wine		
A.L. Carew[28], D.C. Close[28], R.G. Dambergs	Microwave maceration for finished Pinot Noir wine in 37 days		
J. Magyar[29], G. Mihaley[30], P. Moraghan[31], R. McIntyre[32], R. Nadeson[33], R.G. Dambergs	The influence of delayed malolactic fermentation on Pinot Noir phenolic profiles		
R.G. Dambergs, N. Glaetzer[34], J.R. Bellon, N. Scrimgeour, P.W. Godden	Manipulation of Pinot Noir colour and tannin profiles during maceration		
J.M. McRae, A. Schulkin, S. Kassara, H.E. Holt, P.A. Smith	Sensory properties of wine tannin fractions: implications for in-mouth sensory properties		
F.L. Kerslake[28], R.G. Dambergs, D.C. Close[28]	An objective measure of sparkling wine quality?		
F.L. Kerslake[28], J.E. Jones[28], R.G. Dambergs, D.C. Close[28]	Should we crop high or low for Pinot Noir sparkling base wines?		
F.L. Kerslake[28], J.E. Jones[28], D.C. Close[28], R.G. Dambergs	Does removing leaves improve sparkling base wine composition or does it just make us feel better?		
R.G. Dambergs	In-bottle analysis of sparkling wine tirage fermentation and maturation		
S. Andrews[28], J.E. Jones[28], R.G. Dambergs, D.C. Close[28], F.L. Kerslake[28]	Does cluster thinning improve Pinot Noir quality or just thin your profit?		
A. Zerihun[35], D.W. Jeffery[16], D.L. Capone, I.L. Francis, M. Gibberd[35], H.E. Holt, B. Bramley	Influences of vine clone, yeast strain and canopy density on volatile thiols, their potential precursors and sensory attributes of Sauvignon Blanc wines		
S. Connew, N. Scrimgeour, R.G. Dambergs, A. Thomas[36], J. Chatto[37], E. Riley[38]	The Hunter Valley Semillon project: links between soil type and phenolics		
T.E. Siebert, S.R. Barter	Faster and better measurement of the potent flavour compound rotundone in grapes and wine		
M. Marangon, P.A. Smith	What is the latest in the mechanism of protein haze formation in white wines?		
M. Marangon, S.C. Van Sluyter[39], E.M.C. Robinson, N. Scrimgeour, R.A. Muhlack, H.E. Holt, E.J. Waters[25], P.W. Godden, P.A. Smith	Proctase – a viable alternative to bentonite for protein stabilisation of white wines		
N. Scrimgeour, C.M. Kidman[40]	The impact of vintage, environmental and viticultural factors on grape and wine composition		
M.P. Day, M.Z. Viviers, S. Kassara, P.A. Smith	Post-bottling effects of early oxygen exposure during red winemaking		
S.A. Schmidt, A.R. Borneman, J. Chu[41], P.J. Chambers, P.R. Dry, H.E. Holt, J.C. Hack, N. Dry[23], M.G. McCarthy[42] H.J.J. van Vuuren[43], J. Bohlmann[44], S.J.M. Jones[45], S. Turner[43], I.S. Pretorius[6], D.L. Johnson	Chardonnay clonal variation – a comparative genomic and phenotypic evaluation		
P. Zhang[46], N. Scarlett[47], D. Sheehan[48], S. Barlow[46], M.P. Krstic, M.J. Herderich, K. Howell[46]	Intrabunch variability of rotundone concentration in *Vitis vinifera* cv. Shiraz wine grapes at harvest		

Staff	Title of poster	Presented at	Date
Y. Hayasaka, T. Parker, G.A. Baldock, K.H. Pardon, C.A. Black, M.J. Herderich	Seeing through smoke: assessing the impact of smoke exposure in grapes and the resulting wine	15th Australian Wine Industry Technical Conference, Sydney, NSW	13-18 Jul 13
E. Pojer[49], F. Mattivi[49], D.L. Johnson, C.S. Stockley	Solving the puzzle of grapevine metabolome via complementary analytical techniques on many genotypes	WineHealth 2013, Sydney, NSW	18-20 Jul 13
K.A. Bindon, C.A. Varela, H.E. Holt, P.O. Williamson, I.L. Francis, J. Kennedy[24], M.J. Herderich	From grape to consumer: relationships between grape maturity, wine composition and wine sensory properties in Cabernet Sauvignon	Pangborn, Rio de Janeiro, Brazil	11-15 Aug 13

Affiliations: [1]University of Genova, Italy, [2]Universitat Rovira i Virgili, Spain, [3]China Agricultural University, [4]Stanford University, USA, [5]Madrid Institute for Rural Development, Agriculture and Food Research (IMIDRA), Spain, [6]University of South Australia, [7]Lallemand, France, [8]Lallemand, Germany, [9]Institute of Oenology and Food Engineering, Italy, [10]Nomacorc SA, Domaine de Donadille, France, [11]Italiana Vini Soc. Coop., Italy, [12]Formerly: Italiana Vini Soc. Coop., Italy, [13]Formerly: Universidad Pública de Navarra, Spain, [14]Misión Biológica de Galicia (CSIC), Spain, [15]Universidad Pública de Navarra, Spain, [16]University of Adelaide, [17]Seguin Moreau, France, [18]Ausvat Pty Ltd, [19]The University of Auckland, New Zealand, [20]CSIRO Plant Industry, [21]Ecole d'Ingénieurs de Changins, Switzerland, [22]Ehrenberg-Bass Institute for Marketing Science, [23]Yalumba, [24]California State University – Fresno, USA, [25]Grape and Wine Research and Development Corporation, [26]The New Zealand Institute for Plant and Food Research Limited, [27]Tasmanian Institute of Agriculture, [28]Eastern Institute of Technology, New Zealand, [29]Ten Minutes by Tractor, [30]Paradigm Hill, [31]Curly Flat, [32]Moorooduc Estate, [33]Lethbridge Wines, [34]Glaetzer-Dixon Wines, [35]Curtin University, [36]Thomas Wines, [37]Peppertree Wines, [38]Vitibit Pty Ltd, [39]Macquarie University, [40]Wynns Coonawarra Estate, [41]Genome Sciences Centre British Columbia, Canada, [42]SARDI, [43]University of British Columbia, Canada, [44]Michael Smith Laboratories, Canada, [45]Michael Smith Genome Sciences Centre, Canada, [46]Department of Agriculture and Food Systems, University of Melbourne, [47]Rathbone Wine Group, [48]Mt Langi Ghiran, [49]Research and Innovation Centre, Fondazione Edmund Mach, Italy

Appendix 4 – Teaching responsibilities (lectures) of AWRI staff

Institution	Subject number	Subject name	No of lectures	Staff member
University of Adelaide	3046WT/7046WT	Fermentation technology	2	I.L. Francis
			4	P.A. Henschke
	3520WT/7520WT	Advances in wine science	3	E.J. Bartowsky
			2	P.A. Henschke
	3520WT	Advances in wine science	1	C.A. Simos
	3007WT	Stabilisation and clarification	2	J.M. McRae
	3047WT	Winemaking at vintage	1	M.P. Day
	3005WT	Grape industry practice, policy and communications	1	C.S. Stockley
	3016WT	Cellar and winery waste management III	1	S. Nordestgaard
	7010WT	Stabilisation and clarification	1	R. Gawel
	3005WT	Grape industry practice, policy and communications	1	I.L. Francis
	3500WT	Biotechnology in the food and wine industries III	2	P.J. Chambers
	GENETICS 3210	Advanced Molecular Biology IIIB	1	A.R. Borneman
University of Melbourne	AGRI90043	Advanced Viticulture Techniques	1	M.P. Krstic
University of Queensland	MICR3003	Molecular Microbiology	1	A.R. Borneman

Appendix 5 – Student supervision responsibilities of AWRI staff

Student	Supervisors	Source of funds
PhD		
Jenny Bellon	P.J. Chambers, A.R. Borneman, C. Ford[1]	University of Adelaide
Catherine Cox Kidman	C. Collins[1], P.R. Dry, M. McCarthy[2]	
Patricia Williamson	I.L. Francis, L. Lockshin[3], S. Mueller-Loose[4]	GWRDC
Tracey Siebert	I.L. Francis, M.J. Herderich, M. De Barros Lopes[3]	
Ryan Zeppel	A.R. Borneman, C.D. Curtin, J. Kelly[1]	
Anna Carew	R.G. Dambergs, C.D. Curtin, D. Close[5]	University of Tasmania
Pangzhen Zhang	M.J. Herderich, M.P. Krstic, S. Barlow[6], S. Fuentes[6], K.S. Howell[6]	University of Melbourne
Hons		
Ryan Zeppel	A.R. Borneman, C.D. Curtin, J. Kelly[1]	GWRDC

Affiliations: [1]University of Adelaide, [2]SARDI, [3]University of South Australia, [4]University of Aarhus, Denmark, [5]University of Tasmania, [6]University of Melbourne

Appendix 6 – Media interviews

Date	Staff member	Discussed	Media
18 Jul 13	C.S. Stockley	Key messages of WineHealth 2013	Murray Wilton, *2UE radio*
24 Jul 13			Beau Pearson, Rural Report and local radio news, *ABC South West*
25 Jul 13			Andrew Mole, *Australian & New Zealand Grapegrower & Winemaker*
6 Aug 13	T.E. Siebert	'Apricot'/'stone fruit' flavours in white wines	Jen Barwick, *GWRDC R&D@Work*
27 Aug 13	M.G. Holdstock	Identifying crystals in wine	Rebecca Gibb, *Wine-Searcher*
12 Sep 13	E.J. Bartowsky	*Oenococcus oeni* sequencing project	Dennis Rutzou and Anna Caswell, *Dennis Rutzou Public Relations*
4 Nov 13	M.J. Herderich	Wine science and wine flavour	*ABC 639 North and West Mornings program*
13 Nov 13	P.W. Godden	Damage to screwcap bottles	Matthew Doran, *ABC News*
27 Nov 13	C.S. Stockley	Changes to Australian alcohol drinking guidelines and related strategies	Arnaud Terrisson, *Vin et Societe*
28 Nov 13	I.L. Francis	Palate fatigue	Rebecca Gibb, *Wine-Searcher*
6 Dec 13	C.S. Stockley	Changes to health and nutrition labelling in Australia for wine	Jen Barwick, *GWRDC Grape & Wine news*
11 Dec 13	S. Nordestgaard	Bulk wine transport trials	Jen Barwick, *GWRDC R&D@work*
3 Jan 14	I.L. Francis, W.P. Pearson	Sensory analysis at the AWRI	Andrew Mole, *Australian & New Zealand Grapegrower and Winemaker*
10 Jan 14	V.T. O'Brien	HALO project in McLaren Vale	Clint Jasper, *ABC Rural*
15 Jan 14	A.D. Coulter	Smoke taint	Laura Poole, *ABC Country Hour*
22 Jan 14	C.A. Varela	Sequential inoculation/low alcohol	Rebecca Gibb, *Wine-Searcher*
23 Jan 14	P.W. Godden	Research on stone fruit and tropical characters in Chardonnay in Tasmania and AWRI nodes	Damian McIver, *ABC News Tasmania*
5 Feb 14	K.A. Bindon, C.A. Varela, P.O. Williamson	Low alcohol research – including maturity trial, sequential inoculation and consumer surveys	David Sibenaler, *The Advertiser*
10 Feb 14	D.L. Johnson	The AWRI's RD&E plan	*ABC Radio*
14 Feb 14	K.A. Bindon	Maturity trial	Rebecca Gibb, *Wine-Searcher*

Date	Staff member	Discussed	Media
14 Feb 14	S. Nordestgaard	Removing lees from beneath wine	Jen Barwick, *GWRDC Grape & Wine news*
20 Feb 14	C.A. Varela	Sequential inoculation/low alcohol	Lily Barback, *Laboratory Equipment Magazine*
21 Feb 14	M.J. Herderich	Wine flavour	Andrew Masterson, *Cosmos Magazine*
26 Feb 14	C.A. Varela	Sequential inoculation/low alcohol	Kasey Carpenter, *Wine Spectator*
27 Feb 14			Jennifer Frazer, *Scientific American*
7 Mar 14	N. Scrimgeour	Sparkling wine closure trial	Matthew Doran, *ABC News*
21 Mar 14	C.S. Stockley	Wine in moderation	Max Allen, *The Australian*
25 Mar 14	D.L. Johnson	Research and development in the grape and wine sector	Jill Fraser, *Westpac Produce Magazine*
14 Apr 14	M.P. Krstic	Smoke taint in wine	James Bennett, *ABC*
16 Apr 14	T.E. Siebert	Apricot/stone fruit flavour in white wines	Jen Barwick, *GWRDC R&D@Work*
7 May 14	M.L. Longbottom	'Researcher profile' series. Climate change mitigation, adaptation and environmental sustainability	Harvest radio on *Radio Adelaide*
8 May 14	P.R. Dry	Why does deficit irrigation improve wine quality? The benefits of improved clones and new varieties	*ABC Rural Radio*, Renmark, SA
12 May 14	E.J. Bartowsky	The AWRI wine microorganism culture collection	Matthew Doran, *ABC News*
16 May 14			Tracey Holmes, *ABC News Radio*
19 May 14			Carole Duncan, *ABC Newcastle*
22 May 14	E. Wilkes	Manganese levels in wine	Matthew Doran, *ABC News*
26 May 14	D.L. Johnson	Scientists to create world's first synthetic complex life form	Chris Uhlmann, *ABC Radio, AM*
5 Jun 14	J.M. McRae	Tannin and protein research at the AWRI including work at the Australian Synchrotron	Nick Carne, *GWRDC R&D@Work*
14 Jun 14	P.W. Godden	The achievements of the AWRI/TIA Tasmania node	Rosemary Grant, *ABC Radio Tasmania*
18 Jun 14	C.S. Stockley	Nutritional differences between white and red wines	Louise Fulton Keats, *Taste.com.au*
27 Jun 14	I.L. Francis	Pepper flavour results presented at the Victorian Shiraz Symposium	Jen Barwick, *GWRDC Grape & Wine news*

Appendix 7 – Papers published by AWRI staff recorded during 2013/2014

1542 Holt, H., Cozzolino, D., McCarthy, J., Abrahamse, C., Holt, S., Solomon, M., Smith, P., Chambers, P.J., Curtin, C. Influence of yeast strain on Shiraz wine quality indicators. *Int. J. Food Microbiol.*165(2): 302-311; 2013.

1543 Stockley, C. Australia to host international wine and health conference in 2013. *Aust. N.Z. Grapegrower Winemaker* (594): 6; 2013.

1544 Cowey, G., Essling, M. Adapting to difficult vintages. *Aust. N.Z. Grapegrower Winemaker* (594): 26; 2013.

1545 Essling, M. Ask the AWRI: Vary strategies for successful weed management. *Aust. N.Z. Grapegrower Winemaker* (594): 36; 2013.

1546 Hoxey, L., Stockley, C., Wilkes, E., Johnson, D. What's in a label? *Wine Vitic. J.* 28(4): 38-41; 2013.

1547 Pretorius, I. Beyond change. *WBM* (June): 30-31; 2010.

1548 Cordente, A.G., Curtin, C.D., Varela, C., Pretorius, I.S., Flavour-active wine yeasts. *Appl. Microbiol. Biotechnol.* 96(3): 601-618; 2012.

1549 Ristic, R., Pinchbeck, K.A., Fudge, A.L., Hayasaka, Y., Wilkinson, K.L. Effect of leaf removal and grapevine smoke exposure on colour, chemical composition and sensory properties of Chardonnay wines. *Aust. J. Grape Wine Res.* 19(2): 230-237; 2013.

1550 Curtin, C.D., Langhans, G., Henschke, P.A., Grbin, P.R. Impact of Australian *Dekkera bruxellensis* strains grown under oxygen-limited conditions on model wine composition and aroma. *Food Microbiol.* 36(2): 241-247; 2013.

1551 Dry, P., Longbottom, M., Essling, M. Is there a need for improved vineyard assessment for fruit grading? *Wines Vines* 94(7): 52-55; 2013.

1552 Gawel, R., Van Sluyter, S.C., Smith, P.A., Waters, E.J. The effect of pH and alcohol on perception of phenolic character in white wine. *Am. J. Enol. Vitic.* 64(4): 425-429, 2013.

1553 Dry, P. Marzemino. *Wine Vitic. J.* 28(4): 63; 2013.

1554 Holdstock, M. Ask the AWRI: Snapshot of oak-related queries. *Aust. N.Z. Grapegrower Winemaker* (595): 68; 2013.

1555 Leske, P.A., Francis, I.L., Hunt, D. Sensory Evaluation. Bulleid, N., Jiranek, V. (eds) *Australian Winemaking.* Adelaide: Trivinum Press; 2013. www.trivinumpress.com.au/SEN

1556 Bartowksy, E.J., Fleet, G.H. Malolactic Fermentation. Bulleid, N., Jiranek, V. (eds) *Australian Winemaking.* Adelaide: Trivinum Press; 2013. www.trivinumpress.com.au/MLF

1557 Fudge, A.L., Wilkinson, K.L., Ristic. R., Cozzolino, D. Synchronous two-dimensional MIR correlation spectroscopy (2D-COS) as a novel method for screening smoke tainted wine. *Food Chem.*139: 115-119; 2013.

1558 Cozzolino, D., Cynkar, W.U., Dambergs, R.G., Shah, N., Smith, P. *In situ* measurement of soil chemical composition by near-infrared spectroscopy: a tool toward sustainable vineyard management. *Comm. Soil Sci. Plant Anal.* 44(10): 1610-1619; 2013.

1559 Muhlack, R. It's time to power up. *WBM* (August): 39-41; 2013.

1560 Dry, P. Ask the AWRI: Vines: Is an oldie necessarily a goodie? *Aust. N.Z. Grapegrower Winemaker* (596): 57; 2013.

1561 Varela, C., Chambers, P., Johnson, D. Trials turn up new strategies for softening the kick in wine. *Aust. N.Z. Grapegrower Winemaker* (596): 70-73; 2013.

1562 Carew, A.L., Smith, P., Close, D.C., Curtin, C., Dambergs, R.G. Yeast effects on Pinot noir wine phenolics, color, and tannin composition. *J. Agric. Food Chem.* 61(41): 9892-9898; 2013.

1563 Van Sluyter, S.C., Warnock, N.I., Schmidt, S., Anderson, P., van Kan, J.A.L., Bacic, A., Waters, E.J. Aspartic acid protease from *Botrytis cinerea* removes haze-formation proteins during white winemaking. *J. Agric. Food Chem.* 61(40): 9705-9711; 2013.

1564 Pojer, E., Mattivi, F., Johnson, D., Stockley, C.S. The case for anthocyanin consumption to promote human health: A review. *Comp. Rev. Food Sci. Food Safety* 12(5): 483-508; 2013.

1565 Stockley, C. Key messages from WineHealth 2013 – International Wine and Health Conference. *Wine Vitic. J.* 28(5): 16-18; 2013.

1566 Borneman, A., Herderich, M., Johnson, D. The DNA of innovation. *Wine Vitic. J.* 28(5): 52-56; 2013.

1567 Dry, P. Tinto cão. *Wine Vitic. J.* 28(5): 77; 2013.

1568 Kidman, C.M., Dry, P.R., McCarthy, M.G., Collins, C. Reproductive performance of Cabernet Sauvignon and Merlot (*Vitis vinifera* L.) is affected when grafted to rootstocks. *Aust. J. Grape Wine Res.* 19(3): 409-421; 2013.

1569 Mangoni, A.A., Stockley, C.S., Woodman, R.J. Effects of red wine on established markers of arterial structure and function in human studies: current knowledge and future research directions. *Expert Rev. Clin. Pharmacol.* 6(6): 613-625; 2013.

1570 Coulter, A. Ask the AWRI: Understanding the ABCs of CMCs in stabilisation. *Aust. N.Z. Grapegrower Winemaker* (598): 72; 2013.

1571 McRae, J.M., Kassara, S., Kennedy, J.A., Waters, E.J., Smith, P.A. Effect of wine pH and bottle closure on tannins. *J. Agric. Food Chem.* 61(47): 11618–11627; 2013.

1572 Kidman, C.M., Mantilla, S.O., Dry, P.R., McCarthy, M.G., Collins, C. The effect of water stress on the reproductive performance of Shiraz (*Vitis Vinifera* L.) grafted to rootstocks. *Am. J. Enol. Vitic.* 65(1): 96-108; 2014.

1573 Jolly, N.P., Varela, C., Pretorius, I.S. Not your ordinary yeast: non-*Saccharomyces* yeasts in wine production uncovered. *FEMS Yeast Res.* 14(2): 215-237; 2014.

1574 Longbottom, M. Greenhouse gas abatement in viticulture. *Aust. N.Z. Grapegrower Winemaker* (598): 35-38; 2013.

1575 Muhlack, R., Scrimgeour, N., Wilkes, E., Godden, P., Johnson, D. Optimising fermentation through simulation. *Wine Vitic. J.* 28(6): 38, 40-43; 2013.

1576 Dry, P. Schönburger. *Wine Vitic. J.* 28(6): 58; 2013.

1577 Viviers, M.Z., Smith, M.E., Wilkes, E., Smith, P. Effects of five metals on the evolution of Hydrogen Sulfide, Methanethiol, and Dimethyl Sulfide during anaerobic storage of Chardonnay and Shiraz wines. *J. Agric. Food Chem.* 61(50):12385-12396; 2013.

1578 Johnson, D. Fascinating story to tell. *Aust. N.Z. Grapegrower Winemaker* (599): 30; 2013.

1579 Dry, P. If the grape fits then you can grow it. *Aust. N.Z. Grapegrower Winemaker* (599): 57; 2013.

1580 Muhlack, R., Forsyth, K., Scrimgeour, N., Godden, P. There's gotta be a buck in those organic by-products. *Aust. N.Z. Grapegrower Winemaker* (599): 80-82; 2013.

1581 Johnson, D. 2013 AWRI Report: Planning for the future. *Aust. N.Z. Grapegrower Winemaker* (598): 81-84; 2013.

1582 Tran, T., Wilkes, E. How does CMC behave in NZ wines? *N.Z. Winegrower* (83): 67-69; 2013.

1583 Contreras, A., Hidalgo, C., Henschke, P.A., Chambers, P.J., Curtin, C., Varela, C. Evaluation of non-*Saccharomyces* yeast for the reduction of alcohol content in wine. *Appl. Environ. Microbiol.* 80(5): 1670-1678; 2014.

1584 Viviers, M.Z., Smith, M.E., Wilkes, E., Smith, P.A. Effects of metals on the evolution of volatile sulfur compounds in wine during bottle storage. *Aust. N.Z. Grapegrower Winemaker* (600): 49-51; 2014.

1585 Wilkes, E. You've got to be a hot shot to hit the moving target of cold stability. *Aust. N.Z. Grapegrower Winemaker* (600): 43-46; 2014.

1586 Cowey, G. Ask the AWRI: Top tips for a successful yeast culture. *Aust. N.Z. Grapegrower Winemaker* (600): 42; 2014.

1587 Bindon, K.A., Madani, S.H., Pendleton, P., Smith, P.A., Kennedy, J.A. Factors affecting skin tannin extractability in ripening grapes. *J. Agric. Food Chem.* 62(5): 1130-1141; 2014.

1588 Dry, P. Malvasia istriana. *Wine Vitic. J.* 29(1): 53; 2014.

1589 Viviers, M., Smith, M., Wilkes, E., Smith, P., Johnson, D. The role of trace metals in wine 'reduction'. *Wine Vitic. J.* 29(1): 38-40; 2014.

1590 Francis, L. Des études multidisciplinaires à l'Australian Wine Research Institute. *Rev. Oenol.* (149 Supp.): 9; 2013.

1591 Geffroy, O., Dufourcq, T. Carcenac, D., Siebert, T., Herderich, M. Nouvelles acquisitions sur le caractère poivré. Des vins rouges de Duras de l'AOP Gaillac. *Rev. Oenol.* (149 Supp.): 49-51; 2013.

1592 Bartowsky, E., Costello, P., Krieger-Weber, S., Silvano, A., Dumont, A., Francis, L., Travis, B. Au-delà de la fermentation malolactique. Évaluation et caracterisation de l'impact sensorial des bactéries oenologiques sur le caractère fruité des vins rouges. *Rev. Oenol.* (149 Supp.): 61-65; 2013.

1593 Essling, M. Ask the AWRI: Canopy damage from herbicides. *Aust. N.Z. Grapegrower Winemaker* (601): 32; 2014.

1594 Dry, P. Terroir and the topic of wine typicity. *Aust. N.Z. Grapegrower Winemaker* (601): 40; 2014.

1595 McRae, J., Smith, P. Seal the deal on pH, red wine colour and tannin during bottle ageing. *Aust. N.Z. Grapegrower Winemaker* (601): 51-54; 2014.

1596 Gawel, R., Schulkin, A., Smith, P.A., Waters, E.J. Taste and textural characters of mixtures of caftaric acid and Grape Reaction Product in model wine. *Aust. J. Grape Wine Res.* 20(1): 25-30; 2014.

1597 Mayr, C.M., Parker, M., Baldock, G.A., Black, C.A., Pardon, K.H., Williamson, P.O., Herderich, M.J., Francis, I.L. Determination of the importance of in-mouth release of volatile phenol glycoconjugates to the flavor of smoke-tainted wines. *J. Agric. Food Chem.* 62(11): 2327-2336; 2014.

1598 Scrimgeour, N., Wilkes, E. Closure trials show volatile sulfur compound formation can still cause a stink. *Aust. N.Z. Grapegrower Winemaker* (602): 62, 64-67; 2014.

1599 Coulter, A. Ask the AWRI: Can 'Brett' affect white wines? *Aust. N.Z. Grapegrower Winemaker* (602): 54; 2014.

1600 Dry, P. Souzao. *Wine Vitic. J.* 28(2): 60; 2014.

1601 Krstic, M., Barlow, S. Vintage 2030 and beyond: Producing quality wines in warmer times. *Wine Vitic. J.* 28(2): 52-57; 2014.

1602 Smith, P., Bindon, K., McRae, J., Kassara, S., Johnson, D. Tannin: impacts and opportunities along the value chain. *Wine Vitic. J.* 28(2): 38-41; 2014.

1603 Cordente, A.G., Cordero-Bueso, G., Pretorius, I.S., Curtin, C.D. Novel wine yeast with mutations in YAP1 that produce less acetic acid during fermentation. *Fems Yeast Res.* 13(1): 62-73; 2014.

1604 Uberti, F., Danzi, R., Stockley, C., Peñas, E. Ballabio, C., Di Lorenzo, C., Tarantino, C., Restani, P. Immunochemical investigation of allergenic residues in experimental and commercially-available wines fined with egg white proteins. *Food Chem.* 159: 343-352; 2014.

1605 Capone, D.L., Herderich, M.J., Pardon, K.H., Hayasaka, Y., Cordente, A.G., Grant-Preece, P.A., Sefton, M.A., Elsey, G.M., Jeffery, D.W. Formation of varietal thiol aroma compounds in wine: Synthetic and analytical studies of grape and wine thiol conjugates. Hofmann, T., Meyerhof, W., Schieberle, P. (eds) *Advances and Challenges in Flavor Chemistry and Biology: Proceedings of 9th Wartburg Symposium on Flavour Chemistry and Biology*, Eisnach, Germany. Freising, Germany: Deutsche Forschungsanstalt für Lebensmittelchemie: 242-248; 2011.

1606 Mateo, E., Torija, M.J., Mas, A., Bartowsky, E.J. Acetic acid bacteria isolated from grapes of South Australian vineyards. *Int. J. Food Microbiol.* 178: 98-106; 2014.

1607 Song, J., Smart, R.E., Dambergs, R.G., Sparrow, A.M., Wells, R.B., Wang, H., Qian, M.C. Pinot Noir wine composition from different vine vigour zones classified by remote imaging technology. *Food Chem.* 153: 52-59; 2014.

1608 Taylor, A., Day, M.P., Hill, S., Marshall, J., Patriarca, M., White, M. Atomic spectrometry update: Review of advances in the analysis of clinical and biological materials, foods and beverages. *J. Anal. At. Spectrom.* 29(3): 386-426; 2014.

1609 Borneman, A.R., Zeppel, R., Chambers, P.J., Curtin, C.D. Insights into the *Dekkera bruxellensis* genomic landscape: Comparative genomics reveals variations in ploidy and nutrient utilisation potential amongst wine isolates. *PLoS Genetics* 10(2): e1004161; 2014.

1610 Scarlett, N.J., Bramley, R.G.V., Siebert, T.E. Within-vineyard variation in the 'pepper' compound rotundone is spatially structured and related to variation in the land underlying the vineyard. *Aust. J. Grape Wine Res.* 20(2): 214–222; 2014.

1611 Mayr, C.M., Geue, J.P., Holt, H.E., Pearson, W.P., Francis, I.L. Characterization of the key aroma compounds in Shiraz wine by quantitation, aroma reconstitution, and omission studies. *J. Agric. Food Chem.* 62(20): 4528-4536; 2014.

1612 Dry, P. Ask the AWRI: Bunches with ripe and unripe berries. *Aust. N.Z. Grapegrower Winemaker* (603): 49; 2014.

1613 Essling, M. The role of potassium in grapevine function. *Aust. N.Z. Grapegrower Winemaker* (603): 74; 2014.

1614 Contreras, A., Henschke, P., Chambers, P., Curtin, C., Varela, C. New yeast approach is aiming to produce a lower alcohol wine. *Aust. N.Z. Grapegrower Winemaker* (603): 82-83; 2014.

1615 Kutyna, D.R., Cordente, A.G., Varela, C. Genetic engineering of industrial *Saccharomyces cerevisiae* strains using a selection/counter-selection approach. Mapelli, V. (ed.) *Yeast metabolic engineering: methods and protocols.* Totowa, N.J.: Humana Press: 157-168; 2014.

1616 Bindon, K.A., Kassara, S., Cynkar, W.U., Robinson, E.M.C., Scrimgeour, N., Smith, P.A. Comparison of extraction protocols to determine differences in wine-extractable tannin and anthocyanin in *Vitis vinifera* L. cv. Shiraz and Cabernet Sauvignon grapes. *J. Agric. Food Chem.* 62(20): 4558-4576; 2014.

1617 Dry, P. Pruning systems: a short history of a long practice. *Aust. N.Z. Grapegrower Winemaker* (604): 54-55; 2014.

1618 Holdstock, M. Ask the AWRI: Here's the hot topics of vintage 2014. *Aust. N.Z. Grapegrower Winemaker* (604): 79; 2014.

1619 Viviers, M., Smith, M., Wilkes, E., Smith, P., Johnson, D. Role of trace metals in wine 'reduction'. *Wines Vines* 95(5): 86-88; 2014.

1620 Carew, A.L., Lloyd, N.D.R., Close, D.C., Dambergs, R.G. Wine phenolic and aroma outcomes from the application of Controlled Phenolic Release to Pinot Noir must. Beames, K.S., Robinson, E.M.C., Godden P.W., Johnson, D.L. (eds) *Proceedings of the 15th Australian Wine Industry Technical Conference*: Sydney, New South Wales 13-18 July 2013. Urrbrae, South Australia: The Australian Wine Industry Technical Conference Inc.: 80–84; 2014.

1621 Marangon, M., Van Sluyter, S.C., Robinson, E.M.C., Scrimgeour, N., Muhlack, R.A., Holt, H.E., Waters, E.J., Godden, P.W., Smith, P.A. Proctase – a viable alternative to bentonite for protein stabilisation of white wines. Beames, K.S., Robinson, E.M.C., Godden P.W., Johnson, D.L. (eds) *Proceedings of the 15th Australian Wine Industry Technical Conference*: Sydney, New South Wales 13-18 July 2013. Urrbrae, South Australia: The Australian Wine Industry Technical Conference Inc.: 85–89; 2014.

1622 Bindon, K.A., Varela, C.A., Holt, H.E., Williamson, P.O., Francis, I.L., Kennedy, J.A., Herderich, M.J. From grape to consumer: relationships between grape maturity, wine composition and wine sensory properties in Cabernet Sauvignon. Beames, K.S., Robinson, E.M.C., Godden P.W., Johnson, D.L. (eds) *Proceedings of the 15th Australian Wine Industry Technical Conference*: Sydney, New South Wales 13-18 July 2013. Urrbrae, South Australia: The Australian Wine Industry Technical Conference Inc.: 90–93; 2014.

1623 Contreras, A., Hidalgo, C., Henschke, P.A., Chambers, P.J., Curtin, C.D., Varela, C.A. Can non-conventional yeast be used for the production of wines with lower alcohol concentration? Beames, K.S., Robinson, E.M.C., Godden P.W., Johnson, D.L. (eds) *Proceedings of the 15th Australian Wine Industry Technical Conference*: Sydney, New South Wales 13-18 July 2013. Urrbrae, South Australia: The Australian Wine Industry Technical Conference Inc.: 94–96; 2014.

1624 Viviers, M.A., Smith, M.E., Wilkes, E., Smith, P.A. Effect of metals on the evolution of volatile sulphur compounds during wine maturation. Beames, K.S., Robinson, E.M.C., Godden P.W., Johnson, D.L. (eds) *Proceedings of the 15th Australian Wine Industry Technical Conference*: Sydney, New South Wales 13-18 July 2013. Urrbrae, South Australia: The Australian Wine Industry Technical Conference Inc.: 97–101; 2014.

1625 Muhlack, R.A., Forsyth, K.K., Scrimgeour, N., Godden, P.W. Creating value from by-products – and industry review and insights into practical case studies. Beames, K.S., Robinson, E.M.C., Godden P.W., Johnson, D.L. (eds) *Proceedings of the 15th Australian Wine Industry Technical Conference*: Sydney, New South Wales 13-18 July 2013. Urrbrae, South Australia: The Australian Wine Industry Technical Conference Inc.: 117–119; 2014.

1626 Hayman, P.T., Thomas, D.S., Longbottom, M.L., McCarthy, M.G. Predicting and preparing for heatwaves. Beames, K.S., Robinson, E.M.C., Godden P.W., Johnson, D.L. (eds) *Proceedings of the 15th Australian Wine Industry Technical Conference*: Sydney, New South Wales 13-18 July 2013. Urrbrae, South Australia: The Australian Wine Industry Technical Conference Inc.: 133–137; 2014.

1627 Borneman, A.R. Next-generation DNA sequencing and its application by the wine industry. Beames, K.S., Robinson, E.M.C., Godden P.W., Johnson, D.L. (eds) *Proceedings of the 15th Australian Wine Industry Technical Conference*: Sydney, New South Wales 13-18 July 2013. Urrbrae, South Australia: The Australian Wine Industry Technical Conference Inc.: 147–150; 2014.

1628 Curtin, C.D., Borneman, A.R., Zeppel, R., Cordente, A.G., Kievet, R., Chambers, P.J. Harnessing genomics to ensure a 'Brett'-free future for Australian wine. Beames, K.S., Robinson, E.M.C., Godden P.W., Johnson, D.L. (eds) *Proceedings of the 15th Australian Wine Industry Technical Conference*: Sydney, New South Wales 13-18 July 2013. Urrbrae, South Australia: The Australian Wine Industry Technical Conference Inc.: 158–160; 2014.

1629 Dry, P. Gamay. *Wine Vitic. J.* 29(3): 59; 2014.

1630 Gawel, R., Godden, P., Williamson, P., Francis, L., Smith, P., Waters, L., Herderich, M., Johnson, D. Influence of phenolics on white wine quality and style. *Wine Vitic. J.* 29(3): 34-36; 2014.

1631 Wilkes, E., Warner, L. Accurate mid-infrared analysis in wine production – fact or fable? *Wine Vitic. J.* 29(3): 64-67; 2014.

1632 Williamson, P.O., Loose, S.M., Lockshin, L., Francis, L. Thinking outside the bottle: information about Australia can increase the choice of Australian wines by Chinese consumers. *Wine Vitic. J.* 29(3): 71-74; 2014.

1633 Longbottom, M. Grape and wine sustainability program to launch on 1 July. *Aust. N.Z. Grapegrower Winemaker* (605): 85; 2014.

1634 Dry, P. Ask the AWRI: Can you achieve yield control in the vineyard without using bunch thinning? *Aust. N.Z. Grapegrower Winemaker* (605): 40; 2014.

1635 Bindon, K., Holt, H., Williamson, P.O., Varela, C., Herderich, M., Francis, I.L. Relationships between harvest time and wine composition in *Vitis vinifera* L. cv. Cabernet Sauvignon 2. Wine sensory properties and consumer preference. *Food Chem.* 154: 90-101; 2014.

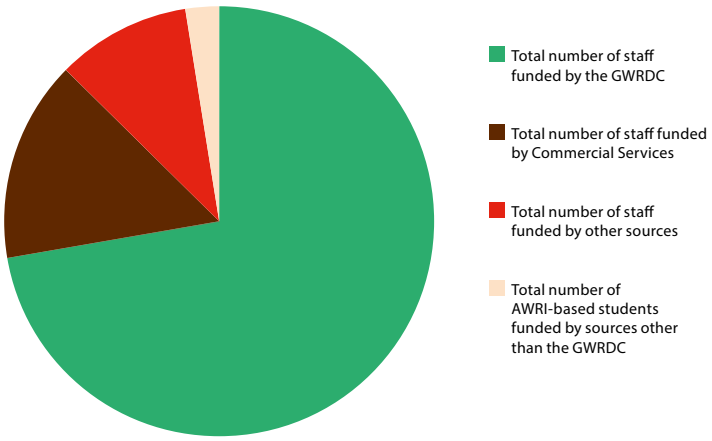


Figure 21. Funding of AWRI staff, excluding overseas students and visiting researchers.

Staff of The Australian Wine Research Institute

Front row (L to R): Kate Beames, Danna Li, Markus Herderich, Caroline Abrahamse, Dimi Capone, Alex Schulkin, Chris Day, Geoff Cowey, Con Simos, Francesca Blefari, Kerry Pinchbeck, Robyn Gleeson, Simon Schmidt, Daniel Tynan, Richard Gawel, Radka Kolouchova, Erin Kearsley, Amanda Agius, Bryan Newell, Eric Wilkes, Alfons Cuijvers, Mark Braybrook, Dan Johnson, Ella Robinson, Wies Cynkar.

Middle row (L to R): Shiralee Dodd, Virginia Phillips, Peter Godden, Martin Day, Michael Downie, Natoiya Lloyd, Jacqui McRae, Simon Nordestgaard, Ryan Zeppel, Alice Barker, Tim Reilly, Marlize Viviers, Tina Tran, Florian Sengler, Cory Black, Oliver Lovat, Kieran Hirlam, Peter Sternes, Darek Kutnya.

Back row (L to R): Deborah Thornton-Wakeford, Pam Solomon, Pauline Jorgensen, Mardi Longbottom, Nina McEwan, Agnieszka Mierczynska-Vasilev, Annette Freeman, Paul Chambers, Candice Newton, Wes Pearson, Jennifer O'Mahony, Jenny Bellon, Esther Kristianto, Yoji Hayasaka, Mark Smith, Neil Scrimgeour, Mango Parker, Anthony Borneman, Matt Holdstock, Creina Stockley, Chris Curtin, Angus Forgan, Mark Solomon.

Absent: Tadro Abbott, Melissa Aitchison, Gayle Baldock, Sheridan Barter, Eveline Bartowsky, Linda Bevin, Keren Bindon, Catherine Borneman, Michael Coode, Toni Cordente, Peter Costello, Adrian Coulter, Peter Dry, Marcel Essling, Andrea Francis, Leigh Francis, Jeremy Hack, Josh Hixson, Adam Holland, Leanne Hoxey, Jelena Jovanovic, Stella Kassara, Anne Lord, Jane McCarthy, Vince O'Brien, Tracey Siebert, Paul Smith, Alana Spears, Fang Tang, Randell Taylor, Heather Tosen, Cristian Varela, Patricia Williamson.

www.awri.com.au