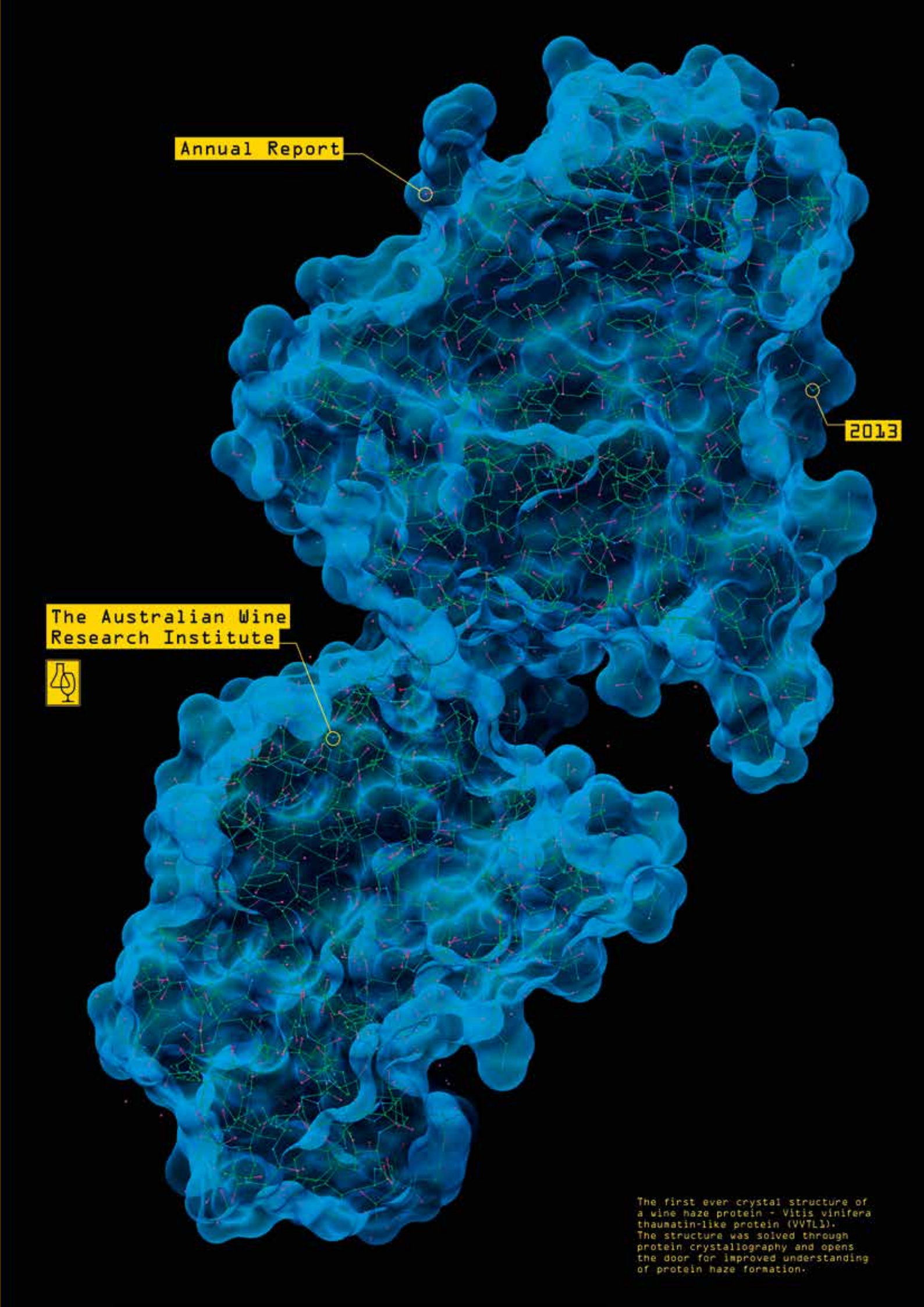

The first ever crystal structure of a wine haze protein - Vitis vinifera thaumatin-like protein (VVTL1). The structure was solved through protein crystallography and opens the door for improved understanding of protein haze formation.

Board members

Mr P.J. Dawson, BSc, BAppSc (Wine Science)
Chair – Elected a member under Clause 25.2(c) of the Constitution

Mr J.C. Angove, BSc
Elected a member under Clauses 25.2(c) and 27.1 of the Constitution

Mr J.F. Brayne, BAppSc (Wine Science)
Elected a member under Clause 25.2(c) of the Constitution

Mr P.D. Conroy, LLB (Hons), BCom
Elected a member under Clause 25.2(b) of the Constitution

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

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

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

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

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

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

The company

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

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

Mission

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

Values

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

- Excellence
- Integrity
- Passion

Behaviours

Behaviours in support of those values:

Excellence

- Outcomes focussed, 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 Precinct at Urrbrae in the Adelaide foothills. Co-located in the Wine Innovation Central Building with the AWRI are grape and wine scientists from other organisations.

The Waite 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, three divisions of CSIRO, South Australian Research and Development Institute (SARDI) and The University of Adelaide's *School of Agriculture, Food and Wine*.

Registered office

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Twitter: www.twitter.com/The_AWRI
ABN: 83 007 558 296

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Presented to the Australian grape and wine sector

Chair's report


Peter Dawson

With the expiry of the GWRDC-AWRI seven year investment agreement on 30 June 2013, the past year has seen a significant focus on the future shape and resourcing of the AWRI.

By any measure, the past GWRDC-AWRI investment agreement framework was very successful in supporting a high level research, development and extension capability within the AWRI. This capability has ably supported our industry in an increasingly complex and challenging global market.

The pressures on the profitability of the Australian grape and wine sector are well known but it is sobering to contemplate where we might be today without cultural change resulting from our improved understanding of such issues as *Brettanomyces*, oxidation and wine closures, to name a few. Strategies driven by this knowledge coupled with new discoveries in aroma and flavour chemistry and the development of new generation yeast have seen real value added to our productive output and provided significant competitive advantage in a highly cost sensitive environment.

Our grape and wine research levy system, with matching funding for research investment by the Australian Government, is unique in the world. It allows small and large producers to share in the benefits of innovation and knowledge development, driving the potential and diversity of the Australian wine proposition at all levels. Similarly, as an industry-owned and dedicated wine research institute, the AWRI is unique in the world of wine. A well-resourced, high performance research capability has long been a source of envy in all other wine producing countries.

The key questions for our Board have been: how do we secure the capability of the AWRI for the future benefit of our industry and how do we adapt that capability to meet changing priorities? Indeed what organisational framework will provide a sustainable, affordable and effective launch pad to support future innovation and profitability in our industry?

Sir Paul Nurse, Nobel Prize-winning scientist and president of the Royal Society of London provided some useful insights to the resourcing of research in a talk titled 'Making science work' featured on the ABC's Science Show in February this year. He talked of:

- a continuum from discovery science, acquiring new knowledge, through research aimed at translation of scientific knowledge on to application and innovation;
- the importance of the individual carrying out the research – the need for in-depth knowledge combined with peripheral vision, creativity, motivation, scientific values and past effectiveness; and
- the value of multi-disciplinary approaches.

The integrated AWRI model, with its mission of supporting the Australian grape and wine industry through world class research, practical solutions and knowledge transfer, aims to capture all of these values and approaches.

More recently Australian Nobel Laureate, Professor Brian Schmidt, addressed the subject of the importance of research to the Australian wine sector in his opening address at the 15th Australian Wine Industry Technical Conference. His comments included:

- "The most valuable discoveries for the industry are those that we do not yet know about"
- "Good science is creative"
- "Scientists need a long term plan... they need continuity"
- "Failure is part of the innovation cycle"

It was a cautionary message to industry and funding bodies about the pitfalls of becoming overly prescriptive and short-term in research investment.

Declining levels of public investment in R&D is now a global phenomenon. At a time when tax receipts and budgets of all persuasion are under pressure, increased productivity is one of the few levers available to drive economies forward. It is ironic that when budgets are under pressure one of the first casualties is investment in the very thing that can drive productivity, namely training and R&D. The agricultural sector in Australia is a notable example. A recent senate enquiry noted that for the first time in history, agricultural R&D in Australia is declining at the same pace as our rate of productivity is flattening. Australia currently spends approximately 2.2% of its GDP on research and development – putting Australia in the middle of the OECD table. By way of context, 5% of GDP was invested in agricultural R&D in Australia in the 1970s. For the wine industry, despite increased levy contributions with recent harvests being higher than six year averages, fewer funds seem to be available for investment in productive grape and wine R&D.

Much effort has been directed this year toward securing a new long-term GWRDC-AWRI investment agreement commencing on 1 July 2013. A new four year funding agreement is now in place providing funding for defined core industry capability building activity and specific contested research projects. This funding will cover approximately half of the AWRI's operational costs over the duration of the agreement.

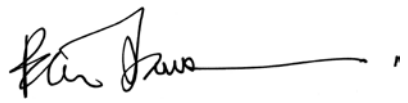
Central to this new agreement was the development of the AWRI's Five Year RD&E Plan 2013-2018. The plan builds on current AWRI activities that have demonstrable benefit to industry and addresses existing and emerging issues using state-of-the-art tools and traditional and emerging scientific disciplines. Input to the plan came from a comprehensive consultation and review process which involved 36 workshops held across six states and the ACT. More than 200 industry personnel representing 135 stakeholders including peak bodies, state and regional associations, winemaking and grape growing organisations, provided input into the development of projects. As a result of this process, and substantial internal planning, 113 project ideas were refined to the final list of 50 projects, grouped under 17 theme headings. Importantly, the projects respond to many of the priorities outlined in the GWRDC's 5-year plan 2012-2017; are based on industry priorities; and integrate research, development and extension activities. I would like to thank all of the participants in that process. A copy of the new plan is enclosed with this Annual Report and I encourage you to provide any feedback to the AWRI's Managing Director, Dr Dan Johnson.

It is worth noting that significant parts of the AWRI's new RD&E Plan remain unfunded, including work on the authenticity and origin verification of Australian wine, while other areas including wine and health and lower alcohol wine are not sufficiently funded in quantum or term given the value placed upon them by industry. There is an urgent need to address the real decline in the levels of funding provided: funding which drives ongoing innovation and productivity in the grape and wine sector.

In the rounds of consultation for the development of the AWRI's new Five Year RD&E Plan, industry made it clear what its priorities were and where it expected R&D levy contributions to be invested. Questions need to be asked, though, how can industry best control the expenditure of its levy funds, and how can non-value-adding activities and bureaucracy be minimised? A shift back to partnerships that clearly focus on delivering on grassroots industry priorities is part of the solution.

The Annual Report of the AWRI provides a detailed financial report related to the past year of operations. It should be noted that the AWRI has been operating for some years on a deficit budget. The result from operating activities in FY2013 was a deficit of $410,851 which was offset by $447,256 in finance income. Cash reserves at the end of FY2013 totalled $10.34 million. However, the organisation has significant obligations and liabilities and the amount of cash reserves in excess of such liabilities being $4.65 million. The current cash surplus is the result of the prudent financial management in areas outside of that funded by R&D levies over an extended period of time. It is current Board policy to hold cash reserves sufficient to cover up to six months of operating activity of the AWRI in the event that there is an interruption or delay in the receipt of funding; a scenario not without precedent. The current available cash reserve is sufficient to cover approximately four months of operating activity and ensures that the AWRI can continue to meet its financial obligations without disruption to service or capability.

After 12 years as an AWRI Board member, I will be standing down at the end of 2013. I feel privileged to have chaired the Board of the Australian Wine Research Institute, and wish to sincerely thank the Board members for their support and for contributing their skills, expertise and time in guiding our industry's innovation engine. I also wish to thank Dan Johnson for his leadership and unrelenting professional approach through what has been a difficult year. The staff at the AWRI should also be commended for their hard work and determination to deliver valuable outcomes for our industry.



Peter Dawson
Chair

Managing Director's report


Dan Johnson

A year of transition – planning for the future

The Australian wine sector continues to show considerable resilience in the face of difficult trading conditions. However, industry bodies, including the AWRI, are not immune from these challenges, and the past year will be remembered as one of transition and restructuring.

The highly successful 7-year investment agreement between the GWRDC and the AWRI, and the associated AWRI 7-year Research, Development and Extension plan, concluded this year. Projects were finalised and findings summarised ahead of a transition to a new AWRI research and funding framework. Key outcomes from the first six years of the agreement were highlighted in my report last year, and highlights from this year are listed below and elsewhere in this document.

Technical outputs continued to be of a very high standard and offered real solutions for industry problems. However, this year there was a need to deliver these outputs with the looming prospect of a substantial decline in the quantum and security of industry funds available for research, development and extension. No stone was left unturned to find operational efficiencies and reduce costs to align with this new paradigm, and difficult decisions were made. Despite this, there remains a need for all sector participants to work together to provide a foundation for strategic research programs and to ensure that the available funds 'hit the grassroots' in the most efficient way. The attraction and retention of expert scientists, sourced from a small global pool, are critical to prevent further decline in research capacity and capability and to ensure the continuation of 'game-changing' research outputs essential for the sustainability of this industry.

This year, a comprehensive consultation and review process was undertaken to prepare a 5-year Research, Development and Extension plan for the AWRI for the period 2013-2018. Workshops involving all of the AWRI's major stakeholder groups including peak body, state and regional-based associations, winemaking and grapegrowing organisations were held around Australia to understand industry priority topics.

Following this process and substantial internal planning, 50 projects were identified in the thematic areas of environment and sustainability; consumers, customers and markets; improving products and processes; extension and adoption; and service capabilities and foundational datasets.

The 2013-2018 plan builds on the achievements of the AWRI's 2006-2013 plan, but shifts the emphasis and direction of future RD&E to align with current industry priorities and feedback. Valued services such as the AWRI helpdesk service and emergency response capabilities will be continued while new directions include an increased focus on: mouthfeel and texture; genomics technologies; the grape to wine interface; packaging and transport practices; new extension platforms; and cost saving options. This is industry's plan for its future.

Copies of the plan are available to all AWRI stakeholders and can be accessed, along with project status updates and contact details, from the AWRI website.

This year, the AWRI was again heavily involved in program planning, preparations and logistics for the 15th Australian Wine Industry Technical Conference (Sydney, July 2013). This 15th conference marks 43 years of the existence of the Australian Wine Industry Technical Conference and its important contribution to the development of the Australian grape and wine industry through information sharing and networking. Many staff members from the AWRI were also involved in the program development, preparations and logistics for the international scientific conference, WineHealth 2013 (Sydney, July 2013) as well as Crush 2012, a two-day national symposium dedicated to grape and wine research (Adelaide, November 2012).

Technical trends

This year, the AWRI published its 1500th paper, a significant milestone for any research organisation and testament to a consistent contribution to the Australian wine sector's innovation efforts over the past 58 years. Fittingly, the paper 'Beyond bentonite', was an AWRI report summarising recent progress in developing efficient, cost-effective alternatives to the use of bentonite, a fining agent used to prevent haze formation in white wine. The AWRI has worked for many years to understand the causes behind protein haze to find cost-effective solutions, and this past year saw substantial advances in both fundamental and practical understanding.

Copies of all AWRI papers, and most grape and wine-related publications from other institutions are available to producers from the AWRI library. This year 2,466 papers were distributed to the AWRI's stakeholders.

These paper requests formed just over half of the total of 4,833 information requests, helpdesk enquiries and problem investigations addressed during the year. 1,453 requests for information were managed through the AWRI helpdesk service, of which: 1,015 concerned winemaking; 357 concerned viticulture; and 100 concerned regulatory or health. A further 914 problem samples were analysed as part of 202 separate investigations on behalf of Australian producers. To put this into perspective, 19 requests for assistance were addressed on each working day of the year; this is roughly in line with previous years.

In addition to these figures, more than 86,000 analyses were undertaken on more than 17,000 grape and wine samples by the AWRI Commercial Services laboratories; an all-time record.

Key technical trends observed in the information and helpdesk enquiries relative to long-term trends included:

- The volume of enquiries from each state was broadly in line, percentage wise, with state production figures. The nature of enquiries was very broad with no key issues specific to a region.
- A spike in the number of enquiries was experienced in October 2012 and March 2013. The October figure was driven in part by an increasing number of *Brettanomyces*-related

enquiries. The percentage of queries related to Brett has been trending upwards over the past few years, and is now at levels similar to that in the early 2000s, suggesting that microbiological and sulfide-related queries are continuing to be a regular issue for many winemakers. Research work will continue in the coming years on new Brett management strategies. The spike in enquiries in March was driven by a large number of stuck fermentation enquiries that arose in a short space of time following the compressed vintage and the associated hot and dry conditions.

- Hazes and deposits continued to represent the majority (37%) of all investigations. Many of the deposits were potassium hydrogen tartrate, although calcium tartrate was also observed often, typically as a result of high calcium concentrations (either naturally or through calcium based additives and processing aids such as skim milk, bentonites or calcium carbonate) or, in the case of calcium DL-tartate deposits, the use of racemic tartaric acid or potassium hydrogen tartrate when cold stabilising. Instability problems are continually being addressed during the AWRI's Roadshow workshops and via other AWRI communication media such as the AWRI website, *eNews* and *eBulletins*.

Technical highlights

The year also saw a number of research highlights. A full list is provided in the annual report, but some of the most noteworthy include those shown below.

Wines produced by sequential inoculation with a non-*Saccharomyces* strain and a *S. cerevisiae* strain were ~1 % v/v lower in ethanol concentration than wines produced by the same *S. cerevisiae* strain. Similarly, a selected *S. cerevisiae* mutant strain produced wine 1.5% v/v lower in ethanol than the parent strain. The flavour properties of mutant strain still need to be optimised, but substantial progress is being made towards the long-standing target of using yeast, a low cost winemaking input, to make lower ethanol wines with full flavour attributes.

- An interspecific hybrid yeast between *Saccharomyces cerevisiae* and *Saccharomyces mikatae* was developed. Hybrids produce wines with altered concentrations of volatile compounds known to contribute to wine flavour and aroma, including compounds associated with non-*Saccharomyces* yeast species. Using these hybrids winemakers may be able to achieve complex wines while avoiding the risks associated with spontaneous fermentation.

- High resolution 3D crystal structures of two haze forming thaumatin-like proteins at winemaking temperature were resolved and passed the Protein Data Bank validation. The availability of very high resolution structures for two isoforms of haze forming proteins will allow identification of differences in structure that might explain their differences in haze behaviour; this information has the potential to open the way to a targeted search for enzymes able to degrade thaumatin-like proteins at winemaking temperature. One of the crystal structures is featured on the front cover of this annual report.

- To inform decision-making concerning the labelling of products containing potential allergens, the AWRI developed and validated a test for milk and egg residues in wine. This simple assay is now available for producers and, providing a wine meets certain analytical parameters, can help to avoid the need for allergen labelling.

- The AWRI Ferment Simulator was released and trialled by 26 major wine producers across four states. The tool can be used to track ferment trajectory and account for conditions such as temperature, yeast, wine type, nutrient levels, agitation regime and tank size. It can be used to test and evaluate alternative ferment management strategies, monitor refrigeration and electricity demand and predict problem ferment behaviour so that early corrective action can be taken when needed.

New partnerships

Opportunities arose through the year for the AWRI to leverage and optimise industry R&D investment by entering into a number of new partnerships with industry bodies, wine companies and research institutes.

- A partnership between the Winemakers' Federation of Australia, the National Wine Foundation and the AWRI was established, with an initial focus on alcohol and pricing and a review of the evidence concerning wine consumption and health.

- An exclusive agreement between Wine Australia and the AWRI was established for the AWRI to undertake analytical tests required under the Wine Australia audit program.

- An AWRI node was established in the Hunter Valley, with in-kind and financial support from local associations and local growers and wineries. The node services the Hunter Valley and other nearby regions and assists in the uptake of the latest information and technologies.

- The 'BAG alliance' – a trilateral partnership between L'Institut des Sciences de la Vigne et du Vin (ISVV) in Bordeaux, Hochschule Geisenheim in Germany and the AWRI was cemented with the support of the respective regional governments. Collaborative research projects will be established in 2013/2014.

- Partnerships with the Australian Government were entered into for the AWRI to extend to the Australian wine sector relevant outputs from carbon farming research projects undertaken across a range of sectors, and to continue the research effort into grape marc use as a feed additive in commercial settings.

- A partnership between the AWRI and IT professionals has led to the development and launch of an Agrochemical Search App and a Winemaking Calculator App. Both apps have seen strong uptake and regular user sessions.

The view over the horizon

The final reports prepared of the work undertaken in the last seven years provide many reasons to be proud of what the Investment Agreement between the GWRDC and the AWRI has achieved. It is inspirational to see the AWRI's activities making a positive impact on the businesses of Australian grape and wine producers. Indeed, the support and feedback the AWRI has received from industry has instilled a renewed sense of purpose and urgency to tackle, in partnership with grape and wine producers, industry's most pressing problems, through embedded expertise and intellect, creativity and state-of-the-art technology. The AWRI's new RD&E plan commenced on 1 July 2013, and the AWRI aims to deliver all aspects of this industry plan over the next five years.

I wish to thank the AWRI Chair, Mr Peter Dawson, and the AWRI Board for their invaluable contribution and guidance this year. I would also like to acknowledge the continued support and partnership of many of the AWRI's stakeholders and funding agencies, which enable such effective outcomes to be produced. Finally, my thanks to Team AWRI, who find ways to turn every challenge into an opportunity and do so with a very high level of excellence, integrity and passion so that for this great industry success is inevitable.

Dan Johnson
Managing Director

Board notes

Chair
Mr P.J. Dawson

Alternate Directors of the Board
Mr M.R. DeGaris (from 18/09/2012)
Mr N.A. McGuigan
Mr C.B. Ryan (until 18/09/2012)
Mr A.N. Sas

Audit Sub-Committee
Mr M.R. Watson (Chair)
Mr P.D. Conroy
Ms. L.E. Rose

Personnel Sub-Committee
Mr P.J. Dawson (Chair)
Mr B.M. McKinnon
Mr J.F. Brayne

Meetings

Ordinary General Meeting
The 58th Ordinary (Annual) General Meeting was held on 4 December 2012.

Special General Meeting
n/a

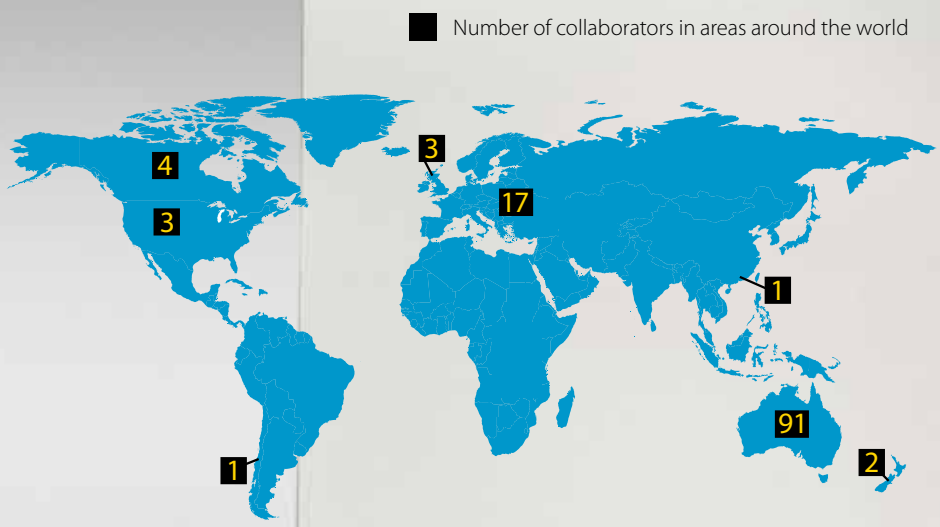
Board
The Board of the AWRI met on the following dates: 18 September 2012, 4 December 2012, 26 February 2013, 22 March 2013 (teleconference), 4 June 2013, 28 June 2013 (teleconference).

Funding

The Board of the AWRI acknowledges the continuing financial support of the Grape and Wine Research and Development Corporation, the Premier's Science and Research Fund, the Government of South Australia, and Bioplatform Australia's EIF/Super Science program.

Appreciation

The activities at the AWRI benefit from collaborations from individuals and organisations from 14 different countries: Australia (Australian Capital Territory, New South Wales, Queensland, South Australia, Tasmania, Victoria, Western Australia), Canada, Chile, China, Denmark, England, France, Germany, Italy, New Zealand, Scotland, Slovenia, Spain, and the USA. The assistance, cooperation and/or collaboration from partners across the globe are gratefully acknowledged.



Highlights of the year 2012-2013

Market and consumer understanding

Highlights towards enabling market access:

Partnership to investigate key wine health questions A partnership between the Winemakers' Federation of Australia, the National Wine Foundation and the AWRI was established, with an initial focus on alcohol and pricing and a review of the evidence concerning wine consumption and health.

Method developed to inform allergen labelling decisions To inform producer decisions concerning the labelling of products containing potential allergens, the AWRI developed and validated a test for milk and egg residues in wine.

Highlights towards improving consumer understanding and acceptance:

Consumer experiences with closures A Shiraz wine bottled under 15 different closures has been characterised at the 24 month post-bottling time point by sensory descriptive analysis, and subsequently seven samples were tasted by more than 200 consumers in Sydney. Although the wines were quite similar in sensory properties, there was a significant difference in purchase intent following blind tasting, with the most oxidised wine having the lowest purchase intent score. The results, which are in line with previous studies, indicate that small sensory differences are important to consumer preference.

A consumer rejection level for salt in wine The amount of sodium chloride that affected consumer preference in white and red wine was found to be above 1.5 g/L, providing guidance for wine companies in setting specifications for grapes or wines with elevated sodium.

A rapid sensory analysis method called 'Napping' has been developed The technique was evaluated and found to provide closely similar results to conventional sensory methods. The method has great potential for application in industry trials, being much cheaper and quicker to apply.

An insight into Chinese consumer descriptive language was obtained In a collaborative study with the University of South Australia, specific Chinese fruit and flavour terms were found to be associated with different wine styles, and knowledge was gained regarding which wines from highly diverse styles were most liked.

Winemaking excellence

Sulfite tolerance in *D. bruxellensis* A clone of the sulfite efflux pump from *D. bruxellensis* AWRI 1499 (*DbSSU1*) has been expressed in a strain of *S. cerevisiae* lacking this pump. *DbSSU1* was able to complement the *S. cerevisiae* defect, conferring sulfite tolerance. This is the first experiment of this type conducted using a *D. bruxellensis* gene, highlighting the value of genomic resources.

New low-ethanol yeast strains Wines produced by sequential inoculation with a non-*Saccharomyces* strain and a *S. cerevisiae* strain were ~1 % v/v lower in ethanol concentration than wines produced by the same *S. cerevisiae* strain. Similarly, a selected *S. cerevisiae* mutant strain produced wine 1.5% v/v lower in ethanol than the parent strain; however it is important to note that the flavour properties of the mutant strain still need to be optimised.

The AWRI wine microorganism culture collection now co-promoted through Atlas of Living Australia website The AWRI wine microorganism culture collection of yeast and bacterial strains has become an associated site of the Atlas of Living Australia (ALA). ALA is an Australian Government initiative and the Australian node of the Global Biodiversity Information Facility; it is providing a national database of all of Australia's flora and fauna that can be accessed through a single, easy to use website. ALA provides another point of entry for researchers and industry to search for wine-related microorganisms housed in the AWRI culture collection. This partnership with ALA illustrates the high standing and recognition of the AWRI culture collection in the Australian scientific community.

New yeast hybrids between *Saccharomyces cerevisiae* and *Saccharomyces mikatae* An interspecific hybrid between *Saccharomyces cerevisiae* and *Saccharomyces mikatae* has been developed. Hybrids produced wines with altered concentrations of volatile compounds known to contribute to wine flavour and aroma, including compounds associated with non-*Saccharomyces* yeast species. Using these hybrids winemakers may be able to achieve complex wines while avoiding the risks associated with spontaneous fermentation.

New analytical method for oxidation-related off-flavour compounds established The compounds phenylacetaldehyde and methional were strongly related to oxidative flavour in wines.

New analytical method for quantifying potent tropical thiols In studies with the University of Adelaide, a relatively simple method has been validated that will quantitatively analyse these hard to measure compounds, with numerous advantages over previous methods.

Structure of protein haze revealed High resolution 3D crystal structures of two haze forming thaumatin-like proteins at winemaking temperature were resolved and passed the Protein Data Bank validation. The availability of very high resolution structures for two isoforms of haze forming proteins will allow identification of differences in structure that might explain their differences in haze behaviour; this information has the potential to open the way to a targeted search for enzymes able to degrade thaumatin-like proteins at winemaking temperature.

Polysaccharides in white wine – the role of fermentation on solids The polysaccharide profiles of Chardonnay, Riesling and Viognier wines made under controlled conditions using different juice extraction and handling methods demonstrated that significant differences can be created in both the total amount of polysaccharides and their size distribution. This provides insight into the relative contribution of yeast, grape pulp and skin to the total pool of polysaccharides. Importantly, fermentation on solids produced the largest increase in total polysaccharides compared to those made from free run juice in all three varieties. This average increase of 80% in total polysaccharides over the clarified free run control was caused by increases in the medium molecular weight fraction which have recently been identified as being responsible for reductions in perceived alcohol hotness.

Predicting wine tannin concentration through grape analysis To establish a grape extraction method that predicts tannin extractability and concentration in wine, 40 grape samples from five growing regions were

sourced in collaboration with Accolade Wines. Comparison of a number of protocols demonstrated that extraction with model wine of gently crushed, whole fresh or frozen grapes consistently gave much lower tannin results compared to the standard extraction protocol across all varieties. This means that grape tannin concentrations obtained from model wine extractions are in the same order of magnitude as wine tannin concentrations.

Microwave maceration leads to extraction of tannin and pigment The efficient extraction of tannin and pigment can occur before fermentation using microwave maceration and short skin contact time, allowing the ferment to be performed off skins. Preliminary histological examination of grape skin samples has revealed that microwaved skin showed more structural disruption of skin cells and release of material from vesicles than skin which had been heated, supporting the theory that extraction might be more efficient with microwave than with conventional heating. Application of the technique to *Botrytis*-affected musts resulted in reductions in mean laccase concentrations from 8.2 µg/mL to 0.9 µg/mL.

Rapid analytical method for key winemaking parameters performs similarly to reference method Over 1,500 juice samples were assessed using a combined rapid spectral analytical method for YAN, pH, TA and TSS during the 2013 vintage. In another trial, 4,300 red grape samples were analysed using the same technology, achieving a similar accuracy to the reference analytical method, representing a dramatic potential saving in analysis costs.

Non-destructive analysis of wine in the bottle Non-destructive in-bottle analysis was applied by wine producers to sort batches of sparkling and red wines, which had developed quality variability during packaging and storage.

Ferment Simulator released Twenty-six major wine producers across four states trialled a fermentation simulator tool. The tool gives winemakers the ability to track ferment trajectory and account for conditions such as temperature, yeast, wine type, nutrient levels, agitation regime and tank size. It can be used to test and evaluate alternative ferment management strategies, monitor refrigeration and electricity demand and predict problem ferment behaviour so that early corrective action can be taken when needed.

Tannin and phenolic measurement moves into the cloud The AWRI Tannin Portal has been improved and extended in the newly released WineCloud™. This web-based tool allows grape and wine producers to upload, analyse and benchmark data in a secure online environment. Producers can use their own equipment to measure colour, phenolics and tannins in red grapes, ferments and wines. The tool can be used to monitor grape maturity, track active ferments and follow wines as they age, to achieve specific target profiles.

Viticulture/sustainability

Chardonnay clonal variation project progresses The proposed sequencing strategy for a Chardonnay reference genome has been successful, and sequencing of all 14 Chardonnay clones, which are to be used in a comparative analysis against the more thoroughly sequenced reference genome, is also complete. Comparative genomics and data analysis will take place in 2013/2014.

The pepper compound rotundone varies widely across a vineyard A project with Dr Rob Bramley and Mt Langi Ghiran showed a dramatic variation in the concentration of aroma compound rotundone across a single vineyard, with clear spatial zones of higher and lower rotundone within the block.

Viticultural practices compared in new extension module A Research to Practice (RtP) training manual and workshop that compares viticulture under conventional, organic and biodynamic practices was prepared. This training module will enable land managers to critically evaluate their practices in light of the research findings about methods of vineyard management.

New assay for measuring *Botrytis* infection A new gluconic acid assay was successfully developed for the analysis of juice infected with *Botrytis*. The results suggest that the gluconic acid concentration can be used as an indicator for *Botrytis* infection, however the testing also revealed that gluconic acid concentration is not a good indicator of laccase activity.

Carbon Farming Future research to be extended to the wine sector The AWRI received an Australian Government grant entitled 'Building resilience and sustainability in the grape and wine sector' to support extension of the Carbon Farming Futures outputs for the wine sector over the period 2013-2016. Outputs from carbon farming research projects in a range of sectors will be extended under this grant.

Research effort into grape marc use as a feed additive expanded The AWRI received an Australian Government grant entitled 'Using grape marc as a feed additive in commercial settings' to continue and expand the AWRI's ongoing work in this area.

Regions benefit from Landcare grants The AWRI assisted in drafting and submitting four successful Community Landcare Grants applications. The regions to benefit were: Macedon Ranges (Vic); the Granite Belt (QLD); and Coonawarra (SA). The AWRI will manage projects on pest and disease management; grapevine nutrition; sustainable vineyard management practices and winery wastewater management.

Extension and educational activities

Workshops delivered in 'packaging' and 'difficult vintages' The AWRI Roadshow workshop 'A guide to trouble-free packaging for winemakers' has been delivered across 29 of Australia's wine regions to over 500 participants. The launch of the next workshop series 'Adapting to difficult vintages', in the Barossa and Clare Valleys, occurred in May. In addition, 14 AWRI Seminar events were held during 2012/2013, to 301 participants.

Hunter Valley node established An AWRI node was established in the Hunter Valley, with in-kind and financial support from local associations and local growers and wineries. The node will service the Hunter Valley and other nearby regions and assist in the uptake of the latest information and technologies.

Crush 2012 In conjunction with other Wine Innovation Cluster partners, the AWRI staff played a major role in organising and supporting the Crush 2012 Symposium.

Preparations for 15th AWITC and WineHealth 2013 The AWRI was heavily involved in preparations and logistics for the 15th Australian Wine Industry Technical Conference and WineHealth 2013, key opportunities for the extension of technical information to producers.

New information made available New information made available to producers included six 'AWRI Reports' published in the *Wine and Viticulture Journal*, as well as six columns on 'alternative varieties'. Twelve 'Ask the AWRI' columns covering topical issues which generated the most enquiries by producers were published in the *Australian & New Zealand Grapegrower & Winemaker*. Five new fact sheets about AWRI activities were produced. New technical literature published from around the world was abstracted in six issues of *Technical Review*. Producers were alerted to topical issues in 17 *eBulletins* issued through the year. Updates of the AWRI's activities were reported in six issues of *eNews*, which were emailed to producers.

Library continued to expand The John Fornachon Memorial Library continued to build an extensive knowledge base, now comprising over 72,500 books, journals, journal articles, conference proceedings, etc. on grape and wine production.

Website goes mobile A mobile version of the AWRI's website was launched to improve access to information for users who access the website using mobile devices. Approximately 80,000 visitors accessed the AWRI website with a total of ~270,000 page views.

Publication milestone reached The AWRI published its 1500th paper, a significant milestone for any research organisation. Copies of all papers are available to producers from the AWRI library.

Webinar series grows in popularity A second webinar series featuring a total of 15 webinars was scheduled, including 3 webinars presented by invited industry guests.

Winemaking and Agrochemical Apps available An Agrochemical Search App and a Winemaking Calculator App were launched. Both apps have seen strong uptake and regular user sessions since the launch, and the format provides a ready avenue for updates to address the latest information.

Throughout the year, AWRI staff gave 369 presentations and 51 media interviews, conducted 71 workshops; authored 3 posters; presented 35 lectures to undergraduate students (plus coordinated a 50 hour subject); and supervised/co-supervised 13 students.

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Technical support

Winemaking queries Project team members responded to a large number of technical queries over the year on a range of winemaking topics. Some of the more frequently received queries were on topics including sulfur dioxide, bottling practices, taints and contaminations, 'brett' spoilage and general microbiological instabilities, assistance with analytical methods for wine analysis, regulation and export-related issues. During the 2013 vintage, a large number of calls were also taken on stuck and sluggish fermentations which appeared to be related to the prolonged hot and dry conditions experienced during the vintage.

Investigations A significant number of investigations were also carried out during the year. A high proportion of the investigations were categorised as haze and deposit related issues, with tartrate deposits being responsible in many cases. The number of helpdesk enquiries received was consistent with the previous two years.

Requests for information The AWRI responded to 4,833 requests for assistance and information, consisting of:

- 2,466 articles requested by stakeholders.

- 2,701 requests for information, of which:
  - 1,015 were managed by the AWRI Winemaking Services team;
  - 338 were managed by the AWRI Viticulture team; and
  - 100 were managed by the AWRI Health and Regulatory Information Manager.

- 914 problem samples analysed under 202 investigations.

To put this figure into perspective, 19 requests for assistance were addressed on each working day of the year.

Partnership with Wine Australia. The AWRI entered into an exclusive agreement with Wine Australia to undertake analytical tests required under the Wine Australia audit program.

Analysis of Australian wine This year saw the AWRI commercial laboratories process a record number of samples (more than 17,000), a significant increase on the previous year, which was itself a record year. More than 86,000 analyses were undertaken on these samples. Despite the increase in workload and general increase in consumable and labour costs, the laboratories have managed to maintain prices at the reduced levels introduced in February 2011.

New directions and collaboration

Consultation and preparation of a 5-year plan 2013-2018 A comprehensive consultation and review process was undertaken to prepare a 5-year Research, Development and Extension plan for the AWRI. Thirty-six workshops involving 135 stakeholder groups including peak body, state and regional associations, winemaking and grapegrowing organisations, were held around Australia to understand industry priority topics. Following this process and substantial internal planning, 50 projects were identified in the thematic areas of Environment and Sustainability; Consumers, Customers and Markets; Improving Products and Processes; Extension and Adoption; and Service Capabilities and Foundational Datasets.

Bordeaux-AWRI-Geisenheim alliance underway The South Australian Government provided a three year grant to enable the establishment of the 'BAG alliance' – a trilateral partnership with L'Institut des Sciences de la Vigne et du Vin (ISVV) in Bordeaux, Hochschule Geisenheim in Germany and the AWRI. Collaborative research projects and a staff exchange program will be established in 2013/2014.

Metabolomics and bioinformatics capability retained The AWRI metabolomics platform and associated bioinformatics service received confirmation of a continued commitment to this platform from the Australian Government and BioPlatforms Australia.

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

Acknowledgements

Edited by Rae Blair Communications, Ella Robinson and Dan Johnson

Compilation assistance from Shiralee Dodd, Virginia Phillips, Annette Freeman and Alfons Cuijvers

Design by Geoffrey Reed Communications

Photography by Jacqui Way Photography

Staff

The actual number of AWRI staff employed in a full-time, part-time and casual capacity as at 30 June 2013 was 116 (94.26 full-time equivalents). When AWRI-based students (both from Australia and overseas) and visiting researchers are added to our complement, the number increases to 119. Of this group of people working on outcomes for Australian grape and wine producers, around three-quarters (73.5%) are funded by the GWRDC.

Office of the Managing Director

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

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

Rae Blair, CertAppMgt (Mkting) *AIM*, GAICD, Communication Manager

Shiralee Dodd, BA, LLB(Hons), *UniAdel*, GradDip (Legal Practice) *Law Society of SA* Executive Officer and Company Secretary

Annette Freeman, DipBusAdmin *Upskilled*, Executive Assistant to the Managing Director (started 16 July 2012)

Kate Beames, AWITC Conference Manager

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

Sandy Davis, BaRTS *UniCanb*, AWITC Admin Assistant (started 12 February 2013)

Corporate Services

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

Chris Day, CA, BAgSc (Oenology) *UniAdel*, MBA *UniAdel*, Grad Chartered Accounting Foundations *Deakin*, Finance Manager

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

Linda Halse, BA, PostGradDip (Ind Rel) *UniNatal*, HR Manager

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

Fang Tang, Undergrad (Foreign Economy) *RenminUniChina*, GradDip (Financial Management), MCommerce Uni New England, Finance Officer (started 19 September 2012)

Alfons Cuijvers, M (Law) *UniAntwerp*, Project Officer HR, OHS and Project Officer Business Development

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

Jan O'Donnell, Receptionist (concluded 29 August 2012)

Deborah Thornton-Wakeford, Receptionist

Jennifer O'Mahony, Receptionist

Jeanette Tooley, Administration Support (concluded 22 October 2012)

Jody Hay, Function Support Officer (concluded 8 March 2013)

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, Dip Eng (Ind Chem) *Tokyo IT*, MPharmSc *Monash*, PhD *Yamanashi*, Senior Research Scientist – Mass Spectrometry Facility

Paul Henschke, BSc (Hons), PhD *UniAdel*, Principal Research Scientist – Microbiology

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

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

Matteo Marangon, BSc (Hons), PhD *UniPadua*, Senior Research Scientist

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

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

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

Deborah Thornton-Wakeford and Jennifer O'Mahony

Dan Johnson and Vince O'Brien

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

Martin Day, BSc (Hons) *UniSussex*, PhD *UNantes*, M (Oenol) *UniAdel*, Research Scientist

Richard Gawel, DipEd, BSc, GradDip (Oenol) *UniAdel*, Research Scientist

Helen Holt, BAgSc (Hons), PhD *LaTrobe*, Research Scientist

Keren Bindon, BSc (Hons) (Biology) *UniNatal*, MSc (Plant Biotech) *Stellenbosch*, PhD (Vitic) *UniAdel*, Research Scientist

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

Christine Mayr, State Examination (Pharm) *LMUMunich*, PhD (Chem), Research Scientist

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

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

Jacqui McRae, BSc (Env Mgmt) *VictUni*, BSc (Hons) (Biotechnology) *Swinburne*, PhD (Natural Products Chemistry) *Swinburne*, Research Scientist

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

Josh Hixson, BTech, BSc (Hons) *Flinders*, PhD *UniAdel*, Post Doctoral Scientist (started 8 October 2012)

Dariusz 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*, Senior Sensory Scientist

Jenny Bellon, BSc (Biochem & Gen) *UniAdel*, Scientist

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

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

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

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

Sheridan Barter, BTech (Forens & Anal Chem), BSc (Hons) *Flinders*, Technical Officer

Danna Li, BSc (Molec Biol), BSc (Hons) *UniAdel*, Technical Officer (started 26 November 2012)

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

Radka Kolouchova, AssDip *TechCollFoodTech*, Technical Officer

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

Kevin Pardon, AssDip (App Chem) *SAIT*, Technical Officer

Wes Pearson, BSc (Wine Biochem) *UniBritish Columbia*, Technical Officer – Sensory

Sam Anderson, BSc (Forens & Anal Chem) *Flinders*, Laboratory Technician

Jelena Jovanovic, Purchasing Officer

Heather Donnell, Administrator

June Robinson, Research Laboratory Support

Microbial Metabolomics Facility

Natoiya Lloyd, BSc (Med Chem) (Hons) *Flinders*, Post Doctoral Research Fellow

Esther Kristianto, BSc (Appl Chem) *UniTech Sydney*, Technical Officer-Metabolomics

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

Bioinformatics

Wade Hines, BA *UC Santa Barbara* (Bio Chem/Molec Biol), PhD *UC San Francisco* (Pharm Chem), Manager AWRI/BPA Bioinformatics Node (concluded 21 June 2013)

Nathan Watson-Haigh, PhD (Biol) *UniYork*, Senior Bioinformatician (concluded 21 November 2012)

Jeremy Hack, Bioinformatician

Casual Sensory Panel

Lynn Alabaster (concluded 23 January 2013), Peter Baldwinson, Brian Beggs, Jaqueline Gould, Philippa Hall, Felicity Harding (concluded 9 April 2013), Sonya Henderson, Gurinder Khera, Lynette Lee, Mary Likos, Catherine Milne, Ralph Osborne, Vivianne Rees, Heather Smith, Mark Werner, Fiona Woodcock (concluded 30 April 2013)

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 & Info Stud) *QUT*, Information and Knowledge Manager

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

Mark Krstic, BAgSc (Hons), PhD *UniTas*, MBA *Melb Bus Sch*, Extension Services Manager Victoria

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

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

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

Michael Coode, BAgSc (Wine Sc) *Deakin/Charles Sturt Uni*, MWineBus *UniAdel,* Winemaker (started 12 November 2012)

Gemma West, BAgSc (Oenology), *UniAdel,* MBA *UniSA*, Winemaker (concluded 12 October 2012)

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

Mardi Longbottom, BAgSc (Vit Sci), MVit, PhD *UniAdel*, Viticulturist

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

Emma Kennedy, BSc (Comp Mod) *Flinders*, Technical Officer

Francesca Blefari, BBus, *Uni Edith Cowan,* Events & Projects Coordinator

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

Michael Downie, GradDip (Lib & Info Manage) *UniSA*, Library and Information Services Officer

Virginia Phillips, Administrator

Industry Applications

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

Neil Scrimgeour, BSc (Hons) (Appl Chem) *Wolverhampton*, Research Manager – Industry Applications

Samantha Connew, LLB/BA, *Uni Canterbury,* Dip Vit and Oenol, *Lincoln* Manager Hunter Valley Node (started 3 September 2012)

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

Bob Dambergs, BSc (Hons) *UniAdel*, PhD *UniQLD*, Senior Research Scientist

Richard Muhlack, BE (Chem) (Hons), PhD *UniAdel*, Manager – Riverina Node

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

Commercial Services

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

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

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

Warren Roget, BEng (Mechatronic) (Hons) *UniAdel*, Technical Manager

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

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

Tina Tran, BSc (Microbiol/Biotech), BSc (App Biol) (Hons), PhD *Victoria*, Scientist

Melissa Aitchison, BAg Science *UniAdel*, Laboratory Technician (started 30 July 2012)

Bryan Newell, BAppliedSc (Chem/Physics) *UniSA*, Laboratory Technician

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

Tadro Abbott, BChem Eng (Hons) *UniAdel*, Project Engineer

Matthew Cream, Customer Relations Manager (concluded 13 June 2013)

Robyn Gleeson, Laboratory Support

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

Heather Tosen, BSc *UniAdel*, Scientist

Slavko Bekavac, BAppSc (Chem & Chem Proc Tech) *UniSA*, Senior Laboratory Technician (concluded 15 April 2013)

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

Pamela Solomon, BTech (Foren & Anal Chem), BInnovationEnterprise (Sc & Tech) *Flinders*, Scientist

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

Students

Ines Botscher, (Food Chem) *UniBonn,* Honours Student (07/11/11-18/12/12)

Bora Kang, *Duke*, Visiting Student (24/06/13-2/8/13)

Vilma Hysenaj, (Food Chem), *UniGenova,* PhD Student (28/11/12-10/5/13)

Visiting Researchers

Angela Contreras, PhD *UniSantiago*, Visiting Researcher(17/04/2012-16/10/2012 and 7/1/13-31/10/13)

Gal Kreitman, BSc, MSc (Food Sci) *Pennsylvania State*, Visiting Researcher (1/2/13-31/7/13)

Jingyuan Li, PhD *ChinaAgric*, Visiting Researcher (19/9/11-19/9/12)

Staff activities

Dan Johnson is Chair of the Australian Wine Industry Technical Conference Inc. and the WineHealth 2013 Steering Committee; 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 Winemakers' Federation of Australia Wine Industry Technical Advisory 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 is a Graduate of the Harvard Business School Authentic Leadership Development program and the Australian Wine Industry Future Leaders Program. He is also a Director of Tacnia Pty Ltd.

Vince O'Brien is an Adjunct lecturer at the University of Adelaide and member of the Winery Engineering Association Conference Planning Committee, Nomacorc Advisory Committee and Wine Industry Suppliers Association Innovation Committee.

Markus Herderich is a Director of the Australian Wine Industry Technical Conference Inc., 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 and a member of the Advisory Board of the *Journal of Agricultural and Food Chemistry*. Markus is a delegate and expert for the Organisation International de la Vigne et du Vin (OIV), and a member of the 15th Australian Wine Industry Technical Conference Planning Committee and the Program sub-committee.

Eveline Bartowsky serves on the Joint Editorial Board of the *Journal of Applied Microbiology* and *Letters in Applied Microbiology,* and the Editorial Review Board of the *Journal International des Sciences de la Vigne et du Vin*, *Acetic Acid Bacteria*, *Frontiers in MicroBioTechnology*, *Annals of Microbiology* and *Food Microbiology* journals. She is Poster coordinator and a member of the 15th Australian Wine Industry Technical Conference Planning Committee, committee member of the SA Branch of AusBiotech, 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 http://www.ayeastgroup.org/). Paul was also a member of the Yeast: Products and Discovery 2013 conference organising committee.

Bob Dambergs is a member of the Wine Industry Tasmania Technical Committee and the National Wine Research Network (NWRN). He is Secretary and Board member of the Australian Society of Viticulture and Oenology (ASVO), was a member of the 8th International Cool Climate Symposium (ICCS) Planning Committee and Chair of the 8th ICCS Program Committee. He is also 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*.

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*, is 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, Laboratory Information Management System (LIMS) and Informatics working groups.

Paul Henschke is an Associate Editor of the *Australian Journal of Grape and Wine Research,* a member of the Editorial Review Boards of *Food Microbiology* and *Mitteilungen Klosterneuburg*, and was a member of the local organising committee for the 8th International Cool Climate Symposium. He is a guest lecturer at the University of Adelaide and Flinders University.

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.

Peter Godden is a member of the 15th Australian Wine Industry Technical Conference Planning Committee and the Program sub-committee, participated as a judge at the 2012 Royal Adelaide Wine Show, and is a member of the Royal Adelaide Wine Show Wine Committee.

Con Simos is a member of the 15th Australian Wine Industry Technical Conference Planning Committee, and the Program sub-committee, Program Convenor for the 15th AWITC Workshop program and is the Deputy Chair of the National Wine Extension and Innovation Network (NWEIN).

Samantha Connew participated as a Panel Chair at the 2013 Royal Queensland Wine Show and the 2013 Sydney Royal Wine Show. She is the Wine Show committee chair and Board member of the Australian Society of Viticulture and Oenology (ASVO), the Deputy Chair of Judges of the Royal Sydney Wine Show and is a convenor at the Len Evans Tutorial.

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

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 the National Wine Innovation and Extension Network (NWEIN), member of the National Wine Research Network (NWRN), Associate Editor of the *Wine and Viticulture Journal*, Honorary Senior Fellow at the University of Melbourne, Coordinator of the Victorian Viticultural Association, Program Convenor and member of the Conference Planning Committee for the 15th Australian Wine Industry Technical Conference and member of the Standards Australia Committee for the Australian Grapevine Propagation Material standard.

Creina Stockley is an Affiliate Senior Lecturer at The University of Adelaide and is the Coordinator of the Wine Science Course entitled *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, WFA Wine Industry National Environment Committee and the WFA Wine and Health Working Group. She is also the Department of Agriculture, Fisheries and Forestry (DAFF) nominated Australian delegate for the Organisation Internationale de la Vigne et du Vin (OIV) and is currently President of Commission IV Safety and Food and a member of the Steering Committee. She 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. In addition, Creina is a member of the Planning Committee and Chair of the Scientific Committee for the WineHealth 2013 International Wine and Health Conference.

Leanne Hoxey is a member of the IWAG (Inter Winery Analysis Group) committee.

Information and knowledge transfer

Transfer of knowledge relating to winemaking

Staff

Con Simos, Geoff Cowey, Adrian Coulter, Matt Holdstock, Emma Kennedy, Virginia Phillips, Francesca Blefari, Ella Robinson

Australian winemakers were supported through the year by the AWRI's Winemaking and Extension Service team. Winemaker queries were addressed and advice and assistance were offered by a small group of qualified winemakers through this problem solving service. Each month the team monitors the type and nature of queries and investigations conducted against industry trends observed over the last 20 years. This allows the team to observe, react to and communicate any current sector issues to Australia's grapegrowers and winemakers; to enact any required emergency response; to conduct small-scale applied winemaking trials; and/or communicate internally any additional research that may be needed to be conducted by the AWRI research team. Any required industry educational tools are then produced and made available through development of workshops or seminars to aid in the prevention of future similar issues or make available information in the event of future occurrences.

The group communicates with industry through the AWRI's *Technical Review*, *eBulletins*, *eNews*, twitter account, Facebook, wine industry magazines and journals, a roadshow seminar and workshop program; Research to Practice workshops; webinars, the Australian Wine Industry Technical Conference program; the Advanced Wine Assessment Course; web-based resources; GWRDC *R&D@Work* and innovator's network newsletters and tailored workshops or seminars on request by sector associations. The group also provides presentations for external seminars and conferences; produces educational material and resources for the AWRI website and also provides lectures to undergraduate students. Daily personal interaction with industry members through phone calls, personal visits and email correspondence is highly valued by the group.

The group prepared three *eBulletins* (excluding Agrochemical updates) which provided packaged information and recommendations in response to industry trends and emerging issues, such as the *eBulletin* on 'Management strategies to assist with the recent hot weather conditions and the potential for smoke taint'. The *eBulletin* 'Timely reminder about slow, sluggish and stuck fermentations' was issued in response to the warm and compressed vintage, and an increase in queries regarding stuck fermentations received in March 2013 (Figure 1).

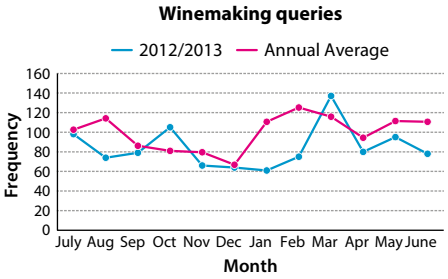
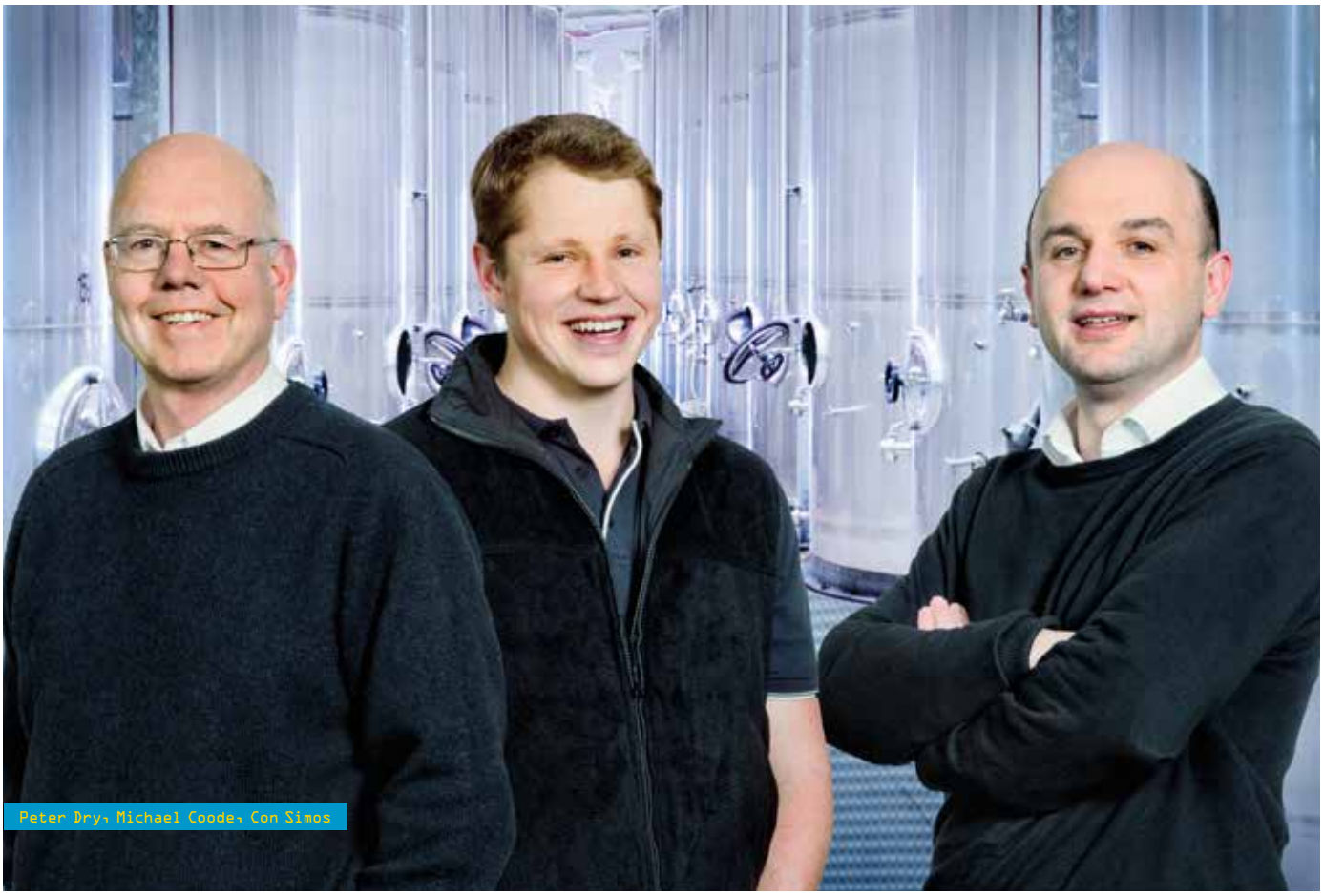


Figure 1. Winemaking query frequency showing a greater number of queries in October 2012 (driven by an increase in Brettanomyces *spoilage advice and advice regarding Cobalt levels in wine) and March 2013 (driven by an increase in stuck fermentation queries).*



Peter Dry, Michael Coode, Con Simos

Informal information was offered through AWRI's *eNews*. Six *eNews* articles were also produced this year in response to trends observed throughout the year:

- *Transport taints* highlighted an increase in the number of wines submitted with taints presumed to have occurred during transport overseas in flexitanks. Appropriate sampling of wine before and after transport was advised to assist in identifying the culprit.

- *The quercetin question for young reds* alerted winemakers that red wines bottled early, or bottled within four months of harvest, in 2012 were showing quercetin deposits. The deposit was also appearing in a few 2009 red wines.

- *Some float, some sink and some can cause a real stink* discussed how to identify wine deposits which remain a common challenge for winemakers year to year. There have been some cold stability issues this year, mostly deriving from calcium L tartrate instabilities. Some have been traced back to higher calcium levels in the vineyard, including wines from the cooler 2011 and 2012 vintages where acid levels were higher and also because wineries had deacidified wines using calcium bicarbonate. Some deposits formed due to reducing calcium levels using racemic tartaric acid, which has been marketed by some companies, but which leads to calcium DL tartrate crystallisation.

- *Slow or stuck ferment? Easy steps to take* detailed how slow or stuck ferments are a challenge a winemaker will face at some stage of their career. The AWRI's Winemaking Services team has had 650 queries over the last 15 years regarding ways to restart a stuck ferment, with queries generally doubling during years when heatwaves occur during harvest.

- *Above average bushfire potential this summer: Be prepared* was issued due to The Bureau of Meteorology predicting above average chances the summer 2012/2013 maximum temperature would exceed the long-term median maximum temperature over far northern Australia, southern and western WA, southern SA, southern NSW, Victoria and Tasmania, with the warmer temperatures increasing the risk of a potential bushfire and smoke tainted grapes.

- *Launch of the new workshop program 'Adapting to difficult vintages'* highlighted the new workshop developed for both grapegrowers and winemakers, and focuses on coping with extreme weather conditions. Topics covered include heatwaves, bushfire, drought and excessive rain.

The AWRI Winemaking and Viticulture teams publish a monthly column in the *Australian and New Zealand Grapegrower and Winemaker* called *Ask the AWRI*. This column also addresses monthly trends observed by the AWRI. Four columns were prepared by the AWRI winemakers during the year:

- *Constant observation key to avoiding dilemma of stuck ferments* highlighted the importance of monitoring fermentations.

- *Malolactic fermentation issues explored*, followed on from the article regarding stuck primary ferments and detailed issues and strategies for a successful secondary ferment.

- *What's that smell? Is that Brett? Part 1 and Part 2* highlighted recent trends in people detecting Brett at levels below reported thresholds, misdiagnosis or confusion of Brett with other faults such as reduction, and why Brett smells different in different wine styles and varieties. The percentage of requests the AWRI receives regarding *Brettanomyces* is now at similar levels to the early 2000s when Brett was more prevalent in Australian wine (Figure 2). An *eNews* item entitled *Is there Brett in your winery? Get the AWRI on the case,* detailed a new AWRI Commercial Services monitoring service to detect the presence of Brett in wine and the winery.

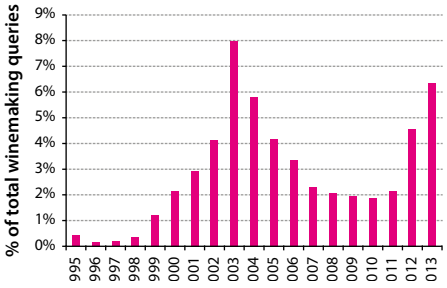


Figure 2. Percentage of Winemaking queries showing Brettanomyces *queries increasing to levels similar to those received in the early 2000s.*

In line with the stuck fermentation issues in 2013, the team contributed toward two GWRDC *R&D@Work* and Innovator's Network newsletters entitled *Helping winemakers avoid a sticky ferment situation* and *AWRI guide to choosing optimal yeast*. A paper was produced for the ASVO Proceedings from their 2011 conference entitled *Managing diseased fruit* and a paper entitled *AWRI workshop wraps up packaging problems*, was published in the *Australian & New Zealand Grapegrower & Winemaker.*

The AWRI's Roadshow seminar and workshop program is delivered on a rotating basis to locations covering Australia's winemaking zones and regions. The seminar program visits all locations once every two years. The workshop program is presented to all locations over a three-year period. The Roadshow schedule is available on the AWRI website and the Australian Grape and Wine Events Calendar website, and is advertised through the national wine press, various publications and through the local wine association websites.

During the year, 18 days of roadshow seminars and workshops were held throughout Australian winemaking zones and regions including: Barossa Valley, Tasmania, Canberra, Clare Valley, Gippsland, Hunter Valley, Langhorne Creek, Margaret River, Mildura, Mornington Peninsula, Mt Barker, Orange, Pemberton, Swan Valley, Toowoomba and Yarra Valley.

Roadshows seminars are organised in conjunction with winemakers' and growers' regional associations and are presented by subject experts. These associations select the presentations to be made from a range of research topics, in order that the seminars are closely tailored to the interests and needs of the audience. The 10 most requested seminar topics over the last five years were:

- Strategies for the control of *Dekkera/Brettanomyces* during winemaking

- Manipulation of phenolic profiles in red grapes and wine by viticultural management

- Vine balance – how does it affect yield and wine quality?

- Strategies for successful induction of malolactic fermentation

- Wild ferments – what are the alternatives?

- Does grapevine nutrition have an impact on wine quality?

- Grape and wine tannins, red wine colour and mouth-feel – an overview on current research, emerging applications and future challenges

- Grape maturity and tannins: the impact of viticultural treatments on grape and wine tannins

- The link between bentonite requirements and vineyard and winemaking practices

- Impact of nitrogen on grape and wine quality

Roadshow workshops are presented by subject experts and are tailored to deliver practical winemaking advice to the wine sector to address current industry concerns, technical issues or challenges. The workshops are interactive in nature and involve tastings, diagnostic tests and practical exercises. The workshop *A guide to troublefree packaging for winemakers* has now been delivered to 29 regions throughout Australia and the new workshop series *Adapting to difficult vintages* was launched in the Barossa and Clare Valleys this year.

An independently developed methodology was used to measure the effectiveness of the AWRI roadshow seminar and workshop program and its impact on uptake of key messages and promotion of practice change. The results confirm that the format is considered a highly relevant and a very credible mechanism for the dissemination of information. The interactive nature of the roadshow format and the opportunity to ask questions were highly valued by survey respondents, which further encouraged adoption. The current timing cycle of visiting every major wine region or centre on a minimum two year cycle was also strongly supported.

Key outcomes of the survey included:

- Strong engagement was observed across both winemaking and grapegrowing/ viticultural roles.
- 72% of participants do not need to travel more than 50 kms to attend a roadshow event, despite the diversity and the geographic location of Australia's wine regions.
- The program had a broad range of participants with respect to level of industry experience, with 38% having 1-10 yrs experience, 40% 11-20 yrs experience and 22% having more than 21 yrs experience.
- Two-thirds of participants are adopting practices presented at the AWRI's roadshow events (significantly higher than the nominated agri-industry average of 30%).
- The usability of information presented and relevance of information was rated as "above average or excellent" by 93% and 96%, respectively, of the attendees.
- Roughly half of those surveyed attended both seminar and workshop events.
- More than 50% of attendees had participated in two to four roadshow events. A further 27% had attended more than five roadshow events since 2006.
- 70% of the participants had a diploma / degree in a winemaking or science discipline.

In recent years, many regions have experienced difficult conditions including drought, heatwaves and unseasonal rainfall and associated high disease pressures. Vintage 2013 will be remembered for one of the earliest and most compressed vintages in recent times. As evidenced in many regions, a water deficit at the start of the season can severely limit canopy development and subsequently yield. Other consequences include an increased risk of sun exposure, especially if the season remains dry. Berry nutrient content, especially yeast assimilable nitrogen (YAN), was also lower than the recent vintages, possibly due to reduced soil microbial activity. The AWRI has taken lessons learnt from these variable vintages, from grapegrowers and winemakers across Australia, in addition to current research conducted across leading providers, and packaged this information into a workshop called *Adapting to difficult vintages*.


Matt Holdstock and Geoff Cowey

In this new workshop, participants are provided with information on how to deal with drought, salinity, extreme heat or heatwave events in the vineyard; bushfires and smoke taint; processing ripe fruit in the winery; avoiding stuck fermentations; compressed vintages and associated logistical pressures. Information about growing grapes and making wine in wet seasons with high disease pressure including *Botrytis* is also provided. The workshop highlights increasing energy costs, limited water availability and the need for sustainable systems in the winery. A presentation from the senior meteorologist/climatologist at the Bureau of Meteorology (BOM), Darren Ray, which explains the science behind weather, has proven popular. With weather predicted to become more variable, the BOM has created a number of tools available to growers, including a seven day forecast by region and tools to determine several months ahead if the season is likely to be wet or dry. The workshop finishes with an eye to the future through a structured tasting of alternative varieties, few of which have been planted on Australian soil, that might suit each region in the future with a warming climate.

At the request of several regions who received GWRDC Grassroots funding during 2013, two one-day tannin and Brett workshops were produced for the NSW Wine Industry Association, and were held in Mudgee and in Canberra. A tannin workshop was also requested and produced for the Limestone Coast Wine Industry Association held in Robe. At the request of Wine Industry Tasmania, two Q&A style workshops were delivered on smoke taint in Tasmania. A workshop called *Taints and their origins*, including a taint threshold tasting and information on taint prevention, was also prepared and delivered upon request.

A further Research to Practice (RTP) module was developed this year on *Quality Control Laboratory Practices*. This module is aimed at vintage staff and focuses on providing practical hands-on training on all aspects of laboratory practices. Combined workshops on wastewater and refrigeration were held in Ararat and in the Yarra Valley.

The Advanced Wine Assessment Course (AWAC) continues to be an important career development opportunity for those who wish to strengthen their knowledge in wine show judging and/or improve their sensory skills. This year, the AWAC was held at the Adelaide Showground. The Showground is home to the Royal Adelaide Wine Show and was thus a fitting venue which received positive reviews from participants. Since the first course in 1992, and in response to feedback from previous participants, the course has been subject to a process of continuous improvement and refinement. The current program is offered in a four day format with more than 40 hours of content. As part of the intensive program, participants have the opportunity to evaluate a diverse range of more than 300 wines under simulated wine show conditions. Lectures are also presented by AWRI staff, and leading wine show judges, journalists and winemakers participate throughout the course.

Feedback from AWAC graduates suggests that it is very difficult to obtain judging positions at

Australia's premier wine show events. In order to fast-track opportunities, and to facilitate the development of talented professionals, the top performing participant from each course now has the opportunity to participate as an associate judge at a national wine show level. Consequently, this year Gwyneth Olsen, then Senior Winemaker from McWilliam's wines (Dux for AWAC 32), was offered a judging place at the Royal Queensland Food and Wine Show.

Over many years, the AWRI has solicited and received considerable feedback from graduates of the Advanced Wine Assessment Course. Graduates continue to seek education programs that will enable them to stay abreast of new developments in world wine styles. On the basis of this feedback the AWRI has developed a series of one day international-themed events: the second such event, 'Sparkling Wines of the World', was delivered twice this year. Wine journalist Tyson Stelzer and experienced winemaker and show judge Tony Jordan led the tasting. The program consisted of eighty wines representing many regions and countries, tasted in a wine show format. Overall feedback was excellent. The importance of staging these focused educational tastings is critical if Australian winemakers are to evaluate wines in an objective and educational forum which ultimately supports the development of quality new wines and wine styles.

The portfolio of education themed wine tasting and evaluation events continues to be expanded. A number of Taints and Faults Clinics were delivered to cellar door sales staff including at Magill Estate and Rockford Wines, and at the Western Australia Cabernet Workshop in Margaret River. A 1.5 day abridged session of the Advanced Wine Assessment Course was also held in the Barossa Valley. Simulated flavours, faults, taints and mouth-feel tastings are also delivered upon request to regions and companies around Australia.

The AWRI hosted the Organisation Internationale de la Vigne et du Vin (OIV) Master of Science in Wine Management Seminar program. Twenty students undertook classes at the AWRI on 28 February, which included four AWRI presentations detailing closure, Brett, smoke and wine flavour research. The AWRI also hosted a Wine Australia 'A+ Australian Wine'/Wine & Spirit Education Trust Group visit on 18 March. Ten students undertook a simulated flavours, faults, taints and mouth-feel tasting as well as a tasting and presentation on AWRI closure trials.

The AWRI and the Institute of Masters of Wine (IMW) continued their cooperation agreement, now in its fourth year. As part of the arrangement, the AWRI hosts the IMW each year for the Australasian education program and additionally contributes to the IMW's education program. As a part of this collaboration, an AWRI presentation was delivered to the IMW Australasian seminar: 'The Avoidance of taints and contaminations during winemaking'. This presentation was then repeated in the Bordeaux seminar. In addition, the presentation was delivered to Wine & Spirit Education Trust (WSET) students in London. The AWRI and the IMW have both seen positive outcomes from this relationship and intend to continue the collaboration in the future.

Transfer of knowledge relating to viticulture

Staff

Dr Peter Dry, Marcel Essling, Dr Mardi Longbottom, Dr Mark Krstic

During the year, the AWRI Viticulture team responded to 357 viticulture-related enquiries. Approximately half (174) were 'agrochemical-related'. The remaining calls related to various general viticulture enquiries including fungal and insect pest control.

Four *eBulletins* on agrochemical updates were issued, predominantly focused on providing information to the grape sector. A smartphone app to convey information from the AWRI's Agrochemicals registered for use in Australian viticulture (known as the 'Dog Book') was completed for iOS and Android operating systems. The app provides recommendations about chemical use in light of export market requirements and an associated online search facility. The app has been widely downloaded and used by Australian producers. Agrochemical issues of note related to the registration status of active constituents with the Australian Pesticides and Veterinary Medicine Authority (APVMA). The newly registered 'actives' that required investigations were proquinazid and cyflufenamid. Reviews were conducted into: boscalid; clothianidin; fenamiphos; and fluazinam, and the results were reflected in the Dog Book. Weather conditions during the season resulted in generally low disease pressure. Residues in wine continue to be a cause for concern, particularly in those key export markets that do not have established Maximum Residue Limits (MRLs). The issue of 2,4-D in grapes as a result from spray drift remains a concern and a review of a discussion paper prepared by PIRSA was completed.

The AWRI assisted the Department of Agriculture, Forestry and Fisheries with separate requests from the Japanese Food Safety Commission regarding changes to MRLs in Japan and the use of peroxyacetic acid in winegrape production. The AWRI hosted a pesticide delegation from China and reviewed 249 Sanitary and Phytosanitary notifications to identify changes to export market MRLs.

To facilitate the trade of table grapes and protect Australia's reputation as a 'clean and green' primary producer, guidelines similar to that used in the AWRI booklet *Agrochemicals for use in Australian viticulture* were finalised for table grape growers as well as the development of an online search facility under an agreement with Horticulture Australia Limited.

Together with other AWRI groups, the Viticulture team members were active in disseminating relevant information for grape and wine producers at roadshow events, conferences and symposia, through journal articles and books, and lectures in undergraduate courses.

A Research to Practice (RtP) training manual and workshop that compares viticulture under conventional, organic and biodynamic practices was completed in collaboration between Luke Johnston and project staff. Regional associations who would benefit from this workshop being conducted in their region should contact the AWRI.

Supporting industry sustainability

Staff

Dr Peter Dry, Marcel Essling,
Dr Mardi Longbottom, Dr Mark Krstic

Collaborators

AHA Viticulture (Jim Campbell-Clause); Braemore Wines (Ken Bray); National Measurement Institute (Roselle Mailvaganam); Perth Region Natural Resource Management (Keith Pekin); South Australian Research and Development Institute (SARDI) (Peter Hayman); University of Adelaide (Luke Johnston); Treasury Wine Estates (Amy Richards); Wine Grape Growers Australia (Lawrie Stanford); The Yalumba Wine Company (Robin Nettlebeck)

The AWRI commenced a project entitled 'Greenhouse gas abatement in viticulture'. This project will run until May 2015. Nitrous oxide (N_2O) emissions and soil carbon storage were measured under varying undervine and midrow management regimes in commercial vineyards across five Australian grape growing regions (Margaret River, Hunter Valley, Sunraysia, Barossa Valley and McLaren Vale) over the season. The aim of this work is to establish baseline N_2O emission data for those regions and to identify and recommend practices which have potential to reduce N_2O emissions and increase carbon storage in vineyards. First year data were compiled and presented in Hunter Valley (NSW), Vasse (WA), Swan Valley (WA) and Eden Valley (SA).

A Department of Agriculture Fisheries and Forestry (DAFF) Extension and Outreach project will require the AWRI to take a coordinated,

national approach to disseminate current technical information about greenhouse gas emissions, carbon storage and the carbon farming initiative to stakeholders of the Australian grape and wine sector and support them to achieve best management practice in this regard. This will be achieved by delivering current and accurate information to key influencers and people on the ground via a range of extension platforms and decision-support tools.

The AWRI assisted in drafting and submitting four successful Community Landcare Grants applications. The regions to benefit were: Macedon Ranges (Vic), the Granite Belt (QLD) and Coonawarra (SA). The AWRI will manage projects on pest and disease management; grapevine nutrition; sustainable vineyard management practices and winery wastewater management.

Extension to Greater Victoria

Staff

Dr Mark Krstic

In early 2012, the AWRI established a Victorian Node office, co-locating with Wine Victoria and the Rathbone Wine Group in Port Melbourne. The node's operations are possible through funding support provided by the Department of Environment and Primary Industries (DEPI), the GWRDC and Wine Victoria. During 2012/2013 the grape and wine producers of Greater Victoria benefitted from the AWRI's local presence in the region. In 2012/2013, strengthening of ties between the AWRI and DEPI research programs, and the establishment of new research programs with the University of Melbourne has been a particular focus. The AWRI remains committed to supporting the delivery of Wine Victoria's GWRDC Regional program for Greater Victoria.

Key outcomes from the node included the delivery of 17 extension events across Greater Victoria (in addition to AWRI's existing national seminar/roadshow and workshop program), including spray application field days, workshops on vine nutrition, soil health, vineyard management, smoke taint, Pinot Noir, precision viticulture, trunk diseases/viruses, winery operations, and a 'Vintage 2030 and beyond' climate change symposium. These extension activities were delivered in partnership with Wine Victoria and the regional grape and wine industry associations across Greater Victoria.

The Victorian Node has established a number of research programs during the year. The AWRI, in partnership with DEPI, Wine Grape Growers Australia (WGGA) and the University of Melbourne started work on a new GWRDC-funded project 'The adoption of grape and wine R&D outputs. Who, why and what?' This project is led by DEPI social researcher Ms Megan Hill and aims to clarify who the target audience is for wine industry R&D outputs/innovations and how best to deliver information that maximises the level of adoption within the Australian wine sector.

Research is continuing on the joint AWRI/University of Melbourne-supervised PhD program investigating the influence of terroir, growth environment and vine physiology on the accumulation of rotundone in Shiraz wine grapes.

Winemaking and Extension Services – Technical problem solving and consulting

Staff

Adrian Coulter, Matt Holdstock, Geoff Cowey, Gayle Baldock, Emma Kennedy, Con Simos and Dr Yoji Hayasaka

The AWRI's Winemaking and Extension Services team provides a range of advisory, problem solving, extension and information services to the Australian wine sector. In addition to its extension and information transfer activities, which are discussed previously in this report, the Winemaking and Extension Services team provides a technical problem solving and analysis service to levy-payers within the Australian wine sector. The primary aim of the service is not only to provide diagnoses of industry problems, but to offer preventative and remedial advice based on the cumulative problem solving and practical winemaking experience of the AWRI staff.

The technical problem solving service represents a significant proportion of the team's workload and is provided according to strict terms and conditions. Client confidentiality is an important aspect of the provision of the services. This approach facilitates a frank exchange of information between the AWRI and its clients, which in turn allows the maximisation of the knowledge gained from the provision of these services. If a particular problem is considered to be of interest to the wider wine sector, the results of investigative work are made available through multiple extension channels including industry and technical journals, magazines and electronic platforms such as *eNews* and *eBulletins*.

Table 1. Enquiries received by Winemaking and Extension Services advisory staff in the period 2010/2011 to 2012/2013.

	2010/2011	2011/2012	2012/2013
Total	1062	979	1015

The significant number of enquiries received from wineries during 2012/2013 indicates that the AWRI remains a trusted and reliable source of quality technical information and problem solving solutions. Queries are assigned keywords and a database is maintained, allowing trends and spikes to be monitored, and appropriate responses coordinated and executed. Compared with the previous year, the figures for 2012/2013 (Table 1) show a >3% increase in the total number of enquiries received. The majority of the queries were received from wine companies and suppliers closely aligned with the wine industry (approximately 95%), whilst the remaining queries were made up from government organisations (4%) and students (1%). Approximately 20% of queries turned into investigations where samples were requested and analysis performed to ascertain the problem and how it could be remediated. Demographically, the source and proportion of the enquiries received are in alignment with the volume of winegrape production of the different states (Figure 3).

Some of the investigations conducted relate to disputes arising between levy-payers or between levy-payers and suppliers of either materials or contract services. Consequently, and with great sensitivity, staff often find themselves in a mediation role in these disputes, and spend a considerable amount of time providing technical information to legal professionals representing grapegrowers and wine companies. Fortunately, however, the majority of disputes are settled before formal court proceedings are instigated, which is of great benefit to clients.

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 which direct 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 often supplied.

A summary of the number and type of investigations conducted by the Winemaking and Extension team over the past three financial years is presented in Table 2.

The figure for the number of investigations conducted during 2012/2013 is 2% higher than the figure for the previous year (Table 3 and Figure 5). Interestingly, the actual number of investigations for the past few years has been relatively constant (Table 2). South Australia recorded the biggest increase in investigations from the previous year, with nearly a 30% increase. Victoria, New South Wales, Tasmania and Queensland all recorded lower numbers this year compared to the previous year, with the ACT recording higher numbers this year compared to none in 2011/2012 (Table 3).

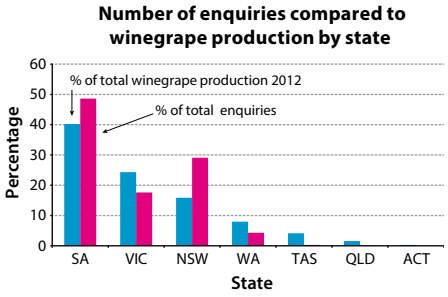


Figure 3. Number of enquiries undertaken by the Winemaking and Extension Services team by state.

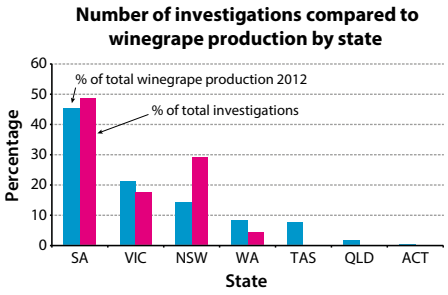


Figure 4. Number of investigations undertaken by the Winemaking and Extension Services team by state.

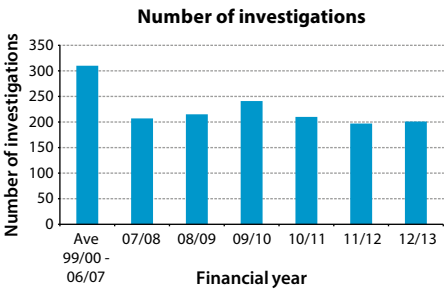


Figure 5. The number of investigations conducted by the Winemaking and Extension Services team during the period 2007/2008 to 2012/2013 and the average number of these types of investigations for the earlier period 1999/2000 to 2006/2007.

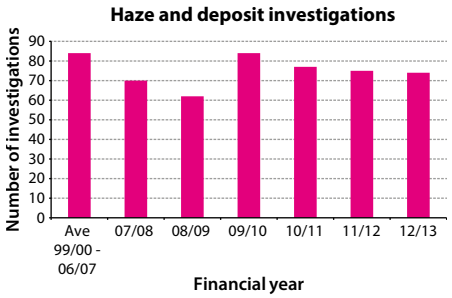


Figure 6. The number of haze and deposit investigations conducted by the Winemaking and Extension Services team during the period 2007/2008 to 2012/2013 and the average number of these types of investigations for the earlier period 1999/2000 to 2006/2007.

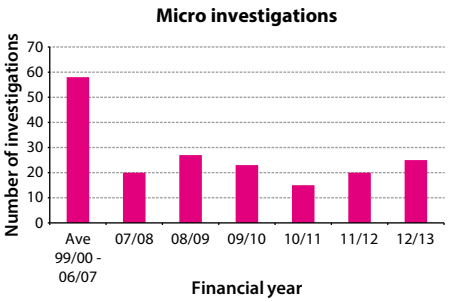


Figure 7. The number of microbiological investigations conducted by the Winemaking and Extension Services team during the period 2007/2008 to 2012/2013 and the average number of these types of investigations for the earlier period 1999/2000 to 2006/2007.

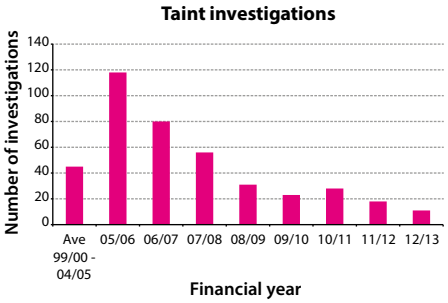


Figure 8. The number of investigations conducted into wines affected by taints during the period 2005/2006 to 2012/2013 and the average number of these types of investigations for the earlier period 1999/2000 to 2004/2005.

Table 2. Summary of the number and type of problem solving investigations conducted, and numbers of samples analysed by the Winemaking and Extension Services team during the past three years.

Type of investigation	Investigations conducted and samples analysed		
	2010/ 2011	2011/ 2012	2012/ 2013
Identification of hazes and deposits	77	75	74
Microbiological investigations	15	20	25
Sensory assessments	5	29	57
Taint problems	28	18	11
Other investigative analyses	37	53	35
Closure-related investigations	2	2	0
Total number of investigations	210	197	202
Total number of samples analysed	1197	816	914

Table 3. Summary of the number of investigations from the different states within Australia during the past two years.

State	Number of investigations conducted	
	2011/ 2012	2012/ 2013
SA	65	92
VIC	50	43
NSW	44	29
WA	11	17
ACT	0	4
TAS	20	16
QLD	7	1
Total	197	202

The number of investigations conducted per state as a percentage of the total and plotted against the state production of winegrapes as a percentage of the total winegrape production data (source 2013 The Australian and New Zealand Wine Industry Directory) is presented in Figure 4.

The total number of investigations conducted into wines affected by hazes and deposits continues to be significant (Figure 6). Many of the deposits identified during the period were crystalline, with a large proportion of these being potassium hydrogen tartrate. Calcium tartrate was another deposit that was observed often and the causes of these were either related to high calcium concentrations (either naturally or through calcium based additives and processing aids 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. These types of problems continue to represent a considerable percentage (37% for 2010/2011; 38% for 2011/2012; and 37% for 2012/2013) of the total number of investigations performed. Consequently, issues related to such instability problems are continually being addressed during the AWRI's Roadshow workshops and via other AWRI communication media such as the AWRI website, *eNews* and *eBulletins*.

The number (25) of investigations conducted into microbiological instabilities increased this year (Figure 7). The investigations were varied and included problems such as increasing volatile acidity (VA), refermentation, Brett-related spoilage, stuck fermentations and post-bottling yeast growth. In some instances, these problems can be attributed to 'carry-over' from the difficult 2011 vintage. In other cases, in particular where Brett was identified, the wineries involved need to become more vigilant at keeping this spoilage yeast under control. Awareness of how to avoid these issues continues to be addressed at regional workshops, as bottling issues have represented a large proportion of the queries received by the AWRI's Winemaking and Extension Services team in recent years.

Investigations conducted under the category 'Sensory assessments' spiked from 29 in 2011/2012 to 57 in 2012/2013. This year's figure (57) is similar to the number (50) of sensory investigations performed during the 2010/2011 reporting period. The types of investigations carried out under the 'Sensory assessments' category vary from year to year, winery to winery, and this year was no different with relatively even numbers of wines being submitted exhibiting 'Brett related characters', 'reductive' characters; wines reported to be affected by 'unknown' or 'unusual' sensory characters; wines showing 'deterioration' or 'variability' after packaging; or wines that might have been the subject of a 'customer complaint' with TCA and 'other' types of taints. Sensory evaluation is an important analytical and research tool, and is also commonly used in problem solving investigations classified under other categories, such as 'Microbiological investigations', 'Taint problems' and 'Other'.

The number (11) of taints investigated in the past 12 months was lower than the previous year (18), and is well below the average figure (45). This is the lowest number of taints ever recorded in a 12 month period (Figure 8). These data might indicate that, at least in part, the strategies for avoiding taints and contaminations advocated in the workshop 'The avoidance of taints and chemical instabilities during winemaking', which was delivered as part of the AWRI's Roadshows from 2006 to 2009, are still being adopted by the Australian wine sector. The taint investigations that were carried out in the period were quite varied in nature, and included wines tainted with musty compounds and wine made from smoke tainted fruit (discussed further elsewhere in this report). Another taint investigation that was carried out involved a wine contaminated with hydrocarbons – the source most likely being the painted concrete tank which the wine had been stored in. Insufficient curing time plays a large part in the migration of compounds from painted tanks into wine, however winemakers fortunately see few taints arising from this mechanism. Interestingly, in the two investigations where musty type compounds were identified, the likely source was water that had been used in the winery. The team regularly reminds winemakers about the numerous potential sources of taint, with water entering the winery being one of these. Encouragingly, no taint investigations were conducted on wines related to transportation in flexi-bags, and no post-bottling cork-type taint investigations were conducted by the team, the latter being most likely related to the volume of wine now being closed under screwcap; however, TCA-type contaminations are still occurring from mechanisms unrelated to cork.

The Winemaking and Extension Services team is in a unique position to investigate unusual problems or problems that a typical winery or winemaker might only encounter once or twice in a lifetime of winemaking. For example, this past year, the team identified quercetin dihydrate (one of the flavonol compounds which are natural components of grape skins and leaves) in wine three times, which makes nine occurrences in the past two years. There were three oxidative pinking investigations conducted in the past 12 months, which was the same number as the previous year. Oxidative pinking is a phenomenon where white wines which have typically been made under highly anaerobic conditions turn pink when exposed to some oxygen. The pink colour can be removed through fining with virtually no damage to the wine. Further research is required in this area to fully understand the mechanism for this pinking phenomenon. Grapeseed oil taint is another problem that the AWRI sees each year, although typically this occurs in vintages that are hotter and drier. This year, grapeseed oil was identified in wine four times. The contamination of grapes during harvest with hydraulic oil is another common query which the team receives during vintage; however, a robust technique does not exist for determining contamination of this type of material in processed juice or wine.

Development of an alternative method for laccase

During the wet 2011 vintage, almost one in every five requests for technical assistance to the AWRI's Winemaking and Extension Services team was related to the presence of *Botrytis* and laccase. A high number of the calls received were requests for assistance in interpreting the results of laccase testing using the two commercially available kits: the *Botrytest* and *Dolmar* laccase test kits.

Laccase is a soluble, extra-cellular enzyme secreted into grape berries by *Botrytis cinerea*, and has been reported to always be present in *Botrytis* rot-affected must (Somers 1983). Laccase is capable of causing serious oxidative damage to juice and wines; consequently, juices and wines made from *Botrytis*-affected fruit should be tested for laccase activity.

Laccase test kit results: issues with interpretation

Interpretation of laccase activity in some red juice and wines proved difficult during 2011, with reports of false positive and false negative results from commercially available tests. In the case of red juice samples, there were observations that laccase test kits seemed to underestimate potential laccase activity, based on the level of *Botrytis* infection in the vineyard and the laccase activity measured in the resulting wines. Conversely, in some deeply coloured Shiraz juices and wines, higher than expected results were obtained based on the level of *Botrytis* infection observed in the vineyard. In some cases, 'control' samples from vineyards with no *Botrytis* infection returned positive results for laccase.

Another issue concerned the laccase activity scales used by the commercial test kits. The *Botrytest* kit reports laccase activity in units of activity per mL (U/mL) and uses a scale of 0 to 20 U/mL, whilst the *Dolmar* laccase test kit reports laccase activity as Laccase Units and uses a scale of 0 to 1.5 Units. Many winemakers queried how the two scales relate to one another and what level of laccase activity should be considered to be of concern.

Possible causes of 'false negative' and 'false positive' results

The issues of 'false negative' and 'false positive' results associated with deeply coloured Shiraz samples were considered to be related to the decolourising step and the fact that the reagent (syringaldazine) used in the laccase test kits produces a pink/purple-coloured oxidation product. Samples might begin with a slight pink tinge if red juice or wine samples were ineffectively decolourised, and this could be misread as a 'false positive' laccase result. Alternatively, the presence of a slight pink tinge at the start of the analysis can make it difficult to detect a small change in pink/purple colour due to a low level of laccase activity, leading to a 'false negative' result. It was also thought possible that the decolourising step might not only remove colour, but laccase as well, which could lead to a 'false negative' result at low laccase levels.

An alternative method

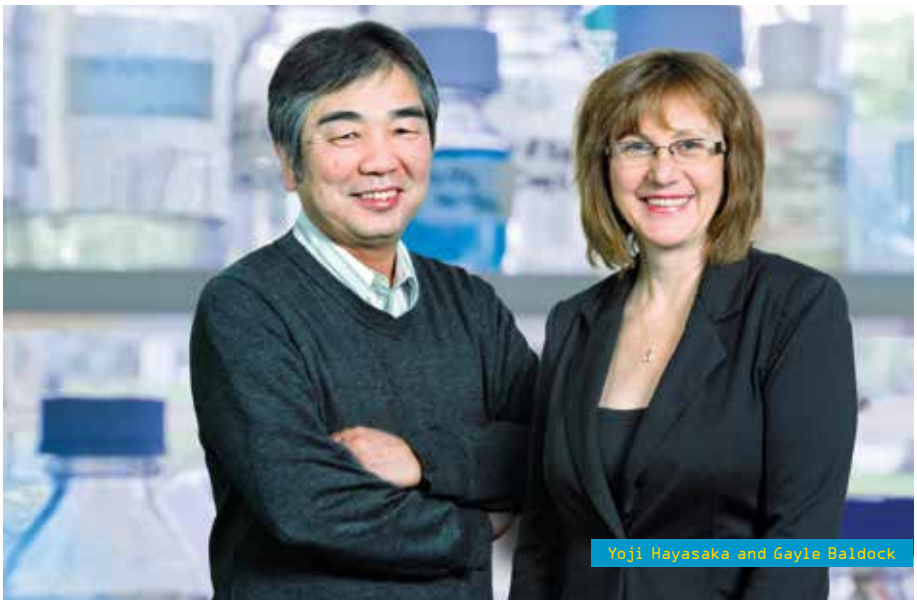
Given that the colour change associated with the syringaldazine oxidation substrate used in the commercial test kits appeared to make the interpretation of results difficult in the case of deeply coloured red wines, an alternative substrate was investigated. The substrate used, which is abbreviated ABTS, turns a green colour rather than a pink/purple colour, making it easier to observe a colour change in the presence of laccase. The colour change was measured using a spectrophotometer; however, a colour chart could also be used, similar to the two commercially available test kits.

Different decolourising agents were also trialled at different rates in order to obtain the best removal of colour whilst at the same time maximising the detection of laccase.

Testing the method

Forty-five grape samples (mainly red) affected by *Botrytis* to varying degrees were collected during the 2012 vintage in order to test the method and compare the results to those of the two commercially available laccase test kits. The grape samples were crushed using a basket press and the juices were fermented to wines. The 45 juices and corresponding wines were tested for laccase activity using the ABTS method and also the *Botrytest* and *Dolmar* laccase test kits. In addition, the juice samples were tested using the QuickStix™ immunoassay, which can quantitatively screen for the presence of *Botrytis cinerea* by providing 'intensity values'. The juice samples were also tested for the concentrations of gluconic acid and glycerol, which can also be indicators of *Botrytis* infection.

During the 2013 vintage, 70 grape samples affected by *Botrytis*, mainly mildly affected samples, were collected in order to further test the ABTS method at low levels of infection. The grape samples were hand crushed and the juices were tested using the ABTS method and also the *Botrytest* and *Dolmar* laccase test kits.


Yoji Hayasaka and Gayle Baldock

Results

The ABTS method appears to be more sensitive at lower levels of laccase in red juices and wines than the two commercially available test kits. In addition, the efficient colour removal method and the green colour change associated with the laccase-ABTS substrate reaction means that the probability of 'false negatives' and 'false positives' is greatly reduced, if not eliminated.

When the Quickstix™ intensity values were compared with the three laccase method results, the best correlation was obtained for the ABTS method, followed by the *Botrytest* kit and then the *Dolmar* test kit. There was very good correlation between the Quickstix™ intensity values and the glycerol results, suggesting glycerol is a good indicator of *Botrytis* infection. Whilst gluconic acid concentration was also correlated with the Quickstix™ intensity values, the correlation was not strong. At higher Quickstix™ intensity values, there was a large variation in gluconic acid results. This is likely due to the fact that high-level *Botrytis* infections are often accompanied by other infections which can also produce gluconic acid. Nevertheless, it appears that the gluconic acid concentration can be used as an indicator for *Botrytis* infection.

The correlations between gluconic acid concentration and the three different laccase methods were poor, suggesting that gluconic acid concentration is not a good indicator of laccase activity.

With regards to the different laccase kits and the units and scales used, it was found that the lowest levels on any of the scales might be indicative of laccase activity.

Availability of the ABTS method

It is intended that the ABTS laccase method will be available before vintage 2014, so that winery laboratories will be able to implement the test if required.

Reference

AWRI publication #236. Somers, C. *Botrytis cinerea* – oenological consequences. *Technical Review* 27: 13–18; 1983.

Applications of mass spectrometry to ensure the quality and integrity of Australian wine

Staff

Dr Yoji Hayasaka, Gayle Baldock, Mango Parker

The members of the Mass Spectrometry team work collaboratively across the AWRI and also with external researchers.

Investigations of taint problems using mass spectrometry

Accidental contamination of juice or wine is a problem with respect to wine quality as well as human health issues. Therefore taint investigation is important to maintain the credibility of the industry at high standard.

Collaborators

The AWRI Winemaking and Extension Services Team.

Nine separate investigations were carried out using various mass spectrometric techniques through the year. The following taint/contamination investigations were highlighted:

- A large study to determine the potential for hoses to taint wine was carried out. Sensory analysis of the hose-contacted wine samples revealed characters such as 'reduced', 'furniture polish' and 'petroleum/kerosene'. Headspace SPME-GCMS analysis revealed that the hose-contact wine contained styrene, benzothiazole, BHT, 2,6-di(t-butyl)-4-hydroxy-4-methyl-2,5-cyclohexadien-1-one,

1,6-dimethyl-4-(1-methylethyl)-naphthalene, isothiocyanato cyclohexane and 2-(methylthio) benzothiazole. Their concentrations increased with an increasing contact time with the hose, indicating that the hose was responsible for tainting wine.

- An investigation was conducted on a 2012 Shiraz wine which was described by the winemaker as having a 'burnt stator' aroma. Elevated levels of hydrogen sulfide (25 ppb) and methyl mercaptan (3 ppb) were detected and were suspected to be responsible for the burnt rubber-like, reduced character. Sulfur is a compound commonly used in the vulcanisation process of rubber products. The sulfides mentioned above, most likely derived from heated sulfur compounds within the stator itself, provide the best marker for these types of burnt stator or overheated pump issues. This finding is in agreement with a similar previous taint case.

- A 2010 Grenache wine was submitted for investigation of a possible taint derived from a painted concrete tank. Taint screen analysis revealed that the suspect wine contained C2, C3 and C4 alkyl benzenes at considerably high concentrations. In addition, five isomers of the compound nonylphenol were also found to be abundant. Nonylphenol is used as a hardener (accelerant) in concrete and epoxy products. The winemaker indicated that the suspected tainted wine had been stored in a painted concrete tank. Interestingly, during a bench tasting of the wine, the descriptor 'Araldite epoxy' was used to describe the tainted wine.

Investigations into smoke-affected grapes and wine

The AWRI continues to play a proactive role in the understanding and management of smoke taint, communicating outcomes and assisting regions affected by fires in providing technical support and educational activities.

Collaborators

The Department of Environment and Primary Industries Victoria (Dr Mark Downey); University of Adelaide (Dr Kerry Wilkinson); the Department of Agriculture and Food Western Australia (Glynn Ward); and Industry partners.

Phenolic glycoside analysis as a smoke diagnostic tool was developed and subsequently implemented

As reported in previous Annual Reports (2011 and 2012), a new diagnostic assay based on phenolic glycoside analysis was developed and validated to assess the level of smoke exposure in grapes and wine. Phenolic glycosides, which are formed in grapes following smoke exposure, were confirmed to be significantly better marker compounds to indicate smoke exposure than guaiacol and other volatile phenols, as judged by the ability to distinguish between smoke-affected and non-smoked samples (AWRI publication #1498).

As part of collaborative activities with the DEPI Victoria, the reference compounds for the glycoside analysis, labelled and non-labelled syringol gentiobiosides were given to DEPI for their adaption of the AWRI method. For the cross-evaluation of the glycoside method, 23 samples (juice, ferment and wine samples) were received from DEPI and analysed by the High Performance Liquid Chromatography-Mass Spectrometry/Mass Spectrometry (HPLC-MS/MS) method for the quantification of phenolic glycosides. The results were reported to DEPI.

Development of a method for the quantification of phthalates in wine

Phthalates are mainly used as plasticisers and are ubiquitous in the environment and low background levels are found in all foods and beverages including wine. In late January 2013, it became apparent that testing of wine for phthalate content could be required for exported wine. In response, it was decided that a reliable quantification method of phthalates in wine needed to be developed.

Collaborators

The AWRI's Winemaking and Extension Services team and AWRI Commercial Services

Although a broad range of analytical methods for the quantification of phthalates have been reported, the application to the wine matrix was limited. Ten phthalates: dimethyl-, diethyl-, di-*n*-butyl-, di-*iso*-butyl-, bis(2-ethylhexyl)-, butyl benzyl-, di-*iso*-nonyl-, di-*iso*-decyl-, di-*n*-octyl- and dicyclohexyl-phthalates were targeted for quantification.

The AWRI has been developing two methods using (1) Gas Chromatography-Mass Spectrometry (GC-MS) with Solid Phase Microextraction (SPME) and (2) HPLC-MS/MS. Both methods were confirmed to be capable of detecting all the phthalates at a concentration of less than 5 µg/L (5 ppb) in wine. Further method validation and evaluation in terms of their reliability, rapidness, simplicity and robustness is in progress.

In addition, the AWRI has participated in an international collaborative study on the validation of the OIV-endorsed method based on liquid/liquid extraction and GC-MS/MS. This validation is organised with the endorsement of the OIV. The AWRI is now preparing for a pre-study trial analysing three different samples sent from the organiser.

Regulatory, technical and trade issues impacting on the Australian wine sector

Staff

Creina Stockley

The AWRI provides regulatory and technical advice and assistance to the Australian wine sector. During the year, 69 independent regulatory, science and technical-related information requests were received from the wine sector, the general public and government.

Support to the wine sector has been provided through membership of numerous international and

Jelena Jovanovic and Angus Forgan

Karl Forsyth and Josh Hixson

domestic government and industry committees. Creina Stockley continued as the DAFF-nominated Australian delegate for the OIV Expert Group and President of the Health and Safety Commission IV. In conjunction with the Wine Industry Technical Advisory Committee, the 'Code of Good Manufacturing Practice for the Grape and Wine Industry' was revised and updated. This is now the third edition and is available on the AWRI website.

Technical and regulatory issues

Technical and regulatory support to the Australian wine sector is ongoing as issues are regularly raised by industry or government, both in Australia and internationally, and often span several years. During 2012/2013, technical and regulatory information and/or issues that have been reviewed, and/or required the preparation of materials include:

- OIV definition for products regarding sugar concentration, classification of wines according to the sugar content in Australia and potential definitions for the adjectives 'dry' and 'sweet'
- Legality of use of acacia barrels; chestnut-derived oak; ascorbic acid; genetically modified products; ethanol additions; grape skin extracts; chaptalisation; liquid oak; ion-exchange resins; hybrid varieties; yeast autolysates; inactivated yeast; inositol and manno-proteins in Australian winemaking
- Acceptable and allowable copper, manganese and lead levels in Australian wine
- Sources of gelatine for winemaking
- Limits on alcohol content of Australian wines and the analytical tolerance for alcohol labelling
- Pregnancy and other health warning labels
- Elements of the blood alcohol concentration curve
- Analyses of health-specific phenolic compounds in wine and the potential health benefits of low alcohol wines
- Allergen and other health warning labels related to additives and processing aids, including analysis of histamine and other biogenic amines in wine, allergen labelling on wine that has been fined with fish products (isinglass) and the production of preservative-free wines
- Human health issues associated with use of diatomaceous earth and silver chloride
- International export regulations and accreditation standards
- Use of flash pasteurisation versus other sterilisation methods

The AWRI is represented on three OIV working groups – 'Taskforce on additives and processing aids in China', 'Protocol for the evaluation of the risks related to food safety for new oenological treatments' and 'Taskforce on allergens'. The former working group is preparing scientific and technical dossiers on the additives and processing aids not currently permitted for winemaking in China and hence not permitted to be present in Australian wine exported to China. The dossiers will be submitted to the Chinese government. The aim of the latter working group has been to coordinate analytical and clinical research into 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. The European Union has implemented the requirement to label for the presence of milk and egg products from 1 July 2012 but has included a caveat to the clause, which defers to the detection limits of 'Resolution OIV-OENO 427-2010 for the methods of quantification of potentially allergenic residues of fining agent proteins in wine'. In practice, if milk or egg products are used in the winemaking process but the wine has tested negative for the presence of residues using a technique with a detection limit of 0.25 mg/L then the presence of residues does not need to be indicated. The OIV Taskforce on allergens has subsequently prepared the *Good fining practice guidelines for wine to be applied after the use of proteinaceous [allergenic] wine fining agents [casein and egg white]* to complement the OIV resolutions. This Code is now included on the OIV website for winemakers and placed within the OIV's step-wise resolution system for eventual adoption and also for inclusion into European Commission regulations. Supporting these endeavours, the AWRI Report entitled *What's in a label? How science is helping winemakers to respond to new EC rules concerning allergens in wine* was published in the *Wine and Viticulture Journal*.

The Health and Regulatory Information Manager also coordinates Course 3005WT 'Grape industry practice, policy and communication' for the School of Agriculture, Food and Wine at The University of Adelaide. In its seventeenth year, 23 students enrolled in the course, which exposes students to organisational, commercial, environmental, political, societal and technical issues relating to the wine sector's operating environment.

Grape and wine composition

Defining and controlling important volatile compounds and their impact on wine aroma and flavour

Staff

Dr Leigh Francis, Dr Markus Herderich, Dr Cory Black, Dr Dimitra Capone, Dr Christine Mayr, Tracey Siebert, Samantha Anderson, Sheridan Barter, Mark Solomon, Kevin Pardon.

Collaborators

Balnaves Wines (Peter Bissell); Casella Wines (Steve Warne); Copenhagen University/University of Adelaide (Dr Damian Drew); Craggy Range Vineyards (NZ); CSIRO Ecosystem Sciences (Dr Rob Bramley); Institut Français de la Vigne et du Vin Pôle Sud-Ouest (Olivier Geffroy); Orlando Wines (Nick Bruer); Mt Langi Ghiran (Nathan Scarlett, Damien Sheehan); Mt Majura Vineyard (Frank van de Loo); Shaw and Smith Winery (Darryl Catlin, Ray Guerin); Medhurst Wines (Matt Steel, Julian Grounds); Victorian Pinot Noir Producers; Pirie Wines (Andrew Pirie); Treasury Wine Estates (Paul Petrie, Roger Schmidt); University of Adelaide (Dr David Jeffery); University of Auckland (Gerard Logan, Assoc. Prof. Paul Kilmartin); University of Melbourne (Pangzhen Zhang, Dr Kate Howell, Prof. Snow Barlow); Professor Philippe Darriet (University of Bordeaux).

Sheridan Barter and Dimitra Capone

A deep understanding of key aroma compounds that give wine its complex and subtle flavours provides the basis for wine producers to adjust and optimise practices to achieve well favoured and balanced wines. Flavour chemistry of wine can be highly challenging, needing high level skills in analytical chemistry, organic synthesis, structural elucidation and reaction mechanisms to disentangle the often tiny amounts of potent odourants from the combination of hundreds of unimportant volatiles. An essential aspect of many AWRI studies is the ability to relate the chemical composition of grapes and wine to sensory properties and linking this to changes caused by grape berry and microbiological metabolism and/or wine production.

The final stages of the project investigating the causes of mint flavour were completed in this past year. Hunting for novel compounds in wines described as minty or eucalyptus showed that all wines studied had substantial amounts of eucalyptol and confirmed that this is indeed the predominant compound contributing this flavour to red wines. While other mint related compounds were identified, it is likely they might adjust the flavour properties of a wine beyond eucalypt to enhance related descriptors such as camphor or menthol.

In previous work, a survey of eucalyptol concentration of a wide range of Australian wines was conducted and, in recent studies, additional data have been obtained on Pinot Noir wines from Tasmania and Victoria and Cabernet Sauvignon wines from Coonawarra, to assess in a more targeted way the prevalence of this compound. The AWRI found that more than 60% of wines had a concentration above the reported aroma detection threshold, with a small number having very high levels. While most wines had low concentrations, less than 2 ug/L, there was a small number of wines with relatively high eucalyptol levels, with five wines surveyed having eucalyptol levels of greater than 10 ug/L. If required, simple avoidance of eucalyptus leaf and woody material being harvested with grape bunches will significantly reduce the ultimate eucalyptol concentration of finished wines.

The black pepper compound rotundone, first discovered by the AWRI as a major compound in Shiraz wines several years ago, has continued to be studied in collaborative projects with colleagues in several research organisations and wine companies. The AWRI was privileged to have worked closely with Nathan Scarlett from Rathbone Wine Group who passed away in July 2013. Nathan was the initiator of and driving inspiration behind a collaborative research project exploring viticultural impacts on rotundone formation. He remained determinedly and actively involved in the project right up to the time of his passing. Results from a highly detailed study that related soil and other precision viticultural measurements with rotundone concentrations on a vineyard block in the Grampians region in 2012 and 2013 with Dr Rob Bramley of CSIRO showed that there was marked variation in berry rotundone across the vineyard, and that this was spatially structured with zones of higher and lower berry rotundone within the block. The 2013 season gave lower overall levels and a narrower range across the block. Potential causes of this variation are now being studied in greater detail together with the University of Melbourne and Mt Langhi Ghiran. A novel membrane-assisted sample preparation method for trace volatiles has been developed; this has improved the quantification of rotundone, sample throughput and cost of analysis. Complementary work with researchers at the University of Auckland and Institut Français de la Vigne et du Vin Pôle Sud-Ouest provided valuable information regarding viticultural effects on rotundone levels (with clonal differences being clearly apparent). The compound was confirmed to accumulate during late stage ripening in both Syrah and Duras; and the effects of leaf removal and high vigour were found to reduce the concentration in berries. The vine water status was also shown to have an effect.

Following from the observation that smoke taint-related flavour precursors can be broken down in-mouth during tasting, investigations have been initiated to assess the extent of fruity flavour release during wine consumption. This work will be continued in the new AWRI 5 year RD&E plan.

A quantification method has been developed for compounds which have been reported to be responsible for oxidative flavour in wines. The method currently includes the key aroma compounds sotolon: furaneol, homofuraneol, phenylacetaldehyde, furfural, methylfurfural, hexanal, E-(2)-hexenal, E-(2)-heptenal, E-(2)-octenal, E-(2)-nonenal, methional, methionol, 3-methylbutanal, 2-methylpropanal, eugenol, benzaldehyde and maltol, using a sophisticated gas chromatography-tandem mass spectrometer instrument.

In applying the method to wines exposed to oxygen, the compounds phenylacetaldehyde (honey-like) and methional (cooked potato-like) were the most important sensorily, and the method will be applied to future studies. The relevance of this method is highlighted in Figure 9, which shows the concentration of phenylacetaldehyde and methional in a Semillon wine under different closures.

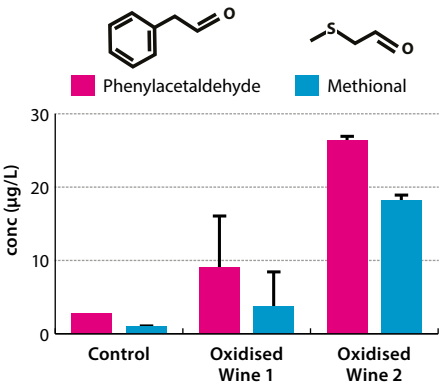


Figure 9. The concentration of phenylacetaldehyde and methional in a control Semillon wine stored anaerobically for 14 years in a sealed ampoule, and two wines stored under cork (wine 1) and a synthetic closure (wine 2). The sensory detection threshold of phenylacetaldehyde is approximately 1 µg/L, while that of methional is 0.5 µg/L.

In studies with David Jeffery of the University of Adelaide, an analytical method has been developed and validated to quantify potent thiols that contribute to tropical fruit flavour and complex roasting notes in wine. The new method requires little sample preparation and has many advantages over previously reported methods; for the first time, the AWRI can now robustly quantify trace amounts of compounds such as benzenemethanthiol (smoky, struck flint) and furfuryl thiol (coffee).

Phenolics and their contribution to wine composition and sensory properties

Staff and students

Dr Paul Smith, Dr Keren Bindon, Dr Yoji Hayasaka, Dr Jacqui McRae, Dr Martin Day, Richard Gawel, Stella Kassara, Alex Schulkin

Collaborators

Accolade Wines (Chris Bevin); The Australian Synchrotron (Dr Nigel Kirby); Flinders University (Dr Ingo Köper); Orlando Wines (Kate Lattey); Rathbone Wine Group (Nathan Scarlett); SARDI (Dr Michael McCarthy); University of Melbourne (Professor Tony Bacic); University of Queensland (Dr Zyta Ziora); University of Sheffield (Dr Robert Falconer); University of South Australia; the staff, students and collaborators of the *Tasmania node* projects.


Paul Smith and Jacqui McRae

This suite of projects has the objective of determining the function of phenolic compounds in grapes and wine. Of specific interest is identifying phenolic compounds that have importance with regard to wine colour, mouth-feel, and taste. The AWRI also aims to develop an understanding of grape and wine phenolic attributes related to consumer wine preference. Building on this, the effective management of relevant components in the vineyard and winery to achieve a targeted wine composition, or style, is evaluated. Finally, the verification of current and potential risks associated with novel practices and new technologies are considered critical aspects to the success of the projects.

Astringency: The impact of wine matrix on tannin composition and protein binding

Red wine astringency is influenced by a variety of factors including tannin concentration, tannin composition, and wine matrix components. In previous years, research has focused on the impacts of tannin concentration and composition on the sensory attributes of red wine (AWRI publications #1504, #975). More recently, the focus of research projects has been expanded to include wine matrix components such as ethanol, pH, oxygen and metal ions.

Wines with lower ethanol concentrations are reportedly more astringent (at similar tannin concentrations) although the reasons for this are unclear. The AWRI investigated the size and shape of different isolated wine tannins in model wine solutions containing a range of ethanol concentrations using small-angle x-ray scattering (SAXS) at the Australian Synchrotron. The samples analysed were the same wine tannin fractions that had previously been investigated for their sensory properties: aqueous and butanol soluble fractions from a three-year and a seven-year old Cabernet Sauvignon wine, as well as the total tannin fraction from each vintage. The aqueous fractions from both vintages contained larger tannins that were more water-soluble and these fractions were more astringent than the butanol fractions which consisted of smaller, more alcohol-soluble tannins. SAXS analysis was used to determine differences in size and shape of these tannin fractions that might explain the differences in sensory properties. The impact of wine matrix variables: ethanol concentration, pH and ionic strength, on tannin size and shape was also investigated using the total tannin fractions of the younger and aged wine tannins.

SAXS analysis enabled the estimation of tannin size in solution under different wine-like solutions, which so far was not possible using the standard laboratory methods for determining tannin molecular mass. Tannin size and shape for each sample remained consistent across the different wine matrix variables, indicating that changes in astringency with, for example, ethanol concentration and wine pH, might be due instead to differences in solubility, aggregation or protein-affinity. Importantly, the SAXS results for tannin size in wine-like conditions correlated well for wine tannins across all methods, validating the laboratory methods for estimating tannin molecular size.

The SAXS data also provided clues to the shape of the different tannin samples. The butanol tannin fractions from both vintages had ellipsoid shapes while the larger tannins in the aqueous fractions had less regular structures, potentially indicative of an extended structure with more branching (rather than linear polymers). This might in part account for the greater astringency that was observed with these fractions compared with the butanol

fractions. The total tannin sample from the aged wine was larger than that of the younger wine, although both samples were of the same ellipsoid shape, contrary to one theory that aged wine tannins are more 'rounded' and thus have less protein interaction than the supposedly elongated young wine tannins. Further investigations using density measures and molecular modelling might provide a more detailed explanation of the mouth-feel differences between aged and young red wines.

Knowledge of the wine matrix components that influence wine tannin structure and structural changes during ageing is one component of managing tannin composition and thus mouth-feel in finished red wines. Two studies have been completed to investigate matrix components: a long-term trial in red wine and a short-term trial in model wine. The impact of wine pH and closure type on wine colour, tannin concentration and composition of a single vintage Cabernet Sauvignon wine was investigated over 24 months of bottle ageing. Just prior to bottling, the pH was adjusted to pH 3.2 and to pH 3.8, and was bottled under screw cap with either a Saranex liner (to allow a minimal ingress of oxygen) or a SaranTin liner (to restrict all oxygen ingress). After 24 months, the wine colour density, total anthocyanin concentration and total phenolics had decreased significantly, while the hue and proportion of stable pigments increased significantly. At pH 3.2, the total anthocyanin concentration was 192.0 ± 5.0 mg/L, compared with 247.8 ± 3.9 mg/L for pH 3.8. The proportion of stable pigments was 7.62 ± 0.22 and 7.11 ± 0.11 % for pH 3.2 and 3.8, respectively.

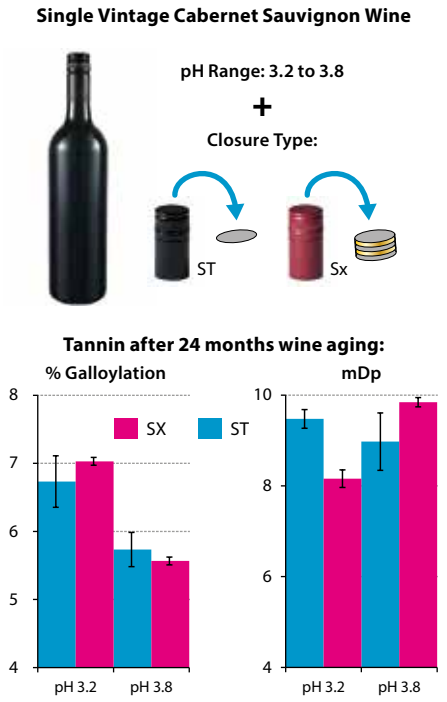


Figure 10. Effects on seed tannin markers (% galloylation) and size (mDp) of Cabernet Sauvignon wine tannin after two years of storage at pH 3.2 and pH 3.8 under two different screw cap closures.

Tannin concentration decreased from 1.86 ± 0.2 to 1.29 ± 0.7 g/L over the 24 months, irrespective of pH or closure type, and tannin composition was influenced by both oxygen exposure during ageing and pH. The molecular size of tannin in all samples remained consistent, except for the wine at pH 3.2 bottled under Saranex which showed a slight decrease in tannin molecular size. The proportion of tannin that is resistant to being broken down into the comprising subunits (i.e. tannin that has undergone oxidation) was significantly increased with wine ageing, most notably at pH 3.2 and particularly under Saranex. The tannin from the wines at pH 3.5 and pH 3.8 contained significantly fewer epicatechin gallate subunits (related to seed tannin) than wines stored at pH 3.2. In summary, low pH wines contained more stable pigments, and those with more oxygen exposure had smaller tannins that were more oxidised, while wine tannin in higher pH wines contained fewer seed tannin-like structures (Figure 10). Changes in red wine mouth-feel with ageing might, therefore, be related to a combined effect of decrease in tannin concentration and change in tannin composition.

White wine mouth-feel perception

Polysaccharides are the most abundant macromolecules in white wine and derive from both the grape and yeast. Previous studies conducted at the AWRI using model wine systems demonstrated that polysaccharides have the capacity to contribute to palate viscosity, and to moderate undesirable characters such as bitterness, metallic character and astringency. In recent work, wine realistic concentrations of purified polysaccharides from two commercial white wines were added back to a white wine that had a range of phenolic and alcohol concentrations. A trained panel profiled the wines and found that adding polysaccharides slightly reduced wine flavour and perceived acidity, but astringency was unaffected. The effect of polysaccharides on these attributes was largely independent of phenolic content. However, the most consistent effect of a higher polysaccharide concentration in white wine was that of reducing palate hotness.

In order to better understand the effect of polysaccharides on the perception of alcohol hotness, whole polysaccharides from white wines were fractionated according to their molecular weight (high > 150kDa, medium 12-150kDa and small <12 kDa). These were added to model wines that had been flavoured using a mixture of compounds commonly found in Chardonnay. The model wines were then presented to a trained panel for aroma, taste and texture assessment, at two alcohol and two pH levels chosen to represent a range typically observed in commercial white wine. This experiment confirmed that alcohol hotness was reduced, and flavour was increased, in the presence of medium molecular weight polysaccharides. Other major findings were that the effect of polysaccharides on taste and texture was dependent on pH and alcohol concentration, and that these aspects of the wine matrix more strongly influenced white wine taste and texture than did polysaccharides.

To complement the reconstitution experiments, the polysaccharide profiles of Chardonnay, Riesling and Viognier wines made using different juice extraction and handling methods were quantified over two vintages. The oenological treatments included free run, whole bunch press, pre-fermentation cold maceration, solids ferment, press fractions and hyperoxidised free-run and hard pressings. Juice extraction and handling resulted in both significant differences in the total concentration of wine polysaccharides and in their size distribution (Figure 11). Whole bunch pressed wines produced more total polysaccharides compared to wines made from hard pressings; hyperoxidised free run juice and pressings consistently produced higher levels of total polysaccharides compared to the equivalent wines that were made using non-oxidative

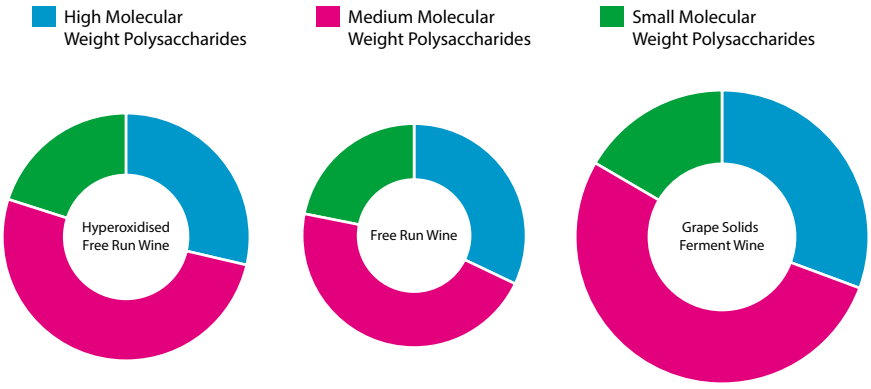


Figure 11. Polysaccharide content of white wine made using different juice handling methods. Size of circles indicates total polysaccharide concentrations.


Esther Kristianto, Mark Solomon, Natoiya Lloyd

juice handling practices. Fermenting on solids produced the largest increase in total polysaccharides compared to wine made from free run juice of all three varieties. While this treatment was only conducted in the 2011 vintage, an average increase of 80% in total polysaccharides over the clarified free run control was observed. Importantly, most of the increase in polysaccharides from solids fermentation was attributable to increases in the medium molecular weight fraction which were later identified as being responsible for reductions in alcohol hotness.

Predicting and modelling tannin extractability

Previous work has shown that the concentrations of total tannin in grapes and wine are not always closely correlated. One possible factor which might significantly affect tannin extraction from grapes is the binding of tannins to grape cell walls. The AWRI aimed to develop a method to predict how much grape tannin is extractable during winemaking and what accounts for back-binding effects; i.e. tannin binding to flesh or marc cell wall material. A diverse sample set of grapes with a broad range of tannins was sourced with assistance from the late Nathan Scarlett (Rathbone Wine Group). Wine made from these grapes had a wide range of wine tannin concentrations: from 200 mg/L to 700 mg/L. Differences in wine tannin concentration were found to be mainly due to changes in skin tannin extractability. Using a simple extraction of crushed whole berries with dilute alcohol (15% v/v) allowed the prediction of wine tannin concentration from grape tannin data. This extraction method mimics the array of interactions which might drive solubilisation or retention of tannin during fermentation, notably the interaction with cell walls. Also, the size (mean degree of polymerisation [mDP]) and composition of the tannin extracted with dilute ethanol was similar to the corresponding wine tannin. This simple extraction method is being further investigated to establish its performance as a tool for the practical assessment of grapes from commercial vineyards.

Further to this, the AWRI's ongoing work on grape tannins has continued with focus on changes in cell wall structure and their influence on the binding between tannin and grape cell walls components. During ripening, changes in skin cell wall polysaccharides occur early in grape development, and only minor changes in their composition are found in the later stages of ripening (AWRI publication #1458). Despite this, the AWRI has shown that skin tannins are bound more by riper skin cell walls (AWRI publication #1458). A key factor which changes during grape ripening is the porosity of cell walls. Through collaboration with researchers at the Ian Wark Research Institute, University of South Australia, the AWRI has found differences in skin cell wall porosity using nitrogen adsorption isotherms, based on the Brunauer–Emmett–Teller (BET) theory which describes the physical adsorption of gas molecules on a solid surface. These experiments demonstrated that the grape cell wall surface area increases significantly with ripening. This was further visualised using scanning electron microscopy (Figure 12). These results partly explain why total skin tannin can increase with ripening with a concomitant decrease in extractability (% of total); this appears to be a result of increases in skin cell wall porosity that lead to grape tannin becoming bound in micropores. Yet, in winemaking, it is commonly observed that skin tannin extraction into wine is enhanced with advancing grape ripeness. This is because the skin tannin concentration increase generally outweighs the binding up of tannin by the pores (which open up with ripening).

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Microbial Metabolomics Facility

Staff

Mark Solomon, Natoiya Lloyd, Esther Kristianto, Mango Parker

Collaborators

Vilma Hysenaj (PhD student), University of Genova, numerous research and industry clients.

The client base at the AWRI-Metabolomics Facility increased during 2012/2013 year. Approximately 70% of all clients were external to the AWRI and 5% were commercial clients. Multiple new methods have been developed and these methods are regularly used by internal and external clients, including commercial clients. These include quantitation of: raspberry flavour compounds; organic acids in berry fruits and plant tissues; markers for smoke exposure of grapes and smoke taint risk of wine; and quantitative and profiling methods for biogenic amines.

Using rapid spectral methods to support objective measurement of grape and wine attributes

Staff

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Collaborators

Agnew Wines (Jeff Byrne and Xanthe Leonard); Bimbadgen Estate (Sarah Crowe); Briar Ridge Vineyard (Gwyn Olsen); Brokenwood Wines (Simon Steele); Casella Wines (Laura Thompson); De Bortoli Wines (Sharon Adams and Henry Perez); David Hook Wines (David Hook); De Iuliis Vineyards (Mike De Iuliis); First Creek Wines (Liz Jackson and Damien Stevens); Glandore Estate (Duane Roy); Hungerford Hill Wines (Adrian Lockhart); Keith Tulloch Wine (Keith Tulloch); Margan Winery (Neville McPike); McWilliam's Wines (Lisa Parker, Jim Chatto); McGuigan Wines Hunter Valley (Australian Vintage) (Andrew Duff and Peter Hall); Meerea Park (Rhys Eather);

Mistletoe Winery (Nick Paterson); Oakvale Wines (James Becker); Peppertree Wines (Scott Comyns); Riverina Wine Grapes Marketing Board (Kristy Bartrop); Scarborough Wine Co. (Jerome Scarborough); Thomas Wines (Andrew Thomas).

Application of mid-infrared spectroscopy for measurement of yeast assimilable nitrogen (YAN) in juice

Spectroscopic methods can be used for the rapid prediction of a range of grape, juice and wine composition parameters, and a number of methods have been developed by the AWRI using affordable, 'off-the-shelf' spectroscopy instruments.

One specific application, developed using a Bruker Alpha mid-IR instrument, has focused on the simultaneous analysis of juices for pH, titratable acidity (TA), sugar content (Brix) and yeast assimilable nitrogen (YAN). Measuring YAN concentrations prior to fermentation is very important as insufficient YAN (<160 mg/L) in the juice/must can result in sluggish or stuck fermentations and the production of hydrogen sulfide. Conversely, elevated levels of YAN (>350 mg/L) can lead to the formation of undesirable flavour and aroma characteristics in the resultant wine. However, few producers measure YAN on a regular basis because, until now, its analysis required a relatively time consuming two-stage wet chemistry assay. Many producers instead rely on 'preventative' routine additions of di-ammonium phosphate (DAP) to all juices, which pose the risk of elevating the YAN concentration to undesirable levels.

YAN calibrations were developed during vintages 2011 and 2012 based on samples collected through the AWRI Riverina Node with participation of major wine producers in the region (Figure 13). In 2013, additional data were collected from producers in the Riverina and McLaren Vale areas and through the AWRI's recently-established node in the Hunter Valley. Spectral calibrations were evaluated with samples from the 2013 vintage, and predictions for YAN concentration in juices sourced from the Hunter Valley were found to be the most accurate; this is most likely due to the concentration range in samples from the Hunter Valley of 98 – 259 mg/L YAN, which is low in comparison with the Riverina.

Data collected on YAN concentration in juices across multiple vintages have shown that the total proportion of samples across a vintage that do not require a DAP adjustment can be as high as 60%. During vintage 2013, over 90% of juice samples tested from the Riverina region would not have required DAP addition. This clearly shows the value of regularly assessing YAN levels in juice. The spectral method developed here can provide rapid feedback on nutrient status to winemakers, thereby avoiding the cost of unnecessary DAP additions, and also provides information that supports optimisation of wine quality.

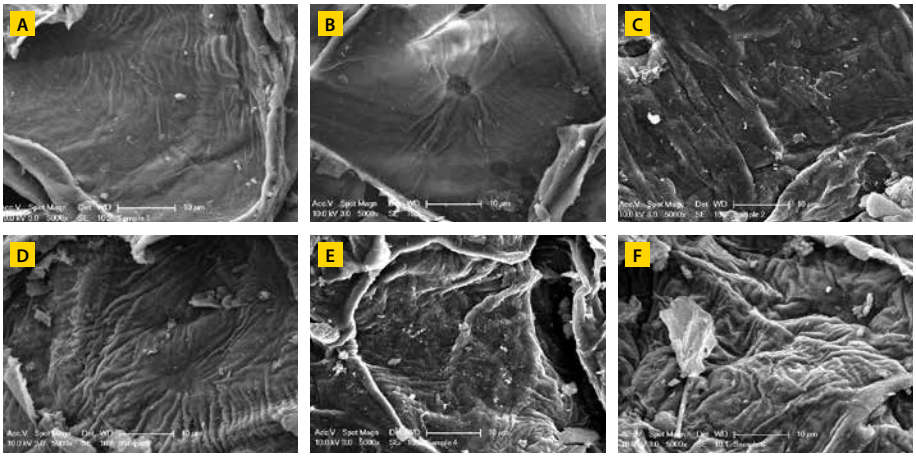

Figure 12. Scanning electron micrographs of isolated cell wall material from ripening Cabernet Sauvignon grape skins for the 2010 season. A, B. 15 January, -11 DAV, 5000x; C. 26 January, 0 DAV, 5000x; D. 23 February, 28 DAV, 5000x; E. 2 March, 35 DAV, 5000x; F. 17 March January, 50 DAV, 5000x (Bars = 10 mm). Microscopy performed by Adelaide Microscopy.

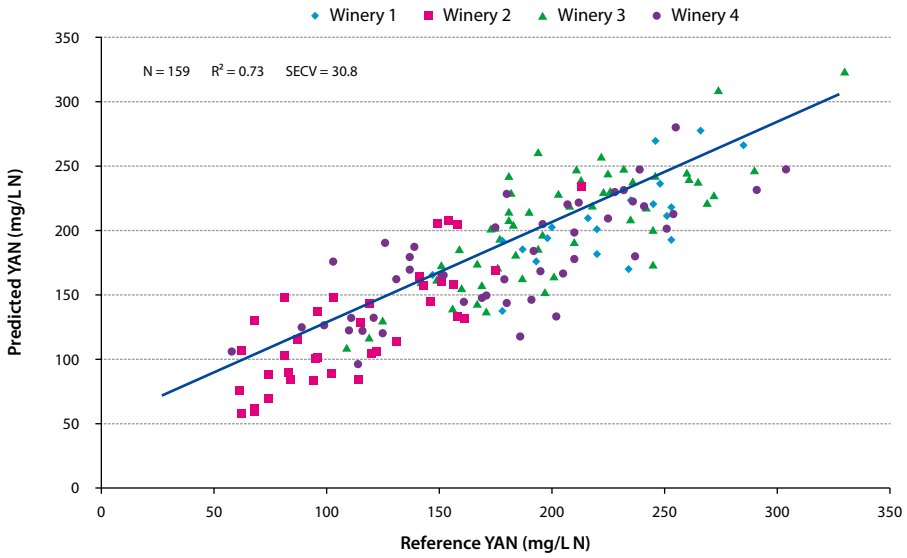

Figure 13. Correlation of yeast assimilable nitrogen (YAN) values measured using enzymatic reference method (x-axis) against values predicted using Bruker Alpha Mid-IR spectral method (y-axis). Calibration model includes data from four individual wineries, covering multiple vintages.

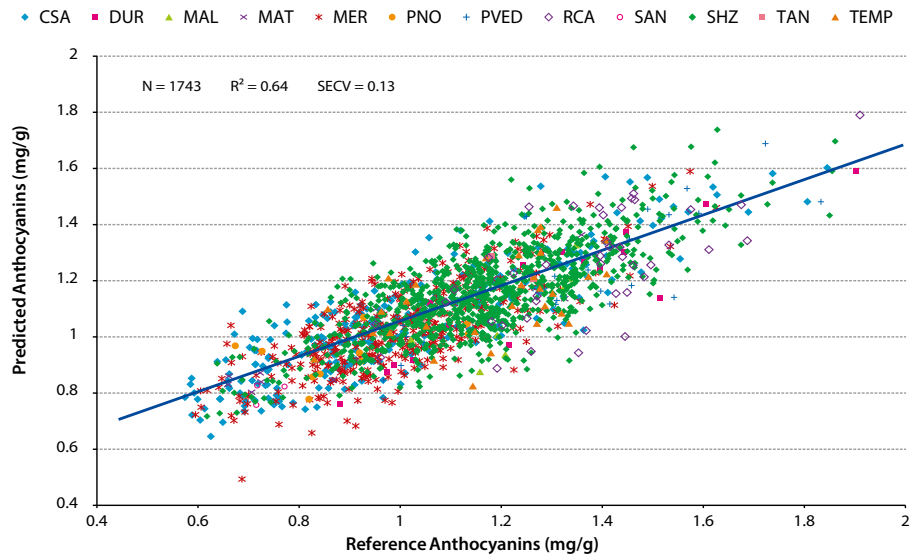

Figure 14. Correlation of anthocyanin values measured using reference method (x-axis) against values predicted using Bruker Alpha Mid-IR spectral method (y-axis). KEY: CSA – Cabernet Sauvignon; DUR – Durif; MAL – Malbec; MAT – Mataro; MER – Merlot; PNO –Pinot Noir; PVED – Petit Verdot; RCA-Ruby Cabernet; SAN – Sangiovese; SHZ – Shiraz; TAN – Tannat; TEMP – Tempranillo

Rapid analysis of colour and sugar levels in red grape homogenates

The Australian wine industry has a clear need for rapid analysis methods for measuring grape composition, in order to: determine optimum harvest dates; identify compositional profiles and differences across the vineyard; and assess grape quality for appropriate grower payments. Spectroscopic methods have been employed in the last decade by some large wine producers for grape colour analyses, as a means of objectively assessing grape quality.

A Bruker Alpha mid-IR ATR instrument was employed to develop a calibration for simultaneous measurement of total soluble solids (Baumé), total anthocyanins (Figure 14), pH, TA, and dry matter in grape homogenates. The initial calibration models included data for Shiraz, Cabernet Sauvignon and Merlot grapes sourced in South Australia during the 2011 and 2012 vintages. A significant amount of additional data for additional varieties and an expansion of the concentration range for the calibration were achieved through collaboration with wineries in the Griffith region in 2013, through the AWRI's Riverina Node.

The rapid method developed for Baumé and anthocyanins exhibited standard errors of 0.29 and 0.13 mg/g respectively, comparing favourably with laboratory reference errors of approximately 0.2 and 0.1 mg/g. This level of performance is likely to be adequate for all grape maturity colour testing carried out by producers and could eventually replace the reference method typically used for this type of analysis. Rapid spectral methods such as this could be used to routinely monitor Baumé and anthocyanin levels in red grapes prior to and during harvest, to support transparent and objective grower payment schemes.

Grape and wine production

Processing steps to optimise wine quality and development in bottle

Staff and students

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Collaborators

Flinders University (Dr Ian Menz); The Yalumba Wine Company (Teresa Heuzenroeder, Luke Wilson); De Bortoli Wines (John Coughlan); Treasury Wine Estates (Dr Vanessa Stockdale); INRA UMR-SPO, France (Dr Aude Vernhet); University of Padua, Italy (Diana Gazzola, visiting PhD student); University of Sheffield (Dr Robert Falconer); University of South Australia (Professor Peter Majewski).

The main aim of these projects is to improve winemaking processes after fermentation. The current focus is on two broad areas: protein stabilisation and post-bottling reductive aroma formation.

How do 'reductive' sulfur aromas form post-bottling?

Some aromas caused by sulfur compounds can be quite positive (e.g. passion-fruit, grapefruit), while others impact negatively on the aroma of wine. Boiled or rotten egg, sewage and rubber are descriptors associated with these undesirable low molecular weight sulfur compounds (LMWSC). The identity of several of these molecules (hydrogen sulfide [H_2S], methanethiol [MeSH] and dimethylsulfide [DMS]) is known, but debate continues over their source and ways to manage them. To minimise the potential for negative sensory experiences associated with these compounds, it is important to determine the origin of key LMWSC and the most effective oenological approaches to control them.

Over the last decade, research from the AWRI has demonstrated that managing the oxygen that travels through closures into wine after bottling can have a big effect on the aroma, texture and colour of a wine. If this 'oxygen transfer rate' (OTR) is low and the wine is also bottled without much oxygen, then a wine occasionally develops a 'reductive' aroma characterised by the presence of 'stinky sulfur'-type aromas. This is quite variable though; one type of wine might form these undesirable aromas, while another type under similar conditions might not. To address this issue, a project is underway to identify factors that control or contribute to the formation of reductive aroma post-bottling.

As part of the current management strategy to deal with reductive aromas, copper is often added to wine prior to bottling to treat unpleasant 'sulfidic' aromas such as rotten egg. It is thought that the copper ions react with hydrogen sulfide (H_2S—partly responsible for the unpleasant sulfidic aroma) to produce an insoluble solid (copper sulfide), which results in the removal of both copper and H_2S from the wine.

However, recent work at the AWRI (AWRI publication #1283) has shown that copper additions at bottling can promote the accumulation of H_2S at later stages of bottle ageing. Following on from this observation, the AWRI has further probed the role of copper, as well as other transition metals, in the development of LMWSC in wine. The AWRI investigated the formation of LMWSC, specifically MeSH from methionine, in wine stored anaerobically (12 months), as catalysed by five transition metals (Al, Cu, Fe, Mn and Zn) which are normally present in wine and are known for their catalytic ability. The evolution of H_2S and DMS, as a result of metal addition, were also investigated and the results were correlated with the amount of oxygen present in the wine.

It was found that the addition of metals significantly influenced the evolution of LMWSCs. Oxygen concentration played a significant role in its effect on the formation of LMWSC in the wine. Initially, at high oxygen concentrations, some metals such as copper (Cu), significantly reduced the concentration of the thiols in the wine tested. During wine maturation, the oxygen concentration decreased to zero ppb after four months of anaerobic storage and the effect of Cu was reversed with the presence of Cu now being associated with a significant increase in MeSH concentration, regardless of the presence or absence of other metals.

Peter Godden and Markus Herderich

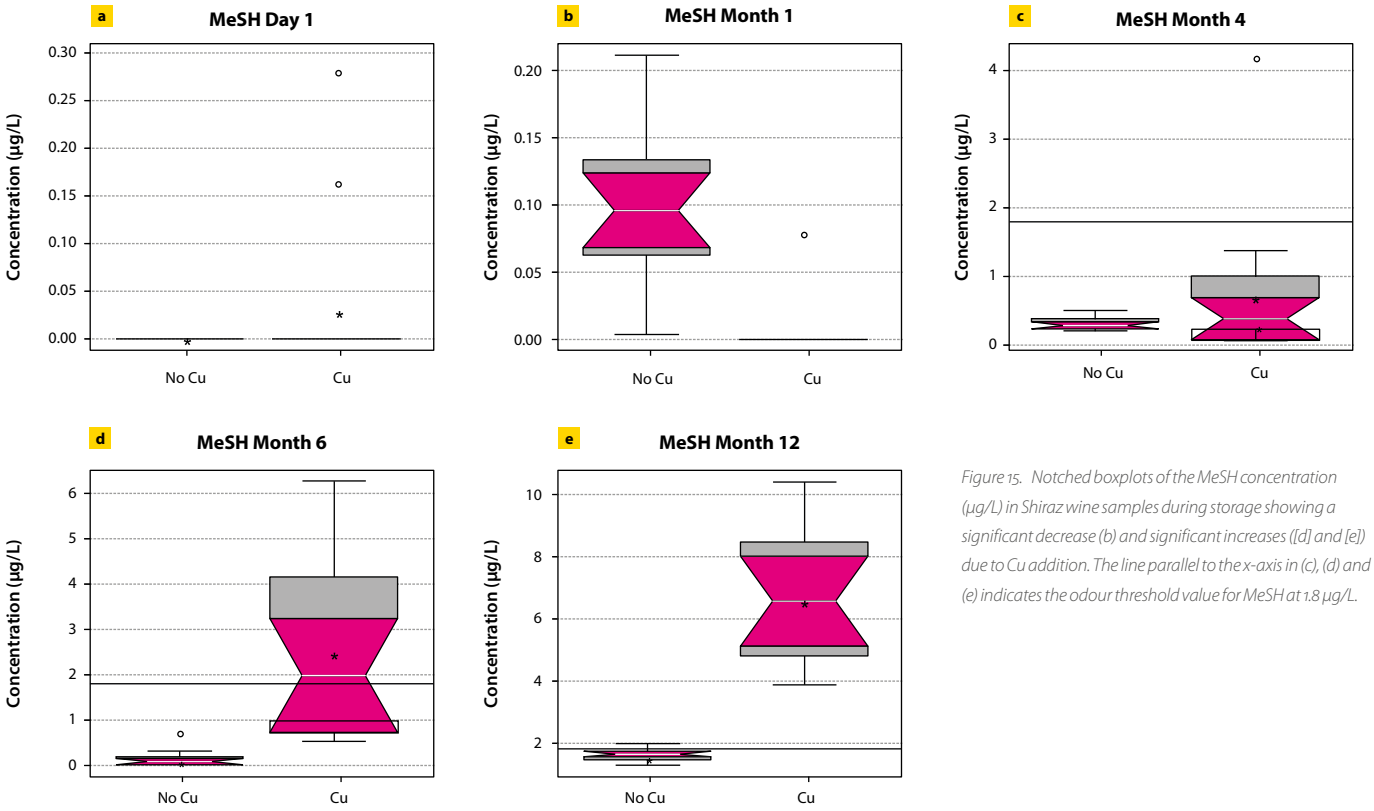

Figure 15. Notched boxplots of the MeSH concentration (µg/L) in Shiraz wine samples during storage showing a significant decrease (b) and significant increases ([d] and [e]) due to Cu addition. The line parallel to the x-axis in (c), (d) and (e) indicates the odour threshold value for MeSH at 1.8 µg/L.

A series of boxplots are displayed in Figure 15 which describes the evolution of MeSH in Shiraz samples (n = 96) with or without added Cu. The boxplots graphically display differences in MeSH concentration among the samples; the median (white line); the mean (star) with the red area depicting the 95% confidence interval for the mean; as well as outliers (black dots). At Day 1 (Figure 15a) no MeSH was present in samples with or without added Cu, but, after one month of storage, the scavenging ability of Cu can be observed in the significantly reduced MeSH concentration in all samples with added Cu (Figure 15b). However, as the oxygen concentration in the wine decreased, the MeSH concentration slowly increased to nearly the same levels in both samples with or without added Cu (Month 4, Figure 15c). After 6 to 12 months of anaerobic storage, the MeSH concentration had significantly increased in all samples with added Cu and reached concentrations above MeSH's odour threshold value of 1.8 µg/L (Figure 15d and e).

From these results, it is clear that the formation of LMWSC from their precursors in wine is not only influenced by the presence of metals, but oxygen concentration in wine also significantly interacts with metals in the evolution of LMWSC.

To assess a potential role of sulfur-containing amino acids as LMWSC precursors, an amino acid assay has been developed with the AWRI Metabolomics group and samples are now being assessed to quantify the sulfur-containing amino acids in wine, cysteine and methionine and the tri-peptide, glutathione.

Post-bottling effects of early oxygen exposure during red winemaking

In a 2012 research winemaking trial, different gases (40% oxygen, air and nitrogen) had been introduced during red winemaking in rotary fermenters and it was confirmed that the oxygen treatments eliminated the production of hydrogen sulfide gas. Following on from these fermentation trials, the finished wines were bottled in September 2012 and subjected to descriptive sensory analysis two months later. From the sensory PCA (Figure 16), wines from both oxygen treatments were described as 'fruity' on aroma and palate without bitter or astringent influences. The control and nitrogen-sparged wines were characterised by 'reductive' aromas described as 'egg', 'sewage' and 'rubber', with the control demonstrating more astringency compared to the oxygen-treated wines. Whereas an aerative splashing was not seen to be effective in reducing stinky sulfur aromas, copper addition – both after pressing and just before bottling – was perceived to be beneficial. However, recent results from this research show an increased risk of developing post-bottling hydrogen sulfide.

LMWSC were analysed several times from post-pressing to six months after bottling. Results after six months in-bottle confirmed the continued absence of ethanethiol and S-ethyl thioacetate in oxygen-treated wines and significantly reduced levels of methane thioacetate compared to the control. The concentration of hydrogen sulfide dropped to stable background levels between threshold (1.1 µg/L) and 4.5 µg/L after bottling for all treatments and remained constant. Concentrations of methanethiol dropped slowly from its peak post-fermentation until a few months post-bottling after which it rose slightly when measured six months after bottling. The 40% oxygen treatment had the lowest methanethiol concentration and the control and nitrogen treatments had the highest. The oxygen-treated wines also had significantly lower concentrations of Cu, Fe and Zn which have an important influence on the subsequent development of stinky sulfur aromas during ageing.

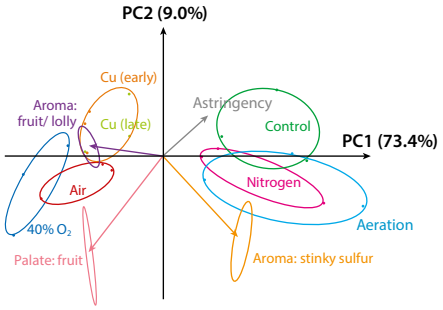

Figure 16. Principal component analysis of sensory attributes in wine treated with oxygen or nitrogen during red winemaking in rotary fermenters. 40% O_2: 40% oxygen in 60% nitrogen; Air: 20% oxygen, N2: 100% nitrogen-sparging; Copper: addition of copper sulfate either after pressing (0.4 mg/L) or before bottling (0.2 mg/L); Aeration: splashing with final DO at 4 ppm.

Uncovering the secrets behind protein haze formation and stabilisation in white wine

Protein haze formation in white wine remains one of the key potential instabilities in wine production that requires costly treatment with potential losses in overall quality. Haze formation

Stella Kassara, Ella Robinson and Wies Cynkar

is a serious quality defect because consumers perceive hazy wines as faulty. This problem is caused by the presence of residual grape pathogenesis-related (PR) proteins in wines after bottling, mainly thaumatin-like proteins (TLPs) and chitinases. These are haze-forming proteins that can become unstable and unfold, an occurrence favoured by exposure of wine to high temperatures (e.g. during transport resulting in fast aggregation) or inappropriate storage conditions (slower aggregation). Once the proteins are unfolded they can aggregate into larger light-dispersing particles that make wine appear turbid. Haze appearance is generally prevented by bentonite fining, a process effective in removing the grape proteins, but with several drawbacks such as wine volume loss and disposal costs, as well as detrimental effects on wine flavour and quality and undesirable processing complexity. In order to find a valid substitute for bentonite, an in-depth understanding of the causes of protein hazing and of the mechanism of protein haze formation is required.

This year, the focus of the AWRI's research was on:

- studying the structure of TLP isoforms differing in hazing behaviour, and solving and comparing their 3D structure;
- exploring protein adsorbent materials as potential alternatives to bentonite for the stabilisation of white wines; and
- summarising the knowledge generated through the study of haze-forming proteins, to revisit the mechanism of protein haze formation in wine.

Protein crystallography

The structures of two isoforms of grape TLPs have been solved, in collaboration with Dr Ian Menz (Flinders University). The first protein deposited to the Protein Data Bank (ID 4H8T) was originally solved at 2.0 Å resolution by using the structure of a TLP from banana as a template. Subsequently, the structure of TLP 4H8T has been used to solve the structure of a second protein (ID 4JRU) for which the AWRI had obtained data at very high resolution (1.2 Å). Once the 4JRU new model structure was available, the AWRI went back and re-processed the dataset from which the first structure was obtained (ID 4H8T), allowing a significant improvement in the predicted structure; this was subsequently re-deposited to the Protein Data Bank under a new ID (4L5H, 1.8 Å resolution), which supersedes the previous one (ID 4H8T).

Despite having very similar structures, these two isoforms of TLPs are known for their differences in terms of unfolding temperature (AWRI publication #1273) and hazing potential (AWRI publication #1487). Therefore, the comparison of their solved 3D structures (Figure 17) is expected to explain the observed differences in function; information that might open the way for a targeted search for enzymes able to degrade thaumatin-like proteins at winemaking temperature.

Exploring the use of protein adsorbents as alternatives to bentonite

Two novel adsorbents, previously studied for protein stabilisation of white wines (carrageenan and zirconia dioxide) were investigated further, and some improvements were made to their application during winemaking.

Carrageenan is a polysaccharide which is negatively charged at wine pH and therefore can bind positively charged wine proteins in a similar way to bentonite. After some early work (AWRI publication #1437), the use of carrageenan was further explored in a vintage trial in collaboration with Treasury Wine Estates (AWRI publication #1539). Carrageenan was tested at different addition times during or after alcoholic fermentation and was capable of fully removing wine proteins at low addition rates (one third or less than those of bentonite) and without significant sensory effects relative to standard wine industry bentonite fining approaches. The possibility for haze formation from residual carrageenan, remaining in wine after the protein removal step, was evident and this will need to be assessed on a case by case basis — although research showed that careful use of carrageenan before or during fermentation might reduce this risk. The regulatory status relating to the permitted use of carrageenan in winemaking needs to be established prior to its commercial application (it is currently not an allowed additive), and the feasibility of carrageenan for protein fining in a winery production setting will need to be determined by individual wineries, as technical issues including frothing, slower filterability and risk of carageenan-induced haze need to be assessed relative to the benefits from reducing bentonite use.

Zirconia is a metal oxide able to adsorb the unstable wine proteins. Despite showing promise, zirconia treatment has not been adopted by the wine industry, particularly because an efficient continuous process is not possible due to the slow protein adsorption rate. In previous work (AWRI publication #1262) a batch process was proposed in which zirconia was enclosed in a metallic cage and left in contact with wine for the time required

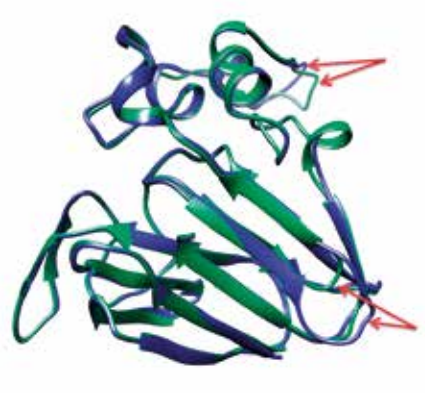

Figure 17. Superposition of the secondary structure of two grape thaumatin-like proteins (TLPs). In green is 4L5H and in blue is 4RJU. Red arrows indicate the two loops showing the largest differences between the two TLP isoforms.

to reach protein stability; an approach that yielded heat stable wines with no losses. The main drawback identified in this first stage of the project was that the wine had to be mixed constantly for three to five days to successfully remove proteins; an expensive operation to perform in a winery. A solution to the requirement for stirring was found by adding zirconia pellets enclosed in a metallic cage to juice so as to exploit the natural mixing occurring during fermentation (AWRI publication #1540); an approach that yielded an increase in fermentation rate, and which produced wines that were fully heat stable with no loss of wine (since the cage with the pellets can simply be removed and regenerated several times with the washing procedure proposed in previous research [AWRI publication #1262]). Both treatment strategies require high dosages of zirconia (5-25 g/L), so the logistics and economics of application in wineries need to be considered; in addition zirconia would need to be approved as a permitted processing aid.

The mechanism of haze formation in white wine

In recent years, knowledge about haze forming proteins has improved significantly, particularly after the development of an efficient method for protein purification from juices and wines (AWRI publication #1180). This faciliated the use of wine fractionation and reconstitution experiments in order to explain, in-depth, the steps involved in the mechanism of haze formation, with particular attention to the role played by particular proteins, polysaccharides, phenolics, temperature, ionic strength and sulfate. Wine ionic strength was found to modulate hazing, and chitinases were more prone to aggregate than TLPs in the normal wine ionic strength range. In addition, sulfate was confirmed to have an important role in haze formation, likely by converting soluble aggregates into larger visible haze particles (AWRI publications #1272). Temperature was found to have a key role in the onset of protein aggregation, and differences in the unfolding temperature of chitinases (55°C) and TLPs (62°C) were determined. Moreover, after heating, chitinases cannot refold upon cooling (irreversible unfolding), while TLPs can refold (reversible unfolding) (AWRI publications #1187). Chitinases were also more reactive with other wine macromolecules than TLPs, formed bigger aggregates and were more prone to precipitate. Therefore chitinases are considered as major players in heat-induced haze in wines, although recent experiments proved that some TLP isoforms can form haze as well (AWRI publications #1487).

These recent breakthroughs in the characterisation of the hazing phenomenon allow the proposal of a detailed scheme of the 'life cycle' of proteins in wine (Figure 18).

Under this model, proteins in their soluble state are found in wines in their folded structure. However, the folded structures can be lost (unfolding); a step that is commonly caused by inappropriate storage temperatures. Once the protein is in an unfolded state, it exposes its hydrophobic binding sites and protein aggregation is induced via hydrophobic attractions with other unfolded proteins. With time, the aggregates can grow and cross-link with other aggregates, a step favoured by the presence of sulfate, phenolics and high ionic strength, until they reach a size that makes them visible to the naked eye (>1 µm).

In summary, the increased level of understanding of the mechanism of haze formation, together with the availability of haze protein structures at high resolution, places the AWRI in an excellent position for developing better tools to predict haze potential of wines and for studying targeted alternatives to bentonite to prevent haze from forming in bottled white wines.

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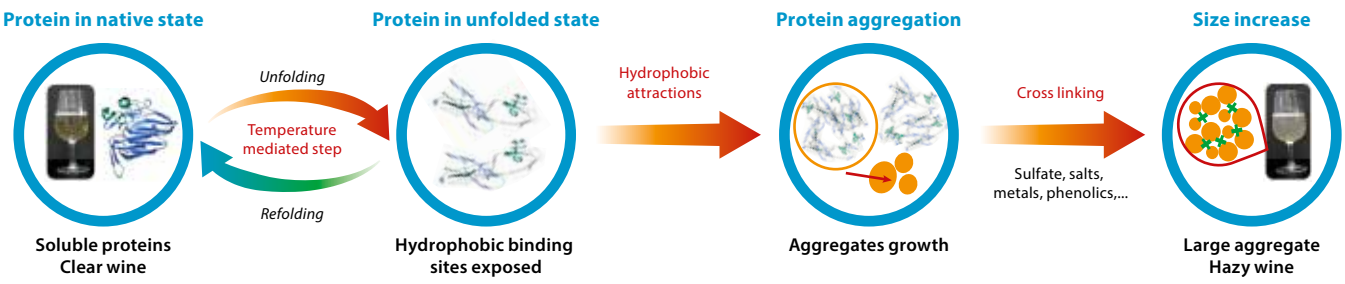

Figure 18. Mechanism of haze formation revisited: 'life cycle' of proteins in wine.

Improving microbial performance, wine diversity and wine quality

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Bioscience research at the AWRI aims to improve microbial performance in wine fermentations and provide options for winemakers to shape wine style. The fields of biology that are brought to this include: microbiology, physiology, genetics, molecular biology, biochemistry and systems biology. All of these disciplines are harnessed to: identify and generate novel yeasts with improved winemaking and sensory-imparting properties; optimise fermentation outcomes by developing improved yeast nutrient supplementation regimes; improve robustness of wine yeasts and MLF bacteria; use MLF to enhance wine quality; and develop 'low-alcohol' yeasts. The following is an overview of recent work conducted by the Biosciences team.

Closing in on microbial strategies for production of lower alcohol wine

Commercially available *Saccharomyces cerevisiae* wine yeast strains do not vary substantially in their capacity to convert sugar into ethanol, falling within a narrow range that, for example, might yield dry wines between 14 and 14.5% ethanol (v/v). Conceptually, a low-alcohol-producing yeast strain that makes wine with 12% ethanol (v/v) of equivalent 'quality' would provide an easy-to-adopt strategy for winemakers seeking to produce reduced alcohol wine. This has become a target of increasing importance, due to health and economic drivers which necessitate a reversal of the trend over recent decades towards wine styles associated with increased grape maturity, ideally without sacrificing wine quality.

Based upon knowledge gained from the AWRI's previous work on genetically modified (GM) low-alcohol yeast strains, the AWRI developed a non-GM strategy that enabled the generation of *S. cerevisiae* yeast strains able to produce higher amounts of glycerol. Several strains generated in this way produced wines with up to 2.0% (v/v) lower ethanol concentration. However, these wines showed elevated concentrations of some volatile compounds associated with unpleasant sensory attributes. To get around this problem the AWRI is, in collaboration with Bioplatforms Australia, using systems biology approaches to develop strategies to improve these strains. Data from several levels of omics analyses of fermentations have enabled the design and construction of novel 'low-ethanol' wine yeast strains that should provide a solution to the above problems. Building on knowledge from this work, the AWRI is now evaluating non-GM strategies to target metabolic reactions which generate these

Anthony Borneman, Paul Chambers, Toni Cordente

undesirable compounds and, thereby, produce non-GM low-alcohol strains that do not impact negatively on wine flavour.

Another, largely unexplored, strategy is to draw upon the much broader genetic variation of non-conventional wine yeasts (non-*Saccharomyces* strains) to divert some sugar away from ethanol formation. These yeast species, which are largely associated with grapes pre-harvest, are present in the early stages of fermentation, but in general are not capable of completing alcoholic fermentation. In fact, non-conventional yeasts are increasingly used for enhancing complexity and flavour profile. The AWRI evaluated 50 different isolates of non-*Saccharomyces* yeasts, covering 40 species and belonging to 24 different genera (Figure 19), for their capacity to produce wine with lower ethanol concentration when used in sequential inoculation regimes with an *S. cerevisiae* wine strain. Sequential fermentations utilising the non-*Saccharomyces* strain AWRI1149 produced Shiraz wines with 1.6% (v/v) lower ethanol concentration. Volatile profiling revealed increased total concentration of higher alcohols and reduced total concentration of volatile acids than in control *S. cerevisiae* wines, potentially increasing aroma complexity and decreasing the perception of unpleasant flavour attributes.

Driving wine complexity with AWRI-developed interspecific wine yeast hybrids

Harnessing natural yeast mating techniques analogous to plant nursery hybridisation practices (for example, the tangelo fruit was produced by hybridisation between the citrus species tangerine and pomelo), it is possible to generate interspecific hybrids between closely-related *Saccharomyces* species. Using this approach the AWRI has successfully generated a new breed of wine yeast: a hybrid of a robust *Saccharomyces cerevisiae* wine yeast strain and *Saccharomyces mikatae*, a species isolated only from soil and decaying leaf litter and not previously associated with industrial fermentations. These hybrids retain robust fermentation characteristics and, due to their genomic complexity, can produce wines with novel flavour profiles – previous AWRI-generated interspecific wine yeast hybrids have been noted for this in several workshop wine tastings.

An important consideration, whether breeding new citrus varieties or new interspecies yeast hybrids, is stability of 'the cross'. Will hybrid traits be retained over time? A genomic analysis of the new hybrid yeast strains showed that their genomes were sufficiently stable over the course of a wine fermentation. Of the 300 end-of-fermentation isolates analysed, 4% had lost a small region of the *S. mikatae* genome, while no changes were detected in the wine yeast parent genome (Figure 20). Importantly, the key fermentation properties of tolerance to high sugar and high ethanol concentrations were retained in all isolates, even those with the fractional loss of the *S. mikatae* genome. It is worth noting that the modern winemaking practice of inoculation with an Active Dried Yeast preparation made from original stock culture minimises the risk of genome instability impacting on fermentation performance and wine quality. Brewers routinely 're-pitch' their yeast, but can only do so for a certain number of fermentations before they are 'no longer true-to-type'.

*Figure 19. Non-*Saccharomyces *yeasts evaluated under winemaking conditions in sequentially inoculated ferments with* S. cerevisiae *for their potential application in production of lower-alcohol wine.*

Table 4. Basic fermentation chemistry analysis of parent (Sc) and hybrid strains (CxM1 and CxM4) in Chardonnay wines.

Strain	Glucose (g/L)	Fructose (g/L)	Acetic acid (g/L)	Glycerol (g/L)	Ethanol (%)
Sc	0.00	0.00	0.41	9.61	16.42
CxM1	0.00	0.00	0.00	11.00	16.12
CxM4	0.00	0.00	0.00	11.28	16.10

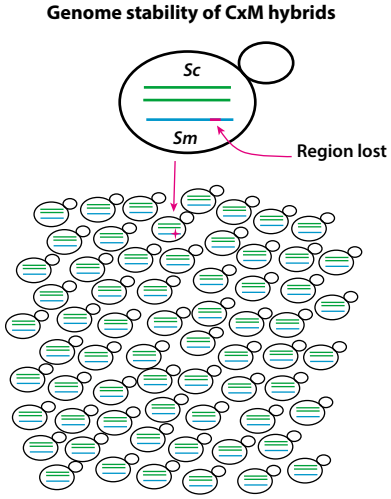

Figure 20. Schematic of genome stability in CxM hybrids. 4% of cells during the course of fermentation lost a small region of the S. mikatae *genome, indicated in red.*

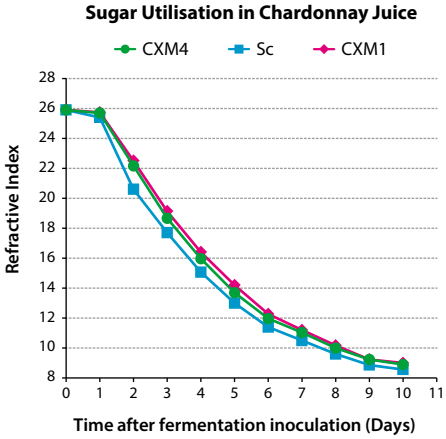

Figure 21. Sugar utilisation of parent (Sc) and hybrid strains (CxM1 and CxM4) during Chardonnay fermentation using Refractive Index measurements.

Two hybrid progeny selected from the *S. cerevisiae* x *S. mikatae* cross were able to ferment Chardonnay juice to completion in a timely manner, with sugar depletion occurring at a marginally slower rate than the *S. cerevisiae* wine yeast parent strain ferment (Figure 21). It is worth noting that the *S. mikatae* parent strain was unable to grow in the same (or any) Chardonnay juice. Basic fermentation chemistry analysis of the wines showed that the hybrid strains were able to convert all sugars to ethanol, with resultant wines containing similar ethanol levels to the *S. cerevisiae* parent-made wines. Differences to note in the hybrid-made wines were an increase in glycerol production and a decrease in acetic acid production relative to the wine yeast parent (Table 4).

The resultant wines were analysed for volatile fermentation products using gas chromotography/mass spectrometry (GC/MS). The hybrid-made wines showed differences in concentrations for a number of volatile metabolite compounds, relative to wine made using the parent *S. cerevisiae* wine yeast. Interestingly, hybrid strain CxM1 produced higher concentrations of a number of compounds associated with flavours of 'fruity' (ethyl propanoate, ethyl butanoate, ethyl-2-methyl butanoate), 'banana' (2-methyl butyl acetate), 'floral' (2-phenyl ethyl acetate) and 'sweet perfume' (hexyl acetate), whilst hybrid strain CxM4 produced lower concentrations of these compounds (Figure 22). Both hybrid strains produced wines with greatly reduced concentrations of ethyl acetate ('nail polish') relative to the wine yeast parent.


Eveline Bartowsky and Jane McCarthy

The hybrid yeast-made wines also showed significantly higher levels of a number of compounds which contribute savoury attributes, including isobutyric acid ('sour', 'cheese'), 3-methyl thiol propanol ('meat', 'potato') and ethyl-2-hydroxy-3-phenylpropanoate ('goaty', 'smokey'), that potentially add complexity to the overall flavour profile of these wines. A number of other compounds with 'sweet' or 'fruity' attributes were also produced in higher amounts by both hybrid strains: ethyl 9-decanoate ('sweet'), 2-phenyl ethyl alcohol ('rose'), 3-hydroxy-4-phenyl-2-butanone (caramel') and 9-decanoic acid ('fruity').

Intriguingly, three volatile compounds remain unidentified, two of which were produced at higher levels by the hybrid yeast and this might indicate that the *S. mikatae* parent is contributing novel metabolites, not previously recognised, to the wines. Of interest also is that two identified compounds produced at higher levels by the *S. cerevisiae* x *S. mikatae* hybrids have been shown to be generated in wine in high levels by non-*Saccharomyces cerevisiae* species: isobutyric acid by *Torulaspora delbrueckii* and 2-phenyl ethyl alcohol by *Kluyveromyces lactis*.

Interspecific yeast hybrids have the potential to deliver increased complexity to wine sensory properties and alternative wine styles through the formation of novel, and wider ranging, yeast volatile fermentation metabolite profiles, whilst maintaining the robustness of the wine yeast parent. An assessment of Chardonnay wines made with the new *S. cerevisiae* x *S. mikatae* interspecific hybrid yeast showed that, relative to the *S. cerevisiae* wine yeast parent, the hybrids produced wines with different concentrations of volatile metabolites that are known to contribute to wine flavour and aroma, including flavour compounds associated with non-*Saccharomyces* species. These new hybrids have the potential to produce complex wines akin to products of spontaneous fermentation while giving winemakers the safeguard of an inoculated ferment.

Addressing the issue of suboptimal primary fermentations

Previous work at the AWRI demonstrated that sensitivity of wine yeast to low pH grape must is yeast strain dependent. To better understand why different wine yeast strains exhibit different levels of tolerance to low pH requires knowledge of which genes contribute to this trait. To this end, a pooled inoculum carrying all strains in the AWRI Wine Yeast Gene Deletion Library* (WYGDL) was put through competitive fitness assays (i.e. the pooled inoculum was grown in low pH juice over many generations) after which the survivors were identified by DNA sequencing of the surviving population (each strain in the WYGDL has a unique DNA tag that enables it to be identified and quantified). Candidate wine yeast genes contributing to tolerance to low pH were identified. Follow-up experiments are underway to corroborate the findings.

In addition to the above, the AWRI has begun to assess the efficacy of fermentation additives for reducing the risk of suboptimal fermentations at low pH. Six products from three suppliers were trialled, individually and in combination, to determine their impact on fermentation efficiency in low pH grape juice. Both rehydration nutrients and fermentation supplements were evaluated. Nutrients added during fermentation were beneficial, resulting in small but significant reductions in duration of fermentation. However, this effect was general and did not enhance low pH ferments specifically which appeared to be independent of must nitrogen status. As a practical outcome these data suggest that choice of yeast strain, rather than the addition of nutrient supplements, is more likely to provide a practical solution to problems associated with low pH must fermentation. Nevertheless, fermentation nutrients may be used to further enhance performance in difficult environments.

The AWRI has also explored how pH can interact with other juice variables, such as free SO_2, to impact fermentation performance outcomes. It is already well known that the concentration of active molecular SO_2 is dependent on pH of the growth medium; the concentration of molecular SO_2 increases three-fold as the pH decreases from 3.5 to 3.0. We have shown that yeast strains susceptible to low pH conditions are dramatically affected by free SO_2 at a concentration as low as 10 ppm. Such a concentration is not uncommon following standard winery addition regimes. Interestingly, we found that even at moderate juice pH such as 3.25, a moderate SO_2 concentration was sufficient to inhibit the performance of pH-susceptible yeast strains. This demonstrates that combinations of factors, usually considered independently when measured in the winery, can conspire to induce adverse outcomes in fermentation performance. In other words, the concentrations of potentially inhibitory factors required to negatively impact on yeast performance might be lower than would not normally be considered problematic.

** The WYGDL is a collection of over 2,500 strains derived from the same wine yeast, each with a different gene removed.*

Wine bacteria and malolactic fermentation (MLF)

The importance of yeast-bacterial interactions for successful MLF

Wine parameters such as pH, fermentation temperature, and ethanol and SO_2 concentrations, are well known to influence efficiency of MLF. However, it is increasingly apparent that the compatibility between the yeast strain used in alcoholic fermentation and the bacterial strain used in MLF is also important for efficient completion of secondary fermentation. Currently there are 100+ commercial yeast strains and 30+ bacterial strains available to Australian winemakers, but the least and most 'risky' combinations are not known. Performing an MLF efficiency screen for all possible combinations of these yeast and bacteria using traditional approaches would be unmanageable. Thus a micro-scale (200 µL) screening method was developed. This method makes it feasible to screen a large number of combinations of yeast and bacteria, with necessary replication. The fermentation platform developed uses a microtitre plate with 200 µL capacity which can be handled on a robotic liquid handling workstation.

The micro-scale MLF performance of three

bacterial strains in two Cabernet Sauvignon wines, produced with different yeast strains, was validated by comparison with 5 mL and 40 mL fermentations. MLF performance of all bacterial strains was consistent across all fermentation volumes.

MLF performance of 19 bacterial strains was evaluated in Cabernet Sauvignon wines prepared from the same grapes and fermented with 14 different *S. cerevisiae* wine strains using the micro-scale (200 µL) screening method; with duplication, this equates to 532 individual fermentations. A summary of the ability of the 19 bacterial strains to complete MLF in the 14 different wines is shown in Figure 23. Most yeast strains produced wines that supported successful MLF, albeit to varying degrees. One exception was yeast strain K which produced high concentrations of SO_2. Bacterial strains responded in various ways.

The results from this experiment have shown that it is important to understand the compatibility between yeast and bacterial strains to ensure a successful MLF. The method developed through this project enables the rapid screening of a large number of yeast and bacterial combinations in a wide range of red and white wines.

Lactobacillus species and MLF

Malolactic fermentation (MLF) is a bacterial-driven winemaking step that is conducted in red wine and some styles of white and sparkling wines, and the lactic acid bacteria (LAB), *Oenococcus oeni*, is the predominant species used in this process. However, other LAB, including *Lactobacillus* species are able to complete MLF, and there has been a growing interest in using *Lactobacillus* spp. for a new generation of MLF starter cultures. In this context, a screening of *Lactobacillus* spp. strains was undertaken to determine their potential to be used for MLF under Australian winemaking conditions.

Thirty-five strains of *Lactobacillus* spp., sourced from the AWRI Wine Microorganism Culture Collection, were screened for their ability to grow at a range of temperatures and tolerances to low pH, ethanol and SO_2. Screening was performed using a synthetic wine matrix and a recently developed micro-scale (200 µL) high-throughput assay (see above: 'Yeast-bacteria interactions'). Variations in growth were evident for all winemaking or wine composition parameters (Figure 24).

Seven *Lactobacillus* spp. strains which exhibited the widest spectrum of wine stress tolerances were selected to test for MLF performance in Cabernet Sauvignon wine. All seven were capable of completing MLF (Figure 25); higher ethanol concentration slowed MLF rate; and pH impacted significantly on the ability of these *Lactobacillus* spp. strains to complete MLF.

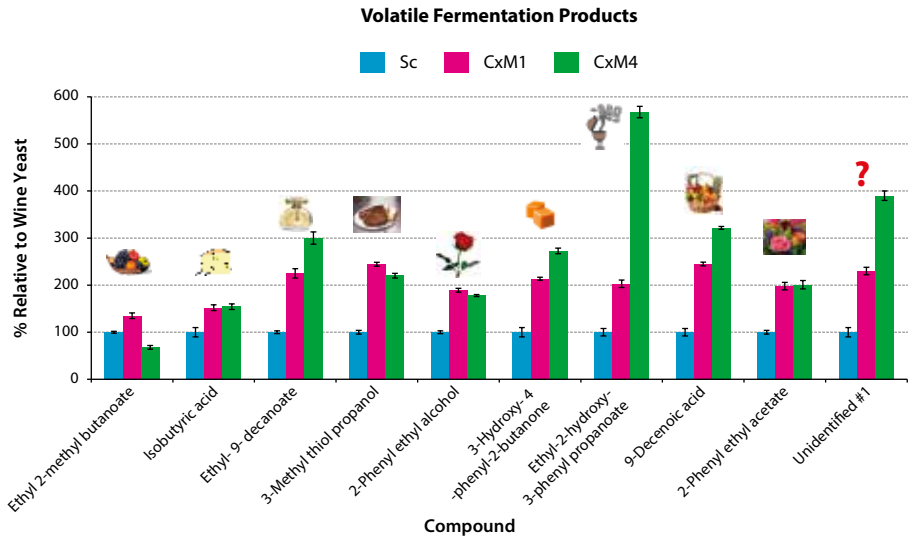

Figure 22. Sample of volatile fermentation products of hybrid strains (CxM1 and CxM4) relative to parent strain (Sc) in Chardonnay wines.

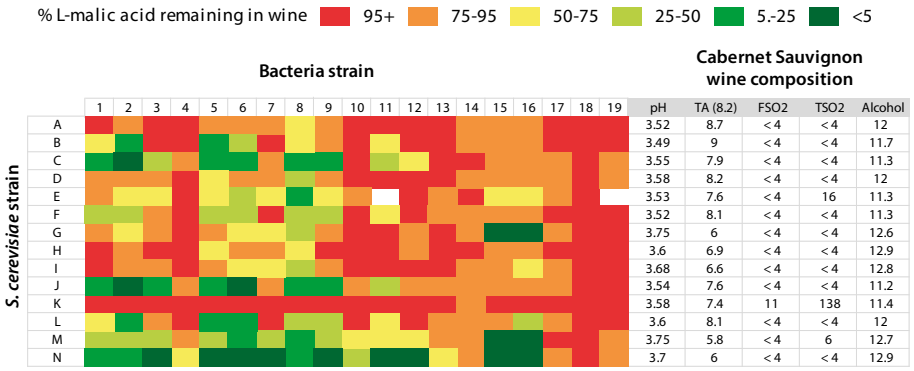

Figure 23. Summary of degree of malic acid metabolism with different yeast and bacteria combinations in a Cabernet Sauvignon wine.

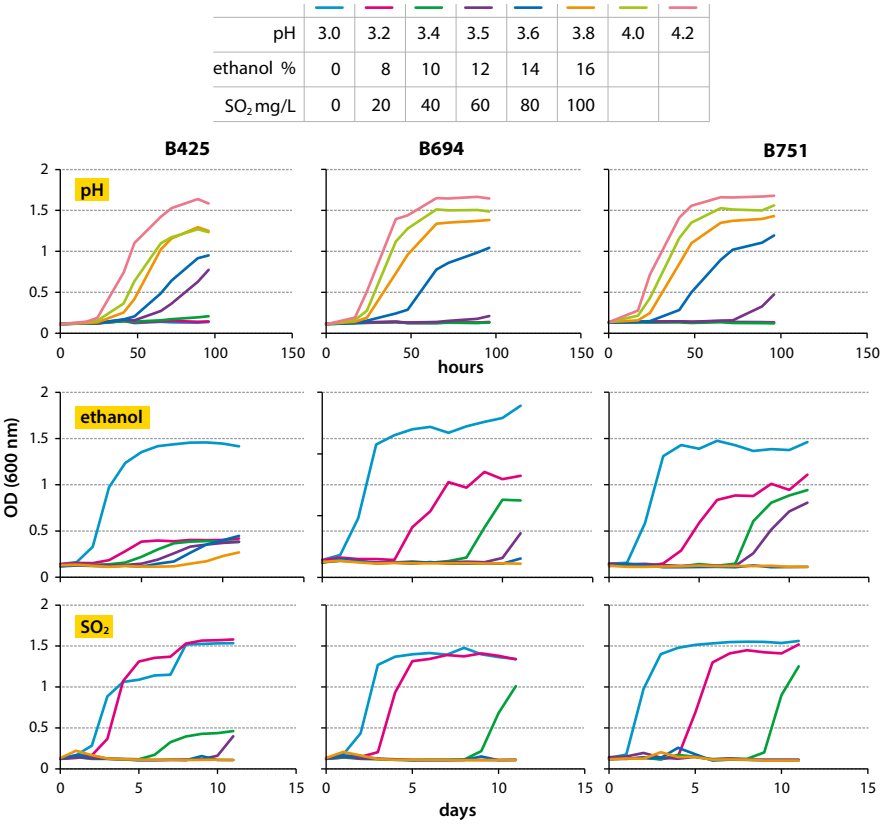

Figure 24. Examples of growth assays for three strains of Lactobacillus *spp. in a synthetic wine with variations in pH, and ethanol and total SO_2 concentrations.*

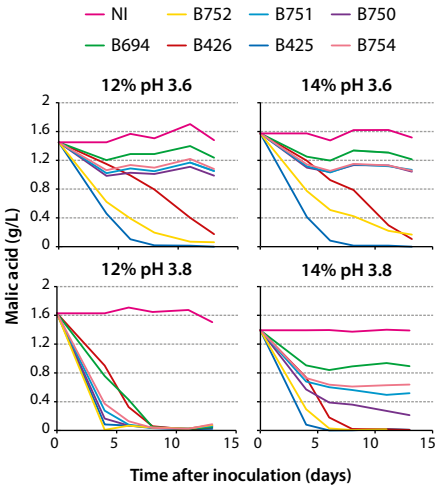

Figure 25. Ability of seven Lactobacillus *spp. strains to complete MLF in Cabernet Sauvignon wine under two different wine pH and ethanol concentrations. (NI – non-inoculated control).*

This research has highlighted that micro-scale (200 µL) screening is an excellent method to rapidly assess large numbers of bacterial isolates under numerous wine conditions to identify potential candidates for larger-scale MLF trials.

The AWRI Wine Microorganism Culture Collection

The AWRI Wine Microorganism Culture Collection (AWMCC) is an invaluable resource for the Australian wine industry. It is a world-recognised collection and an active member of World Federation of Culture Collections, the Australian Microbial Resources information Network (AMRiN) and part of the Atlas of Living Australia. The role of the collection is to maintain a repository of diverse wine-relevant yeast and bacterial strains that can be easily accessed by Australian wine producers and for research purposes. Over the last seven years the AWMCC has almost tripled in size, and currently houses over 2,900 microbes (Figure 26).

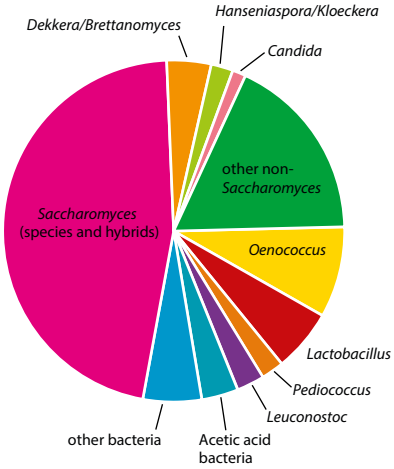

Figure 26. Yeast and bacterial genera housed in the AWRI Wine Microorganism Culture Collection. Currently there are more than 2,900 strains maintained by the AWRI.

In addition to maintaining AWRI research strains and the AWRI Wine Yeast Gene Deletion Library, the collection also provides cultures for oenology teaching, to testing laboratories (mainly as controls), and to universities and other researchers. All strains are provided as live cultures on agar slopes. Provision of cultures, except experimental strains, incurs modest fees to cover costs of materials and delivery.

Chardonnay clonal genetic variation and how this impacts on wine style

Chardonnay has an unusual genetic heritage resulting from a cross, centuries ago in northeastern France, between Pinot Noir and Gouais Blanc. There are now many clones of this variety exhibiting variation in a number of viticultural and oenological traits. The AWRI aims, in collaboration with scientists from the University of British Columbia (Canada) and Bioplatforms Australia, to assess the genetic variation between 15 clones of Chardonnay that are available in Australia, and link this to variation in defined traits in the vines and its impacts on wine style.

To this end, the genomes (i.e. the full complement of DNA) of all clones will be sequenced and compared with each other to identify differences. Sequence variations will be aligned with chemical and sensory variation in grapes and wines derived from the same clones. This will enable the identification of genes that shape important wine-relevant traits.

To date, the AWRI has learnt that sensory descriptors such as stone fruit, citrus and viscosity are important drivers of oenological variation across the 15 clones, enabling them to be classified into three groups. A similar degree of classification was evident from chemical profiling of the juices. Comparative genome analysis is now underway and is beginning to shed light on the genetic differences among clones that give rise to chemical and sensory differences in juices and wines.

Providing practical tools to increase processing efficiency and reduce processing costs

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Peter Godden, Emma Kennedy, Dr Richard Muhlack, Ella Robinson, Neil Scrimgeour

Collaborators

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Proctase – a viable alternative to bentonite

Bentonite clay is used as a fining agent in the production of white, sparkling and rose wines in order to remove proteins that could otherwise form unsightly haze after the wine is bottled. While it is a very effective way to remove those proteins, the bentonite fining step is cumbersome, tends to tie up tank time, causes volume and quality loss and presents waste disposal challenges. Bentonite is also very abrasive, causing accelerated wear on winery equipment such as pumps and centrifuges. Although in-line dosing of bentonite is currently used by several of Australia's largest wine producers due to its lower cost and efficacy on a large-scale, most Australian wineries do not have the necessary infrastructure to consider this process modification.

The AWRI has sought alternatives for preventing haze formation. One of these alternatives is Proctase, a commercially available mixture of two acidic proteases produced from Aspergillus niger (EC no. 3.4.23.18 and 3.4.23.19). Proctase has previously been shown to be effective on a commercial-scale at removing the proteins responsible for haze formation when combined with flash pasteurisation of white juice at 75°C.

The AWRI has continued to investigate the regulatory environment surrounding the use of acidic protease enzymes in winemaking. The enzymes present in the Proctase formulation are listed synonymously (carboxyl proteinase or EC no. 3.4.23.6) as approved winemaking additives in the current Food Standards Code (1.3.3). The AWRI has submitted a draft application to Food Standards Australia and New Zealand (FSANZ), to effect the required enzyme nomenclature change in the Food Standards Code to allow Proctase to be used with certainty by Australian producers. It is hoped that FSANZ will be in a position to approve the use of Proctase in winemaking in time for the 2014 vintage.

In parallel with this initiative, a dossier is in preparation for tabling at the October 2013 and March 2014 meetings of the Organisation International de la Vigne et du Vin (OIV), as the first step towards seeking permission for Proctase to be approved as a processing aid for Australian wines destined for the EU.

Reducing vintage costs and improving process control with ferment simulation

Current fermentation management places huge demands on winery resources, with process efficiency further impacted by stuck fermentations. After extensive testing with commercial wine producers over several vintages, the AWRI's breakthrough Ferment Simulator is now available for access by all levy-payers. This novel tool gives winemakers the ability to track ferment trajectory and

account for conditions such as temperature, yeast, wine type, nutrient levels, agitation regime and tank size. The tool can be used to test and evaluate alternative ferment management strategies, monitor refrigeration and electricity demand and predict problem ferment behaviour so that early corrective action can be taken when needed.

During industry evaluation, fermentation completion times predicted using the first 2-3 days of fermentation data, were found to deviate from actual by 1 to 1.5 days in most cases. Capability has been included to allow wine producers to follow multiple concurrent ferments across a tank farm, with a visual 'traffic-light' style display of fermentation status for each active ferment.

'What if?' analysis capability allows winemakers to assess the impact of strategies like temperature adjustment, yeast nutrient addition and tank agitation. Process changes can be simulated before being implemented, to ensure the optimal strategy is chosen. The tool also allows wine producers to be better informed to manage site electricity use on hot days and minimise punitive electricity demand tariffs.

The Ferment Simulator provides a unique and powerful resource for continuous quality improvement and product consistency from ferment to ferment. It is now available for download by Australian grape and wine producers from the AWRI website.

Extending research through regional nodes

Staff

Samantha Connew, Dr Wies Cynkar, Dr Bob Dambergs, Peter Godden, Dr Richard Muhlack, Ella Robinson, Neil Scrimgeour

Collaborators

Bay of Fires (Peter Dredge); Bimbadgen Estate (Sarah Crowe); Brokenwood (Simon Steele, Stuart Hordern and Lorrae St Vincent); Casella Wines (Laura Thompson and Steve Warne); Classic Oak (Peter Dunlop); De Bortoli Wines (Sharon Adams, Henry Perez, Julie Mortlock, Rob Glastonbury, Tarek Heiland and John Coughlan); Frogmore Creek (Nick Glaetzer);The Grape and Wine Research and Development Corporation; The Hunter Valley Wine Industry Association; Jansz (Natalie Fryar); Joseph Chromy (Jeremy Dineen); Keith Tulloch Wine (Keith and Amanda Tulloch); Lillypilly Wines (Robert Fiumara); McWilliam's Wines (Nevil Shah and Andrew Higgins); Peppertree Wines (Jim Chatto); Pirie Tasmania (Dr Andrew Pirie); Pressing Matters (Paul Smart); The Riverina Institute of TAFE; Riverina Wine Grapes Marketing Board (Kristy Bartrop); Tamar Ridge (Tom Ravech); The Tasmanian Institute of Agriculture (Dr Dugald Close, Dr Anna Carew and Angela Sparrow); Thomas Wines (Andrew Thomas); University of Adelaide (Dr Peter Ashman); University of Sydney (Brendan Malone); The Victorian Department of Primary Industries; Vitibit (Liz Riley); Warburn Estate (Moreno Chiappin and Amba Goldsmith); Westend Estate (Bryan Currie, Jeremy Nascimben); Winemaking Tasmania (Julian Alcorso); Wine Victoria; The Yalumba Wine Company (Dr Alana Seabrook and Luke Wilson).


Chris Curtin, Radka Kolouchova and Paul Henschke

In September 2012, the AWRI established its fourth regional node in the Hunter Valley of NSW, with Samantha Connew appointed as the Node Manager.

Using rapid spectral methods for assessment of sparkling wines

Sparkling wine is an important, growing, and highly-profitable sector of the Australian wine industry. Producers often obtain fruit from a variety of vineyards, varieties and clones, with the phenolic profile being a particularly vital element of perceived sparkling wine quality. Phenolic profiles can easily be 'fingerprinted' using Ultra-Violet (UV) spectroscopy to provide an objective measure of sparkling wine quality. This can also be used to assist in evaluating fruit and the impact that different viticultural techniques can have on grape composition, particularly in regard to the preparation of juice for sparkling base wine production.

Previous studies have shown that differences in the phenolic profiles of sparkling base wines can be monitored with UV spectra and that these differences can be seen in commercial premium sparkling wines. Typically, Australian sparkling wines can be spectrally distinguished from Champagne and sparkling wine from other regions around the world. Using UV spectroscopy to provide a chemical fingerprint of sparkling wines provides greater understanding of the differences of these wines from various regions around the world. Such fingerprints can be used to identify and investigate compositional differences which lead to stylistic differences in the wines, as well as being used during production to guide winemaking towards achieving targeted styles.

The AusIndustry program conducted in Tasmania, 'Improving Australian sparkling and Pinot Noir wines', provided opportunities for research and development trials which focused on manipulating sparkling wine quality through viticultural management. Trials showed that crop load, fruit exposure and pruning method all have the potential to influence phenolic profiles (particularly hydroxycinnamates) in the grapes, juices and wines from commercial Chardonnay and Pinot Noir vineyards, with pre-flowering leaf removal having the most consistent impact.

Vis-NIR spectroscopy, employed using BevScan™ (a non-destructive spectrophotometer developed by the AWRI and Jeffress Engineering) has also been used to fingerprint sparkling wines and discriminate between wines stored at different temperatures and with differing levels of carbon dioxide (CO_2). Trials carried out in collaboration with a number of sparkling wine producers in Tasmania have shown that secondary fermentation can also be tracked using the BevScan instrument, providing a particularly valuable application of the technology, especially in scenarios where wine value is high and cost-prohibitive destructive testing needs to be avoided.

Long-term maturation of sparkling wines is generally a cost sensitive part of the winemaking process, where wines are kept on yeast lees until desirable autolysis/ageing characters have evolved. Currently, many winemakers use informal sensory assessment to evaluate the degree

of autolysis and formation of desirable sensory characteristics. Development of lees-aged attributes during autolysis has been successfully tracked using UV spectroscopy. Spectral analysis has shown that differences between wines treated with different pectolytic enzymes can be effectively monitored, and that those UV fingerprints could be used to predict sensory ratings in sparkling wines that are directly linked with autolysis characters.

Developing innovative methods for improved phenolic extraction in red wines

One focus area at the AWRI's Tasmania Node has been to understand the kinetics and physical conditions which govern the extraction of phenolics during the production of Pinot Noir table wines and to exploit this knowledge through the development of innovative maceration methods. Pinot Noir is a difficult variety to use for red wine production due to its unusual phenolic profile and low concentration of colour (anthocyanins).

Trials utilising different tannin sources (skins, seeds, stalks) in Pinot Noir maceration have indicated that skin tannin appears to be more desirable, due to better long-term colour stability. Work has therefore focused on enhancing skin tannin extraction during the maceration process. Several small-scale commercial trials have shown that extraction of skin tannin can be enhanced by selectively macerating skins during fermentation. When compared with standard cap management methods, anthocyanin and tannin extraction in Pinot Noir was enhanced and higher levels of pigmented tannins were formed in the resultant wines. The original work was carried out on a laboratory-scale. The 2013 vintage trials were performed in three commercial wineries on a 500 kg scale, using different batches of fruit, but all using the same winemaking protocol. Wine analysis confirmed that in all three cases the positive effects of selective skin maceration were achieved and sufficient wine was produced to allow subsequent sensory assessment and to monitor long-term stability.

Previous laboratory trials have shown that microwave treatment can also be used to enhance phenolic extraction in Pinot Noir. The technique has shown potential for achieving full phenolic extraction with as little as three hours of skin contact time and could allow must to be pressed early and the wine fermented off-skins, dramatically increasing winery efficiency and reducing costs. Wines and juices analysed from 2013 Tasmanian trials have identified that hold time management after microwave maceration offers control over phenolics extraction in Pinot Noir (particularly with tannin). As expected, anthocyanins are extracted quickly and tannins are extracted efficiently but at a lower rate (Figure 27). This could allow the phenolics profile to be directly monitored during the high temperature hold time after microwave maceration, allowing the must to be pressed when pre-determined tannin concentrations and degree of colour extraction had been achieved.

Commercial-scale trials carried out in conjunction with the Hunter Valley Node during vintage 2013 have shown that longer hold time microwave maceration produced Shiraz wines that were phenolically equivalent to a control wine fermented in the conventional manner. Shiraz wines made using shorter hold microwave maceration were significantly lower than the control wine for mean concentration of total pigment, free anthocyanin and colour density, but equivalent for total phenolics, total tannin and pigmented tannin.

Small-scale microwave maceration trials with early press-off appear to have produced aromatically distinct Pinot Noir wine compared with control wines and wines produced from microwave macerated must which were fermented on skins.

Hunter Valley trials have also shown that microwave maceration can be used to reduce laccase activity in *Botrytis*-affected grapes. Laccase concentration in musts obtained from *Botrytis*-affected bunches of Shiraz with infection levels ranging between 1% and 40% were reduced, on average, by around 90% from an initial average level of 8.2 µg/mL.

Powering up the wine sector with bioenergy

Wine producer margins are facing real pressure, with currency strain and rapidly rising energy and production costs putting the squeeze on bottom-line profitability. It is essential that key resources such as energy and water are sourced and managed efficiently and full value is extracted from by-products and waste streams. The Australian wine sector generates substantial quantities of biomass, such as grape marc and stalks, yeast lees and wastewater sludge, and those waste products could be used for a range of purposes that would create additional value, such as heating and refrigeration, or farming applications such as composting, biochar and stockfeed supplements.

Technical and economic evaluation of potential renewable energy scenarios for consideration by the wine industry has been an area of focus by the AWRI's Riverina Node. Various scenarios for energy cost reduction have been considered, with a detailed study performed on one promising technology (gasification) with assistance from collaborators such as the University of Adelaide's Centre for Energy Technology. Both well established and emerging technologies have been assessed, as well as combinations such as biomass technology together with solar thermal, to identify whether any synergies exist that will multiply technology benefits.

The most promising outcomes from the evaluation are shown in Table 5. More details can be found on the AWRI's website. Biomass options for electricity generation that appear to be the most economically attractive at this point include gasification, or combustion together with an Organic Rankine Cycle (ORC) engine. These provide the shortest payback together with the greatest electricity cost savings (upwards of 25-50% in some cases). Meeting refrigeration demand with an Anaerobic Digester (AD)-powered refrigeration compressor shows a similar payback scenario, and a watching brief on grant opportunities for producers that offset capital costs (and reduce payback time) has been in place. Analysis suggests that solar thermal options which focus on non-fermentation energy loads are less economically attractive than biomass at this time; however the technology is more mature and easier to deploy. Renewable energy technology options which cover ferment loads appear far from economic, with simple payback in excess of 20 years in most cases.

Interest in new technology that lowers operating costs or improves process efficiency within the wine industry remains strong. However, for more emerging renewable technologies, such as bioenergy, the perceived technical risk has to date deterred investment. Fortunately, that is set to change, with a major grape marc biomass facility

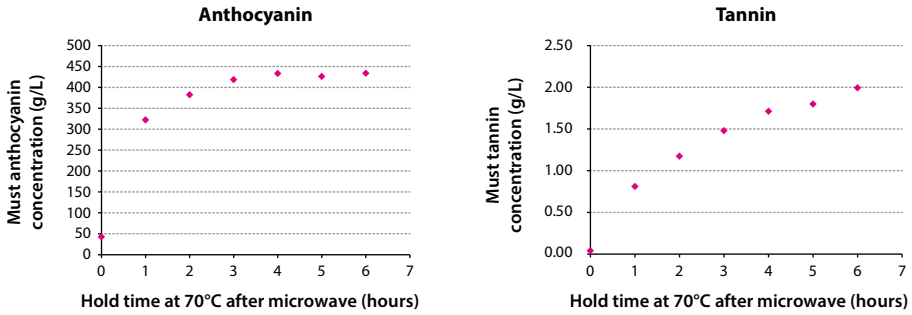


Figure 27. Impact of post-microwave maceration hold time on anthocyanin and tannin extraction in Tasmanian Pinot Noir must samples.

under construction at Australian Tartaric Products' production facility near Mildura. Supported by the Australian Government's Clean Technology Food and Foundries Investment Program, this new biomass plant will supply 63% of the site's electricity demand, with construction due for completion by the end of 2013. A similar project is also under consideration by Tarac Technologies at their Griffith plant, and several individual wine producers have expressed interest in innovative renewable technology. These are all significant developments that will progressively de-risk the technology and provide necessary momentum for similar developments in other wine regions.

Table 5. Technical and economic evaluation of potential renewable energy scenarios for the wine industry.

Scenario	Simple payback (years)	Projected Grid Energy Savings (%)
Site electricity supplemented by biomass energy using gasification technology	5.6	49%
Supplementary refrigeration supplied by AD powered refrigeration compressor	4.5	25%
Site electricity supplemented by biomass using ORC technology	5.2	49%

Understanding the impact of soil type on phenolics in Hunter Valley Semillon

Mirroring the general trend across premium Australian grape growing regions, Hunter Valley winemakers are increasingly focussing on single vineyard wines and sub-regions to highlight the different styles available to consumers, as well as expressing the unique characteristics of the vineyard.

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 with different flavour, style and phenolic profiles. Trials carried out during 2013 have attempted to determine whether soil type (and thus sub-region) plays a significant role in the phenolic profile of Semillon juices and what impact the winemaking process has on the resultant wines.

The first stages of the project have involved tasting 55 single vineyard wines from the 2011 and 2012 vintages, in order to determine if wines crafted from fruit grown on different soil types and in different sub-regions are phenolically unique. To assess the impact of the winemaking process, the winemakers of these wines completed a survey in order to align winemaking practices used with differences in wine style.

Chemical analysis of the wines did not show any significant trends, but UV/Mid-IR spectra showed that vintage had a significant impact on the phenolic profile and there was an apparent separation between wines made from fruit grown on Sandy Alluvial and Alluvial Loam soils.

During the 2013 vintage, fruit samples were collected from over 20 different vineyards and the resultant juices assessed using phenolically important UV-Vis wavelengths (265, 280 and 330 nm). This initial data set indicates that there are correlations between soil types and juice phenolics and that hydroxycinnamates might be one class of compounds responsible for the differences seen among the wines. Fruit from five of these vineyards was processed using the same winemaking techniques at the same winery and phenolic profiles for these samples are currently being collected for assessment.

The implications of the initial outcomes are important for Semillon as one of the characteristics of hydroxycinnamates is that they are powerful antioxidants and could give white wines, such as Semillon, good ageing potential. This study has so far shown that soil type and sub-regional characteristics may have a role to play in the phenolic profile of the resultant wine.

Development of web-based tools continues

Staff

Dr Wies Cynkar, Dr Bob Dambergs, Peter Godden, Emma Kennedy, Ella Robinson, Neil Scrimgeour

Collaborators

Casella Wines (Steve Warne); De Bortoli Wines (Rob Glastonbury, Tarek Heiland and John Couglan); Lillypilly Wines (Robert Fiumara); McWilliam's Wines (Andrew Higgins and Nevil Shah); Warburn Estate (Moreno Chiappin); Westend Estate (Bryan Currie); The Yalumba Wine Company (Luke Wilson).

To many winemakers, phenolic compounds are the things that define the intrinsic value of red wines, being a major influence on their colour and textural properties. Until now, however, they have been difficult to measure, and largely overlooked by winemakers. The availability of tools that can be used to measure phenolic compounds in wines, such as the AWRI Tannin Portal, has allowed winemakers to gain a better understanding of tannin and colour extraction in red fermentations and wines and allow winemaking practices to be tailored to achieve targeted wine styles.

This capability has now been extended to incorporate the analysis of tannins, phenolics and anthocyanins in grapes. These attributes can be calculated using absorbance data collected at three key UV-Vis wavelengths (280, 320 and 520nm). The ability to measure these critical attributes in grapes and wines is now available through an extended version of the Tannin Portal, known as the AWRI WineCloud™.

The WineCloud contains a significant volume of grape and wine analytical data (over 21,000 samples), against which users can benchmark grapes and wines across different varieties, regions and vintages. The platform also contains a suite of tools that allow simple graphical representation of data such as grape maturity trends, attribute profile charts and fermentation trajectory plots. The WineCloud has the potential to substantially increase understanding of the relationships between grape and wine composition, thus informing the way grapes are treated and harvested and the way wines are processed. Australian grape and wine producers can access the AWRI WineCloud through the AWRI website.

WIC Winemaking Services

Staff

Michael Coode, Con Simos

Wine Innovation Cluster (WIC) Winemaking Services (WWS), a joint venture between the AWRI and the University of Adelaide since 2010, is based at the Hickinbotham-Roseworthy Wine Science Laboratory (also known as Wine Innovation Cluster East [WIC East]). WWS shares the University's purpose-built small- and pilot-scale winemaking facility to offer a service that provides consistent small- and pilot-scale quality wines, for research and commercial projects to aid the Australian wine industry.

WWS is managed by a qualified winemaker, Michael Coode, and the service offers an opportunity to outsource the winemaking component of R&D projects for viticulture, winemaking or processing treatments. The service also provides industry with the opportunity to trial upcoming varietals, new technologies and production methods.

Michael Coode has worked closely with clients to design trials to ensure effective fruit selection and volumes for vintage 2013, resulting in good quality fruit being delivered for research. WWS also offers a bottling capability.

In 2013, over 300 different wines were vinified in fermentation sizes from 1 litre to >1,000 kgs.

Wine in society

Wine quality and consumer needs

Staff

Dr Leigh Francis, Dr Helen Holt, Patricia Williamson, Wes Pearson

Collaborators

Accolade Wines (Chris Bevin and James Wilson); CSIRO Plant Industry (Dr Rob Walker, Peter Clingeleffer); Premium Wine Brands (Kate Lattey, Shane Hanna); Treasury Wine Estates (Vanessa Stockdale and Clare Flintoff); Sensory Insights (Mark Stevens); The Yalumba Wine Company (Geoff Linton); Tyrrell's Wines (Tom Lynar); Australian Vintage (Nick Yap, Jakub Rys); Wine Australia (James Gosper and Willa Yang); Cape Mentelle (Evan Thompson); Angoves Wines (Richard Angove); University of Adelaide (Dr Sue Bastian); University of South Australia (Prof. Larry Lockshin, Dr Armando Corsi, Dr Simone Mueller-Loose); Aarhus University, Denmark (Dr Simone Mueller-Loose).

The sensory science team supports many activities across the AWRI and also runs a dedicated research program. The objective measurement of wine sensory properties and consumer responses forms the backbone of work to evaluate the effects of viticultural and/or oenological treatments and establish fundamental relationships of sensory attributes with wine composition.

The AWRI technical quality panel continues as an invaluable resource that assesses wines for suspected off-flavours and faults, providing direction for investigative studies by the AWRI Winemaking and Extension Services team. During 2012/2013, the panel evaluated 91 individual samples using free choice comments and off-flavour scores, as well as rated attributes of wines for several studies.

Numerous comprehensive sensory research projects were conducted through the year, which are reported elsewhere in this document. Studies have included: examining the effects of simultaneous malolactic fermentation and two different nutrient additions during Chardonnay fermentation; a Chardonnay Clonal evaluation; a novel yeast strains study; a copper addition study; and a study investigating polysaccharide fractions in model wines.

In a collaborative project with Rob Walker and Peter Clingeleffer of CSIRO Plant Industry, the AWRI continued to assess the effects of salt excluding rootstocks on wine sensory properties, using Padthaway Shiraz wines for descriptive sensory analysis. Wines from one particular rootstock were scored significantly higher for *salty* and *viscosity;* this rootstock also produced wine with the highest concentrations of chloride. Interestingly, there were only relatively low levels of sodium, which in previous studies was most associated with salty taste. In assessing the sensory properties of sodium chloride in white and red wine, its detection threshold and consumer rejection threshold were also measured. A *best estimate detection threshold* was determined to be 1.1 g/L and 1.3 g/L of NaCl added to white and red wine respectively, similar to that determined in two different base wines in a previous experiment. The same wines with identical NaCl additions were presented to 59 consumers for a 'Consumer Rejection Threshold' (CRT) test, where consumers were asked to state whether they preferred the Control wine (no NaCl addition) or the wine with added NaCl, tasted blind. The results showed a decreased preference only for relatively high levels of salt (CRT 1.5 g/L and 1.6 g/L for white and red wine respectively). The results indicate that quite high concentrations of sodium chloride are required before consumers are likely to reject a wine, providing useful guidance for winemakers when setting specifications.

During the year, assessments were conducted to determine the value of a new sensory technique known as 'Napping' (a form of sorting/projective mapping – Figure 28): Napping results in a map of the main differences and similarities among a set of wines, and also allows selection of terms to characterise the main attributes of the wines studied. Much faster results can be obtained through Napping compared to conventional sensory profiling using descriptive analysis. Conventional sensory profiling can take several weeks to achieve results that require only one or two sessions with Napping. To validate Napping, wines were evaluated during the year from several sample sets and the results have consistently been very similar to those obtained from conventional sensory profiling. The disadvantage of Napping is that the data must be analysed using quite sophisticated methods; estimates of statistical significance are not obtained, and quantitative differences in specific attributes among wines are not readily available. However, the technique provides a rapid overview of the sensory properties of the samples which is often sufficient for many studies. In addition, the Check All That Apply (CATA) method was adopted,

Helen Holt, Patricia Williamson and Wes Pearson

which is of interest as it allows rapid characterisation of samples using consumers, trained panels or experts with minimal training.

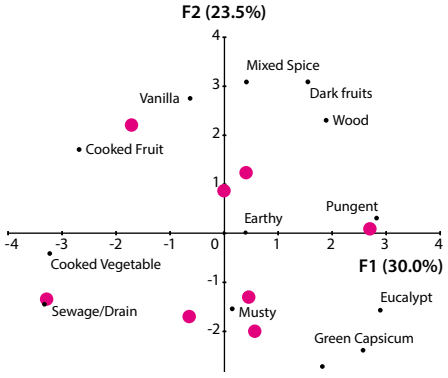


Figure 28. An example of the results from Napping (large pink circles) to characterise the aroma for a set of red wines (Shiraz, Grenache and Cabernet Sauvignon) in a single session by a panel of 10 assessors.

A Shiraz wine bottled under 15 different closures was characterised at the 24 month post-bottling time point by sensory descriptive analysis. Sensory differences were relatively small with only two samples displaying clear oxidative aromas. Based on the largest sensory differences from the sensory descriptive analysis data, a subset of seven wines under different closures was selected for a consumer test with 205 consumers in Sydney. There was a significant difference in purchase intent among the seven samples tasted blind (without any information) by the consumers. The results indicate that small differences are important to consumer preference, and allow specifications to be developed for producers to ensure oxidative flavour is at acceptable levels. Liking ratings followed the same trend as purchase intent. Cluster analysis showed evidence of groups of consumers with different preferences. The largest group, with 46% of the consumers, preferred wines with high fruit aftertaste and was driven negatively by bitterness and bruised apple.

The first phase of a collaborative study with University of South Australia looking at consumer responses in China to a broad range of wine styles has been completed, in partnership with Wine Intelligence. Twelve focus group sessions were conducted in three cities in China (Beijing, Guangzhou and Chengdu), where wine consumers tasted four different wines (red, white, sparkling and dessert) and provided feedback in the form of descriptive terms and overall acceptability of each style. Not surprisingly, wine was normally described by consumers in broad terms including good taste, smooth, sweet, acid, fruity, astringent, while specific terms were not mentioned unprompted. Of the prompted terms, citrus fruits such as *pomelo* and *lime* were preferred for white wines and sparkling, while red fruits such as *yangmei* and *dried Chinese hawthorns* were used to describe red wines. Red wines and sweeter styles like Moscato were the styles preferred by the focus groups, but interestingly very sweet wines such as a fortified Muscat or botrytis Semillon were not so well received. The next phase of the project will involve consumer quantitative sensory testing of different Australian wine styles.

Over 1500 red wine consumers in Beijing, Shanghai and Guangzhou completed the first stage of a study to assess the effect of information about Australia or Australian wine on consumer choices in China. The online study included reading one article about Australia (*Great place to visit*, *Clean and unpolluted*, *Safe food and wine*, *Wines with tradition and prestige*, *The best tasting wines in the world* or, as control, an unrelated message), followed by a choice experiment simulating a supermarket shelf. The objective of this ongoing study is to establish which message will potentially increase choice of Australian wines, and which extrinsic attributes are more important to consumers in China when choosing a wine.

Human health, nutrition and food safety issues impacting on the Australian wine sector

Staff

Creina Stockley

Collaborators

Brain Sciences Institute, Swinburne University (Prof. Andrew Scholey); Department of Colorectal Medicine and Genetics at The Royal Melbourne Hospital (Prof. Finlay Macrae); Edmund Mach Foundation, Italy (Prof. Fulvio Mattivi); University of Aberdeen, Scotland/Flinders University, South Australia (Prof. Arduino Mangoni).

One of the activities of the AWRI is to provide health and nutritional advice and assistance to the Australian wine sector. From 1 July 2012 until 30 June 2013, 31 information health and nutrition requests from industry, the general public and government were managed.

Health and nutrition issues

During the year, the AWRI database of research on the beneficial and detrimental health effects of alcohol, and in particular wine, was expanded and these records are available online for levy payers. This is facilitated by the subscription to relevant medical and scientific journals, and by the formal and informal exchange of information between complementary organisations, both national and international. The journals have been regularly scanned, and abstracts have been selected for inclusion in the AWRI's publication, *Technical Review*. Articles and other material have been prepared for publication in electronic and print media (see Appendix 5). For example, an 'Ask the AWRI' column was published titled 'Wine as part of a healthy diet – Australian Dietary Guidelines' in the *Australian and New Zealand Grapegrower and Winemaker* and the AWRI Report was published titled 'What's in a label' in the *Wine and Viticulture Journal*. An article was also prepared for each of *AIM-Alcohol in Moderation* and *Technical Review*. In addition, two peer-reviewed papers were published in *Food and Function* and the *Journal of Agriculture and Food Science*. A book chapter titled 'The protective effects of wine and wine-derived phenolic compounds on brain function' was also published in *Advances in Natural Medicines, Nutraceuticals and Neurocognition* by Taylor & Francis: Bosa Roca/US. Six media interviews were also conducted (see Appendix 4).

A submission was prepared for the Australian National Preventative Health Agency's issues paper titled 'Exploring the public interest case for a minimum (floor) price for alcohol'. In addition, a 35-page project report was prepared for the Winemakers' Federation of Australia titled 'Review of wine's role in alcohol abuse in Australia' to help inform the WFA strategic plan. The project reviewed the available literature on the role of alcohol, and specifically wine, in abuse and short and long-term harms (both health and societal) and associated costs in Australia. Five areas were specifically evaluated as follows: What is available and where is it generated?; What does it suggest?; What is its quality?; What is missing?; and Current research being undertaken in Australia. General and specific gaps in the existing databases and literature were identified from the evaluation.

Project coordination

The project titled 'Resveratrol in the chemoprevention of colorectal neoplasia' funded by Cancer Australia has continued, in collaboration with Professor Finlay Macrae, Head of the Department of Colorectal Medicine and Genetics at The Royal Melbourne Hospital.

The project titled 'Determination of the beneficial cardiovascular effects of red wine and the three primary wine-derived phenolic compounds and their metabolites in humans' has continued in collaboration with Professor Arduino Mangoni formerly of the University of Aberdeen, Scotland and currently Flinders University, South Australia. The results to date point to the conclusion that resveratrol delivered in red wine improves vascular outcomes such as blood pressure, endothelial function and augmentation index, which is a measure of arterial stiffness and central aortic pressure.

The project titled 'Effect of resveratrol in red wine on cognitive function in older adults – a pilot study' has been undertaken in collaboration with Professor Andrew Scholey, of the Centre for Human Psychopharmacology, Swinburne University. The project has investigated the effects of grape-derived resveratrol, administered in a moderate amount of

red wine on specific and sensitive biomarkers for cognitive function in an elderly patient population, with an aim to attribute any beneficial effects to resveratrol and /or its metabolites. The results show that resveratrol is absorbed and becomes available to the proposed sites of action, confirming that red wine is a candidate vehicle for the delivery of resveratrol in older adults. Resveratrol delivered in red wine improved cognitive function during more demanding cognitive processing. Low amounts of alcohol have previously been shown to improve attentional function, while it has previously been shown that the consumption of cocoa-derived phenolic compounds, which improve cerebral blood flow, are capable of improving cognitive function during heavily loaded tasks, that is, those which require a relatively high level of mental effort to execute. These results are promising and show for the first time that acute doses of resveratrol delivered in red wine can modulate cognitive functioning.

The project titled 'Tracking the metabolome of grapes into wine' has commenced, in collaboration with Dr Fulvio Mattivi of the Fondazione Edmund Mach and University of Trento, Italy. This two-year project aims to identify, quantify and potentially characterise compounds in grapes that are transferred to wine which might have therapeutic effects in humans. Grape samples from three varieties, Shiraz, Cabernet Sauvignon and Pinot Noir were collected during the 2012 vintage period, and small-scale wines were made from these grapes. The matching grape and wine pairs were subjected to reverse phase profiling using Liquid Chromatography Time-of-Flight Mass Spectrometry (LC-MS/MS), which revealed more than 400 features. While some of the features could be identified using reference materials, a number of these features are likely to be phenolic compounds that have not been considered in previous wine and health studies, and accordingly might be additional candidates for the observed therapeutic effects of grapes and wine.

Communications and information delivery

Staff

Con Simos, Rae Blair, Linda Bevin, Anne Lord, Michael Downie.

The Communication and Information Services (CIS) team is responsible for the strategic sourcing and effective delivery of relevant technical information to Australian grape and wine producers of all sizes. The operations of the CIS team also complement and support the knowledge management and communication activities of all of the AWRI staff.

Highlights and activity

Specific activities of the team include:

- Corporate communication and brand management
- Information and knowledge management
- Provision of library services via the John Fornachon Memorial Library
- Management of the AWRI website, and web-accessible information databases
- Production of corporate publications, including *eBulletins*, *eNews*, *Technical Review* and the Annual Report
- Coordination and hosting of the AWRI's annual webinar program
- Managing the AWRI's presence on social media (Twitter, Facebook and LinkedIn)
- Provision of an editorial service for the staff of the AWRI
- Managing requests from media

Progress reports on key activities are shown elsewhere in this document. Highlights for the 2012/2013 financial year include:

- The 2012 webinar series was expanded to 15 sessions with 360 participants.
- Seventeen *eBulletins* were issued, which proved a particularly effective way of distributing crucial information about agrochemical and other important technical issues to wine and grape producers.
- The 'AWRI Report' and the AWRI's 'Alternative Varieties' column were published in every issue of the *Wine & Viticulture Journal*, and the 'Ask the AWRI' column was published in every issue of the *Australian and New Zealand Grapegrower and Winemaker* throughout the year.
- The AWRI's electronic newsletter *eNews* was distributed six times throughout the year, in alternate months to the production of *Technical Review*. Requests for TR articles increased to 765 articles delivered in 2012/2013.
- The AWRI website continued to be a key source of information for the Australian grape and wine sector. A mobile-friendly version was launched in October 2012.
- Information requests managed resulted in 2,466 articles delivered during 2012/2013.

Provision and development of mechanisms for the efficient transfer of knowledge and technical information to the Australian grape and wine sector

Staff

Rae Blair, Linda Bevin, Michael Downie

The AWRI uses several strategic and effective mechanisms to disseminate knowledge and information to Australian grape and wine producers. Reported elsewhere in this report are the face-to-face extension activities undertaken by the other members of the Industry Development and Support group. Below are details of the other extension/communication mechanisms which make information available to the AWRI's stakeholders.

Annual report

For the past 58 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 been made available also for download from the AWRI's website. In an endeavour to improve the circulation across Australia of the AWRI's annual activities, the AWRI also publishes a four-page supplement in the November issue of the *Australian and New Zealand Grapegrower and Winemaker*, and the AWRI approaches all the major State-based winemaking associations and offers 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).

AWRI website

The AWRI website is a key communication tool. Approximately 80,000 visitors accessed the AWRI website during the year with a total of ~270,000 page views. Incorporated into the website are a number of online databases and tools to support the Australian grape and wine industry and they include:

- Permitted additives and processing aids
- Export requirements
- Agrochemical online search
- Maximum Residual Limits online search
- Winemaking products and support
- Online winemaking calculators
- Library catalogue
- Journal article ordering

The top five tools (based on the number of hits per year) on the AWRI website are:

- Winemaking calculators (over 10,000 hits)
- Staff publications ordering (over 7,600 hits)
- Maximum residue limits (over 7,000 hits)
- Export requirements online search (over 5,700 hits)
- Agrochemical online search (over 4,700 hits)

A mobile version of the AWRI website was launched in October 2012. The purpose of the mobile website is to deliver web content in a mobile-friendly format for use through smartphones and tablets. Access to the AWRI website via a mobile device is automatically re-routed to the mobile website and users have the option to launch the original version of the website.

The number of visits to the AWRI website using a mobile device was steady when compared to last year. However, tablet users made up 65% of the mobile device user base; an increase of 40% from the previous year.

Technical Review

Technical Review publishes abstracts of current technical literature surrounding grape and wine production. It also includes research updates from staff of the AWRI, as well as information on Roadshow seminars and workshops. *Technical Review* is published six times a year, and is available to grape and wine producers via the AWRI website or in hard copy. 765 articles featured in *Technical Review* were requested and forwarded to readers.

Editorial services

The AWRI contributes regular columns in each of the *Wine and Viticulture Journal* and the *Australian and New Zealand Grapegrower and Winemaker* and also contributes other papers to these and other Australian and international industry journals. All papers authored by the AWRI staff, to be published in non-peer reviewed publications, are edited by the Communication Manager (details of the articles published are in Appendix 5).

Improvement of knowledge management and stakeholder communication

Staff

Rae Blair, Linda Bevin

The AWRI aims to ensure knowledge is used for innovation in industry and acts as a catalyst to create new knowledge more freely. These project activities complement the communication objectives of all staff members at the AWRI.

Rae Blair and Linda Bevin

Information and knowledge management

The AWRI continues to use W*i*SE (the AWRI's Intranet and collaboration system) for communication and project management. The establishment of two project sites facilitated the coordination of the AWRI's input into the review of, and reporting against, the GWRDC's investment in the AWRI's 7-Year Research, Development and Extension (RD&E) Plan and also the development of the AWRI's new 5-year RD&E Plan.

Improved communication with stakeholders

The AWRI continued its focus of connecting with stakeholders throughout the year. Specific evidence of this can be found in the Appendices, which detail the presentations given, and papers published, by staff at the AWRI. Electronic delivery of information to stakeholders' desktops has continued to be a priority. The AWRI uses three email address lists to communicate with its stakeholders. Users can automatically subscribe to, or unsubscribe from, the lists at any time via the AWRI website, thus ensuring that only those who want the information receive it. With a continued emphasis on agrochemical updates, 17 email bulletins were delivered during the year and are shown in Table 6.

The AWRI's electronic newsletter, *eNews*, continued to be distributed bi-monthly to around 2,600 email addresses. *eNews* provides snapshot updates of the AWRI's activities. The distribution of *eNews*, in alternate months to *Technical Review*, means information is formally received by stakeholders from the AWRI at least monthly.

Support for the AWRI's Twitter presence is continuing with more than 1,800 followers. A multi-platform approach is facilitated through the use of social media and other communication methods. Using multiple avenues ensures grape and wine producers are empowered and engaged through access to innovative and collaborative tools which facilitate learning and easier access to information, to ultimately improve processes in wineries and vineyards.

Webinars

The AWRI webinar series was launched in 2011. Webinars are considered an effective method for disseminating information and knowledge with the advantage that participants are able to attend a live seminar from their desk. It provides greater convenience for industry to gain access to latest research findings, obtain updates on industry related activities, speak with researchers and share knowledge with other webinar participants.

In 2012, the webinar series expanded to 15 sessions and included three external presenters. A total of 360 participants attended the webinars. Results from evaluation questionnaires indicated a positive adoption of webinars as one of the AWRI's education platforms. All survey participants indicated they would attend future webinars. Over 95% of survey respondents indicated the webinars were well organised and over 85% indicated the software was easy to use. All respondents attended the webinars to build on their existing knowledge base and to find out the latest research on the topic and over 85% of respondents indicated they attended the webinars to look for ways to improve winery or vineyard operations.

Mobile Apps

The integration of smartphones and tablets into everyday business use is enabling a more mobile workforce and changing the way grape and wine producers operate. Two mobile apps (Agrochemical search and Winemaking calculators) were launched this year. The apps are available for download from the iTunes and Google Play Stores.

Media liaison

The AWRI is regularly approached for comment on wine technical matters from national and international media. This provides an excellent opportunity to ensure accurate information is published about wine made in Australia and to generate further communication opportunities with AWRI's stakeholders. Many requests from the media were handled during the year, and specific details can be found in Appendix 4. Four media releases were prepared and distributed during the year and are listed in Table 7.

Provision of scientific, technical and regulatory information

Staff

Linda Bevin, Anne Lord and Michael Downie.

The John Fornachon Memorial Library

The John Fornachon Memorial Library holds the largest collection of grape and wine technical literature in the Southern Hemisphere, covering winemaking, viticulture, wine microbiology, flavour chemistry, phenolics, food chemistry, wine and health, wine and the environment. The collection includes books, journals, article reprints, conference proceedings, reports, theses, standards and legislations, as well as a reference collection of directories, foreign dictionaries and atlases.

While the John Fornachon Memorial Library's print book and journal collections continue to grow; an increasing emphasis is being placed on building collections of digital resources. In line with past years, the majority of information requests received by the library are filled by electronic document delivery. While most requests are received via email or through the AWRI website ordering system, requests can also be made in person, by phone or by mail.

The completion of a digitisation project has improved access to information. Since the launch of the AWRI online article ordering system, over 500 requests for articles have been received via the website. The team has completed a review of eBook management platforms and two platforms were shortlisted for further investigation.

Online information databases

Three information databases, available via the AWRI website, can be accessed by all levy payers. The library databases (Table 8), which include the records of books, journal articles, conference proceedings, reports, standards and legislation held in the AWRI collection, enable online information search and ordering options.

There continues to be strong demand for information access via the web, either directly via the online information databases; through the reference lists on common topics (such as *Botrytis* and general taints and faults); or by direct contact with the library.

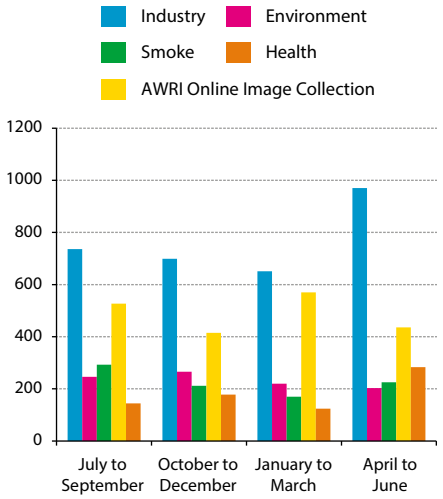


Figure 29. Summary of database use during 2012/2013.

John Fornachon Memorial Library catalogue databases

The Library holds 74,254 records of books, conference proceedings, theses and scientific, technical and medical reprint articles. These records are indexed in the John Fornachon Memorial Library's

Table 6. eBulletins issued during 2012/2013.

Date	Topic	Author	No. email addresses
7/8/12	AWRI's August issue of *Technical Review* now available online	Linda Bevin	2,444
9/8/12	Agrochemical update	Marcel Essling	2,428
9/8/12	AWRI 2012 webinar series	Michael Downie	2,422
4/10/12	AWRI's October issue of Technical Review now available online	Linda Bevin	2,423
28/11/12	Download new AWRI Agrochemical Search app now	Linda Bevin	2,414
2/12/12	Technical Review: December 2012 issue now available online	Linda Bevin	2,395
10/12/12	Agrochemical update December 2012	Marcel Essling	2,387
10/1/13	Management strategies to assist with the recent hot weather conditions and potential for smoke taint	Con Simos	2,554
12/2/13	Technical Review: February 2013 issue now available online	Linda Bevin	2,561
1/3/13	Vale Dr Bryce Rankine AM	Rae Blair	2,543
27/3/13	Register for these industry events before 5 April to save	Rae Blair	2,603
27/3/13	Timely reminder about slow sluggish and stuck fermentations	Matt Holdstock	2,584
11/4/13	Grant ensures grape and wine producers will be climate change ready	Rae Blair	2,553
4/6/13	AWRI webinar series	Michael Downie	2,548
6/6/13	Agrochemical update	Marcel Essling	2,534
7/6/13	Technical Review: June 2013 issue now available online	Linda Bevin	2,528
21/6/13	WineHealth 2013: is wine just another alcoholic beverage?	Rae Blair	2,759

Table 7. Media releases prepared and distributed 2012/2013.

Announcement	Date distributed
NSW wine producers to benefit from new AWRI node	9/8/12
Toby Barlow takes top honours at AWAC 2012	21/8/12
Grant ensures grape and wine producers will be climate change ready	11/4/13
Gwyneth Olsen joins elite few as Dux of AWAC	5/6/13

Table 8. Description and number of records of online information databases and library catalogues.

Web accessible information databases	
Library catalogue	74,254
Environment	2,218
AWRI Online Image Collection	2,338
Reprint Collection to date	50,246
- *Reprints*	38,907
- *AWRI publications*	1,551
- *Articles indexed via* Technical Review	9,788

Randell Taylor, Eric Wilkes and Leanne Hoxey

database catalogue which is accessible online via the AWRI website. Records of the library's journal holdings including newsletters, statistics and annual reports are held in the *Journals* database. A summary of the library catalogue's holdings and information databases is given in Table 8. Figure 29 tracks the use of the databases throughout the year.

Specialised information services

While the AWRI's 'Industry' online information database is available to all levy payers, customers continue to request that the AWRI library perform literature searches across in-house databases and other external resources in order to meet their information requirements. Fifty literature searches were conducted in 2012/2013.

Document delivery services

'Document delivery' services entail the supply of journal articles, books, DVDs or other library items to customers upon request via the AWRI website, email, fax, phone or mail. Other Australian and overseas libraries or publishers are used to source requested items which are not held in the John Fornachon Memorial Library. The ability to order items online means that the majority of document requests are able to be completed within 48 hours.

Library collection

Sixty-seven new books were added to the collection in the financial year of 2012/2013. The Library subscribed to, or received through exchange or donation, over 75 journal titles. The collection also holds over 50,000 reprints which include AWRI staff publications, articles featured in *Technical Review* and articles obtained from other suppliers.

Commercial Services

Staff

Dr Eric Wilkes, Leanne Hoxey, Randell Taylor, Matthew Cream, Alana Spears, Heather Tosen, Tim Reilly, Bryan Newell, Melissa Aitchison, Dr Simon Nordestgaard, Pamela Solomon, Daniel Tynan, Warren Roget, Neil Scrimgeour, Dr Tina Tran, Karl Forsyth, Robyn Gleeson, Tadro Abbott and Dr Kerry Pinchbeck.

The operating environment for the Australian wine sector continued to be a challenging one for the year with restructuring and write-downs announced by a number of major industry players. This environment highlights the importance of a strong and high quality independent technical service to support industry as many companies reduce internal capability to save costs, but it also limits the opportunities of new projects. To meet demand, Commercial Services continued to offer a high quality service at competitive pricing while implementing a range of new services. These strategies have seen Commercial Services continue to improve its financial performance while, at the same time, retaining its reputation as the reference body for technical and analytical services within the wine industry.

Providing technical services the sector needs

Recognising the needs of the sector, the AWRI has maintained the pricing of its analytical service offerings at the reduced levels introduced in 2011. It has also implemented new services while maintaining or improving the time it takes for results to reach the customer. A focus has been placed on offering services most appropriate to particular regions. For example, the trialling of a sample pick-up service in McLaren Vale and targeted trace and microbiological offerings in regions geographically isolated from technical services, such as the Hunter Valley and Margaret River, were implemented. The success and relevance of these strategies is reflected in the number of samples processed by the analytical laboratory (Figure 30) which analysed 50% more samples compared to the previous year, with every month processing record numbers of samples compared to the previous two years.

The AWRI Commercial Services laboratories are also increasing the range of testing that can be undertaken internally to reduce the need for outsourcing and hence the cost and turnaround times for end users. Included in this area of continuous improvement is the provision of internationally recognised accredited testing certificates that facilitate or meet legislative requirements for wine export to a wider range of countries. The AWRI is constantly monitoring international requirements and tailoring its certificate services for the wine sector. The laboratories also continue to offer critical analytical services to research projects within the AWRI ensuring these projects can be run with minimum cost and maximum efficiency.

The requirements for residue testing of wine and grapes to meet both national and increasingly complex international requirements continue to grow.

The team increased the range of analytes covered by its standard screens with a range of new compounds while keeping costs and turnaround times the same as the previous year. The high standard of this service is demonstrated by the close working relationship between the AWRI and Wine Australia and the appointment of the AWRI as Wine Australia's supplier of testing services for their wine audit program.

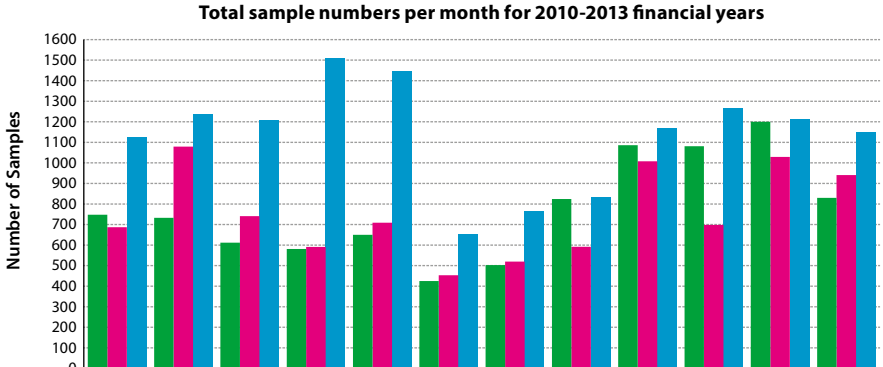
Beyond everyday testing

One of the risks that wine producers face is in the area of contamination of non-grape raw materials used in the production process. Reduction and management of this risk is important to ensure the continued protection of consumers and the profitability of the wine sector. There has been continued uptake by industry of Codex-level testing for a number of the most common raw materials used in Australian wineries. This expanding program, which increasingly is being used by suppliers before they market their products to producers, helps to ensure that the materials used in wineries do not add any unwanted taints or chemical impacts during the course of normal processing. Plans are in place to expand this testing to a wider range of winery materials to give producers greater flexibility in choosing production materials with confidence.

Another area of non-traditional testing which has increased in importance has been testing for potential allergens in wine. Recent changes in EU regulations have required Australian producers to assess their processes to quantify any residual fining materials to enable the correct labelling of products. To support producers, Commercial Services developed and implemented an egg and milk allergen testing service in 2012, which has continued to grow in uptake. The AWRI is also working proactively with international bodies to develop a proficiency testing program for allergen testing to ensure that results among different countries and methods are comparable and accepted by regulatory bodies internationally. The AWRI will continue to monitor changes in regulations to ensure that the testing it provides continues to meet the needs of the sector.

The AWRI introduced bottling line microbiological and oxygen audit programs in an endeavour to ensure that packaging processes meet the best practice standard. These services, which have seen increasing uptake both in Australia and overseas, allow packaging providers, or their customers, to commission a third-party audit of the packaging process to ensure its integrity in regards to microbiological contamination. This style of audit has now extended back down the supply chain with the offering of winery-based *Brettanomyces* and microbiological hygiene audits. As with the other audit programs, the audit process does more than just provide information on the absence or presence of issues: auditors actively identify weaknesses or problems in processes and provide suggestions on improvements or solutions as well as training on monitoring and management practices. This service has already helped a number of producers identify and address issues in an area many had considered already defeated by the Australian wine industry, and can do much to ensure that the gains made in the past in the area of *Brettanomyces* control are retained.

One of the strategies that has been used increasingly by the Australian wine industry is the move to bulk transport of wines to be packaged in their destination markets. More than half of the volume of Australian wine exports is now transported in bulk compared with less than one fifth of exports ten years ago. In response, the AWRI has started a project to better understand any compositional changes that might occur during bulk wine transport; the influence of using different types of flexitank and ISO tank; and the influence of using trans-shipping compared with direct shipping. The project is being performed in collaboration with three wine companies. Key project tasks include a statistical analysis of existing analytical records and a year-long sampling, chemical and sensory analysis program covering the variables described.



	July	August	September	October	November	December	January	February	March	April	May	June
2010-11	748	733	612	581	650	425	503	824	1086	1081	1200	830
2011-12	687	1079	741	591	709	453	520	592	1008	698	1029	941
2012-13	1126	1238	1210	1508	1445	651	765	831	1170	1266	1214	1150

Figure 30. Number of samples processed in the AWRI Commercial Services analytical laboratory for the 2010-2013 period.

Benchmarking performance

Highly successful consortium-style projects to benchmark the performance of various wine closures have continued with the white wine closure trial being completed at the 36-month stage and the red wine closure trial reaching the 24-month time point. These trials are evaluating the impact of popular closure technologies on the flavour, aroma and shelf-life of both a premium white and red wine. No further testing will be undertaken on the white wine trial. Trial participants have received information on how closure choice drives wine style evolution and insights into consumer preferences for the variations that result from different closures. Interest from some trial participants has resulted in the red wine closure trial extending at least to the 36-month time point. Both trials have continued to show that closure performance (predominantly related to oxygen transmission rate [OTR]) can have a significant impact on wine development and resulting sensory attributes.

The planned commercial trial to evaluate the performance of sparkling closures is currently being reviewed with the aim of being bottled in early 2014. The trial will involve a consortium of both wine producers and closure suppliers with participants receiving information on closure performance and its impact on wine sensory parameters as well as consumer insights. The trial will involve a range of traditional and innovative closures, all of which are commercially available.

A consortium-style benchmarking trial, not related to packaging performance, has commenced on CMCs. This major trial will assess the performance of the cold stabilisation additive, carboxymethylcellulose (CMC), and will give trial participants independent, real world information on the efficacy and production constraints of using these products to inhibit tartrate precipitation. Stage one of the project has assessed the performance of a range of different industry nominated CMCs on the ability to attain initial tartrate stability for 37 white wines across 8 different varieties. Trial participants include a number of major additive suppliers and wine producers. Participants have received information on varietal and dosage impacts as well as sensory results. Stage 2 of the trial, which is currently being completed, will look at the six-month performance of the CMCs on a range of representative wine styles. Stage 3 will assess the long-term performance of the additive in inhibiting tartrate precipitation and also provide information on impacts on processes such as filtration.

The AWRI has been working with suppliers to test the performance of products including innovative closures, barrels and barrel alternatives, and alternative methods for cold stabilisation and filtration. The ability of a reliable and independent

third-party such as the AWRI to evaluate performance objectively not only benefits suppliers but gives wine sector producers credible data upon which to base purchasing decisions.

Creating a sustainable future

The AWRI has an active interest in the area of sustainability in the wine and grape sector, and has been involved in the key areas of life cycle analysis, energy and water management, and greenhouse gas abatement. Outputs from these activities have included reference guides such as *Improving winery refrigeration efficiency*, and lifecycle analysis services used by a number of producers to assess and promote the environmental footprint of their products. Through the year, the AWRI has continued its participation in 'The Sustainability Consortium', a global organisation which collaborates on scientific research and the development of standards and tools related to the environmental, social and economic impacts of products.

This year, the AWRI, in collaboration with CSIRO, completed the major GWRDC-funded project on 'Cleaner production'. This project reviewed and assessed the viability of caustic reuse; evaluated lees cross-flow filters; and involved a study to understand product movements in large complex wineries which manufacture many interdependent products. A final report has been produced, which includes case studies, and will be available to industry through the GWRDC.

The AWRI commenced a major three-year project to assess the ability of tannin in grape marc to reduce methane production in livestock when used as feed supplement. This project is undertaken in conjunction with the National Livestock Methane Program and is funded by the Department of Agriculture Fisheries and Forestry under the 'Filling the research gap' program. To date, this project has characterised the tannin content and make-up of a range of grape marc samples, including fresh, ensiled and steam distilled, and across a range of varieties and producers. Initial *in vitro* work with the University of Melbourne has shown significant differences among the samples in their ability to depress the evolution of methane in enteric fermentation. The next step in the project, to be undertaken in conjunction with DEPI Victoria, will assess the collected marc samples *in vivo* with dairy cows to validate the results achieved in the *in vitro* trials.

Corporate Services

Staff

Catherine Borneman, Mark Braybrook, Alfons Cuijvers, Chris Day, Linda Halse, Adam Holland, Pauline Jorgensen, Jennifer O'Mahony, Fang Tang, Deborah Thornton-Wakeford.

The Corporate Services Group is a dedicated team of specialists who work together to provide infrastructure, administration, financial, human resources, OH&S and IT services in a seamless manner. Its objective is to enable the AWRI's staff to focus on their core capabilities to ensure the organisation meets its business objectives and in turn meets the expectations of the AWRI's stakeholders.

The Group continues to strive to find ways to effectively and efficiently deliver services to the organisation in the face of constrained funding and resources. In addition to endeavouring to provide the usual level of service to operational staff, major initiatives throughout the year focused upon reducing future IT expenditure requirements and ensuring compliance with new OH&S legislation.

The Finance Manager, Chris Day, assumed primary responsibility for managing the AWRI's finances in July 2012. The Finance team over the year made a significant contribution to the preparation of a broad range of funding submissions, most notably the renegotiation of the multi-year investment agreement through which the bulk of GWRDC's funding to the AWRI is delivered. Other initiatives resulted in improved record management and the further strengthening of financial reporting to improve organisational transparency and accountability.

The Operations Manager, Mark Braybrook, manages and attends to all AWRI infrastructure, equipment and engineering requirements as well as representing the AWRI's interests, in partnership with the other occupants of the WIC building, on the WIC Management Committee. Cost effective custom designed and manufactured engineering solutions are supplied throughout the organisation, such as more than 120 Nitrous Oxide monitoring units for installation throughout Australian vineyards as part of the AWRI's greenhouse gas mitigation project. Considerable focus has been directed towards organising and supplying appropriate guarding, laboratory modifications and alarms to ensure compliance throughout the AWRI with the new OH&S Harmonisation Legislation requirements. These compliance requirements have been, and continue to be, pursued not only throughout areas which the AWRI uses exclusively, but (in collaboration with the University of Adelaide) also throughout all shared areas in the WIC Central building and the Hickinbotham Roseworthy Wine Science Laboratory (WIC East).

The IT Co-ordinator, Adam Holland, successfully migrated all desktop users into the new Virtual Desktop Infrastructure (VDI) and is now expanding the desktop virtualisation into the laboratory environment. This will help the AWRI further reduce its IT hardware spend, while creating a central management point for the majority of the IT environment.

The focus for the HR Manager, Linda Halse, was to provide support to managers and employees to develop the AWRI's new RD&E plan and restructure their groups to accommodate the objectives of the new AWRI plan and associated funding frameworks with AWRI's major investor, the GWRDC. The HR Manager also assisted employees with professional development activities, including preparation for the 15th AWITC through the organisation of workshops focusing upon presentation and communication skills.

Catherine Borneman and Chris Day

Financial statements - Directors' report

The directors present this report to the members of the Australian Wine Research Institute Limited (the Company) for the year ended 30 June 2013.

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)	31 Jan 2002	–	6	6
Mr John C. Angove	1 Jan 2010	–	5	6
Mr James F. Brayne	1 Jan 2009	–	4	6
Mr Paul D. Conroy	2 May 2006	–	2	6
Dr John S. Harvey	1 Jan 2012	–	6	6
Dr Daniel L. Johnson	1 Dec 2011	–	6	6
Mr Brett M. McKinnon	1 Jan 2008	–	4	6
Ms Elizabeth A. Riley	1 Jan 2012	–	6	6
Ms Louisa E. Rose	1 Jan 2011	–	4	6
Mr Mark R. Watson	24 Jun 2008	–	4	6
Alternate directors				
Mr Michael R. DeGaris	17 Sep 2012	–	2	2
Mr Neil A. McGuigan	22 Mar 2011	–	–	2
Mr Corey B. Ryan	18 May 2010	18 Sep 2012	–	–
Mr Alexander N. Sas	25 May 2004	–	–	–

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 2013 the organisation recorded a surplus of $36,405 (2012: surplus of $1,143,214). This surplus is primarily due to the recognition of $281,480 in funding for the purchase of capital equipment (2012: $991,347), with $229,968 provided by the Grape and Wine Research and Development Corporation (2012: $327,537) and $51,512 by other funding bodies (2012: $663,810), and requiring recognition as income within the reported upon period 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; and

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

These activities collectively constitute a mechanism to implement the strategies outlined in 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

Mr Peter J. Dawson
Chair (non-executive)
Qualifications: BSc BAppSc (Wine Science)
Experience: Principal Peter Dawson Consulting, Chair & 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, 35 years' technical and winemaking experience in the Australian wine industry.
Special Responsibilities: Mr Dawson is the Chair of the Personnel committee.

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 James F. Brayne
Non-executive director
Qualifications: BAppSc (Wine Science)
Experience: Production Director/Chief Winemaker McWilliams Wines Pty Ltd, national wine show judge, 39 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 & 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 (Hon) PhD MBA GAICD
Experience: Managing Director and owner of Bathe Wines Pty Ltd, President of the Adelaide Hills Wine Region and formerly Executive Director of the Grape and Wine Research and Development Corporation. Thirteen years of wine industry research, R&D management and commercial experience. Director of the Can:Do 4 Kids Group of Charities, Spina Bifida and Hydrocephalus Association of SA and External Appointed Member of the Programs Committee of the Adelaide Women's and Children's Hospital Foundation.

Dr Daniel L. Johnson
Managing Director
Qualifications: BSc (Hons) PhD MBA GAICD
Experience: Chair of the Australian Wine Industry Technical Conference, Chair of the WineHealth 2013 Steering Committee, director of the National Wine Foundation, member of the International Scientific Board of L'Institut des Sciences de la Vigne et du Vin (ISVV) Bordeaux (France), member of the WFA Innovation Policy Committee, member of the WFA Wine Industry Technical Advisory 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 Australian Wine Industry Future Leaders Program, director of Tacnia Pty Ltd, 16 years' experience in research, development and innovation.

Mr Brett M. McKinnon
Non-executive director
Qualifications: BAgSc (Oenology) (Hons)
Experience: Managing Director Orlando Wines, 25 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 Industry 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, 21 years' experience in the Australian wine industry.

Ms Louisa E. Rose
Non-executive director
Qualifications: BAppSc (Oenology) BSc
Experience: Head of Winemaking The Yalumba Wine Company and Hill Smith Family Vineyards, Co-Chair of the South Australian Wine Industry Council, member of Wine Barossa, former director of the Barossa Grape and Wine Association, national wine show judge, 22 years' technical, winemaking, viticultural and commercial experience in the Australian wine industry.
Special Responsibilities: Ms Rose is a member of the Audit committee.

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) (from 17 September 2012)
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)
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 Corey B. Ryan
Non-executive alternate director (for Mr Brayne) (to 18 September 2012)
Qualifications: Masters of Oenology, Grad Dip Wine Bus
Experience: Group Chief Winemaker McWilliams Wines Group Ltd and Echelon Wine Partners, former Chief Winemaker Villa Maria Estates NZ, domestic and international wine show judging experience, 23 years' technical winemaking, viticulture and commercial experience.

Mr Alexander N. Sas
Non-executive alternate director (for Mr Dawson)
Qualifications: BSc Agric (Hons)
Experience: Chief Viticulturist Accolade Wines, 24 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 $20 (2012: $26).

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 2013.

Dated at Urrbrae on this the 17th day of September 2013.

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

Peter J. Dawson
Chair

Daniel L. Johnson
Managing Director

Auditor's independence declaration

As lead auditor for the audit of the Australian Wine Research Institute Limited for the year ended 30 June 2013, I declare that, to the best of my knowledge and belief, there have been no contraventions of:

(a) the auditor independence requirements of the *Corporations Act 2001* in relation to the audit; and

(b) any applicable code of professional conduct in relation to the audit.

Ian Painter
Partner
BDO Audit Partnership (SA)

Adelaide, 17 September 2013

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 2013

	Note	2013	2012
Revenue from operating activities			
Grape and Wine Research and Development Corporation			
Investment agreement project funding		9,316,593	9,433,621
Investment agreement capital funding		136,973	106,469
Other project funding		20,207	202,080
Other capital funding		92,995	221,068
Capital specific grant funding		51,512	663,810
Other grant funding		718,628	647,213
Commercial services analytical and consulting income		2,343,726	2,112,922
Contract research and other commercial income		1,078,217	986,256
Other revenue		296,362	395,833
Total revenue		14,055,213	14,769,272
Other income	2	2,089	12,032
Expenses from operating activities			
Personnel expenses	3	9,641,361	9,636,919
Analytical and project operating expenses		1,958,155	1,935,967
Infrastructure and general services expenses		1,335,181	1,057,978
Depreciation and amortisation expense	8, 9	1,171,150	1,150,101
Travel expenses		362,306	363,173
Total expenses		14,468,153	14,144,138
Results from operating activities		(410,851)	637,166
Finance income		447,256	506,048
Profit for the period		36,405	1,143,214
Other comprehensive income		–	–
Total comprehensive income for the period		36,405	1,143,214

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 2013

	Retained Earnings	Total Equity
Balance at 1 July 2011	12,198,713	12,198,713
Total comprehensive income for the period		
Profit or loss	1,143,214	1,143,214
Other comprehensive income	–	–
Total comprehensive income for the period	1,143,214	1,143,214
Balance at 30 June 2012	13,341,927	13,341,927
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

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 2013

	Note	2013	2012
Assets			
Cash and cash equivalents	4	3,092,752	4,436,091
Other investments	5	7,250,000	6,500,000
Trade and other receivables	6	1,244,250	1,145,972
Inventories	7	79,705	51,561
Prepayments		236,693	294,800
Total current assets		11,903,400	12,428,424
Property, plant and equipment	8	2,006,613	2,683,647
Interest in WIC Building	9	5,165,965	5,369,303
Total non-current assets		7,172,578	8,052,950
Total assets		19,075,978	20,481,374
Liabilities			
Payables and accruals	10	3,050,534	4,926,613
Project funds not expended	11	653,828	328,292
Provisions	12	1,626,060	1,474,565
Total current liabilities		5,330,422	6,729,470
Payables and accruals	10	101,000	81,001
Provisions	12	266,224	328,976
Total non-current liabilities		367,224	409,977
Total liabilities		5,697,646	7,139,447
Net assets		13,378,332	13,341,927
Equity			
Retained earnings		13,378,332	13,341,927
Total equity		13,378,332	13,341,927

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 2013

	Note	2013	2012
Cash flows from operating activities			
Cash receipts from project grants and other income		12,236,069	14,439,305
Cash paid to suppliers and employees		(13,509,116)	(13,244,801)
Net cash from operating activities		(1,273,047)	1,194,504
Cash flows from investing activities			
Cash receipts from capital specific funding		292,544	759,215
Interest received		692,994	478,370
Proceeds from sale of property, plant and equipment		4,026	24,122
Acquisition of property, plant and equipment		(309,856)	(1,112,338)
Acquisition of other investments		(750,000)	(1,500,000)
Net cash used in investing activities		(70,292)	(1,350,631)
Cash flows from financing activities			
Payment of finance lease liabilities		–	–
Net cash used in financing activities		–	–
Net increase (decrease) in cash and cash equivalents		(1,343,339)	(156,127)
Cash and cash equivalents at 1 July		4,436,091	4,592,218
Cash and cash equivalents at 30 June	4	3,092,752	4,436,091

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 17th day of September 2013.

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 has elected to adopt early the 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*. As a consequence, the Company has also adopted early AASB 2011-2 *Amendments to Australian Accounting Standards arising from the Trans-Tasman Convergence Project – Reduced Disclosure Requirements* and AASB 2012-7 *Amendments to Australian Accounting Standards arising from Reduced Disclosure Requirements* in respect of AASB 2010-6 *Amendments to Australian Accounting Standards – Disclosures on Transfers of Financial Assets* and AASB 2011-9 *Amendments to Australian Accounting Standards – Presentation of Items of Other Comprehensive Income*.

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 2013 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

	2013	2012
Net gain / (loss) on sale of property, plant and equipment	2,089	12,032
	2,089	12,032

3. Personnel expenses

	2013	2012
Wages and salaries	8,096,379	8,131,380
Other associated personnel expenses	826,314	779,988
Contributions to defined contribution plans	718,668	725,551
	9,641,361	9,636,919

4. Cash and cash equivalents

	2013	2012
Cash on hand	500	500
Bank deposits at-call	3,092,252	4,435,591
Cash and cash equivalents in the statement of cash flows	3,092,752	4,436,091

5. Other investments

	2013	2012
Held-to-maturity investments	7,250,000	6,500,000
	7,250,000	6,500,000

Held-to-maturity investments consist of term deposits with interest rates between 4.07 and 4.45 percent (2012: between 5.20 and 6.11 percent) and mature within 6 months of balance date (2012: within 7 months of balance date).

6. Trade and other receivables

	2013	2012
Trade receivables due from those other than related parties	904,233	573,399
Trade receivables due from related parties	42,679	53,930
Other receivables	297,338	518,643
	1,244,250	1,145,972

Trade receivables are shown net of impairment losses amounting to $769 (2012: $12,925) 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:

	2013	2012
Balance at 1 July	12,925	6,463
Impairment charge for the year	769	6,462
Written off during the year	(12,925)	–
Balance at 30 June	769	12,925

7. Inventories

	2013	2012
Course materials on hand – wine	79,705	46,328
Course materials in transit – wine	–	5,233
	79,705	51,561

8. Property, plant and equipment

	Plant and machinery	Office furniture and IT	Laboratory equipment	Total
Cost				
Balance at 1 July 2012	346,314	1,167,879	7,972,351	9,486,544
Additions	102,479	101,099	89,138	292,716
Disposals	(57,750)	(201,707)	(7,153)	(266,610)
Balance at 30 June 2013	391,043	1,067,271	8,054,336	9,512,650
Depreciation and impairment losses				
Balance at 1 July 2012	205,175	765,386	5,832,336	6,802,897
Depreciation charge for the year	53,746	156,795	757,271	967,812
Disposals	(57,750)	(201,557)	(5,365)	(264,672)
Balance at 30 June 2013	201,171	720,624	6,584,242	7,506,037
Carrying amounts				
at 1 July 2012	141,139	402,493	2,140,015	2,683,647
at 30 June 2013	189,872	346,647	1,470,094	2,006,613

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 (26th November 2008).

Cost	
Balance at 1 July 2012	6,100,140
Balance at 30 June 2013	6,100,140
Amortisation and impairment losses	
Balance at 1 July 2012	730,837
Amortisation charge for the year	203,338
Balance at 30 June 2013	934,175
Carrying amounts	
at 1 July 2012	5,369,303
at 30 June 2013	5,165,965

10. Payables and accruals

	2013	2012
Current		
Trade payables due to those other than related parties	425,288	632,270
Trade payables due to related parties	835	–
Income received in advance	1,319,868	2,827,988
PAYG and GST	240,357	381,060
Non-trade payables and accrued expenses	1,064,186	1,085,295
	3,050,534	4,926,613
Non-current		
Other payables and accrued expenses	101,000	81,001
	101,000	81,001

11. Project funds not expended

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

The unspent investment agreement funds for the current year totalled $402,494 (2012: $299,204). The unspent funds from other GWRDC contracts for the current year totalled $4,480 (2012: $4,466).

During the year the Joint Agreement Committee approved the retention by the Company of unspent prior years' funds totalling $50,000 for the purpose of specific capital purchases (2012: $315,672) and $26,972 for other purposes. During the year no unspent prior years' funds relating to other GWRDC contracts were utilised in the course of those projects' current year activities (2012: $5,740), and unspent prior years' funds relating to other GWRDC projects totalling $4,466 were returned to the GWRDC.

	2013	2012
GWRDC current year's investment agreement funding unexpended	402,494	299,204
GWRDC current year's other contract funding unexpended	4,480	4,466
GWRDC prior years' funding unexpended and uncommitted	246,854	24,622
	653,828	328,292

12. Provisions

	2013	2012
Current		
Employee entitlements	1,626,060	1,474,565
Non-current		
Employee entitlements	266,224	328,976
Number of Employees (FTEs)	94.3	100.7

13. Operating leases

Leases as lessee

Non-cancellable operating lease rentals are payable as follows:

	2013	2012
Within one year	20,532	20,532
One year or later and no later than five years	18,680	39,212
Later than five years	–	–
	39,212	59,744

The Company entered into no new leases during the year.

During the year ended 30 June 2013 an amount of $20,532 was recognised as an expense in respect of operating leases (2012: $8,716).

14. Capital commitments

	2013	2012
Plant and equipment		
Contracted but not provided for and payable		
Within one year	69,934	179,861
One year or later and no later than five years	–	–
Later than five years	–	–
	69,934	179,861

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:

	2013	2012
Total remuneration	1,480,172	1,862,578

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	
	2013	2012	2013	2012
Services received from related parties	10,517	10,719	835	–
Services provided to related parties	178,703	119,984	42,679	53,930

16. Contingencies

In the opinion of the Directors, there were no material or significant contingent liabilities at 30 June 2013 (2012: none).

17. Subsequent events

In August 2013 the Company entered into an 'Agreement for industry capability building activities and research and development program' with the GWRDC, which will provide a material level of funding to the Company until 30 June 2017 in the first instance. There has not arisen in the interval between the end of the financial year and the date of this report any other item, transaction or event of a material and unusual nature likely to significantly affect the operations of the Company, the results of those operations, or the state of affairs of the Company, in subsequent financial years.

18. Limited liability

In accordance with the Company's constitution, each member (both during the time he or she is a member and within one year afterwards) is liable to contribute $2 in the event that the Company is wound up. The total amount members would contribute is $20 (2012: $26).

Directors' declaration

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

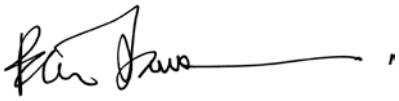
(a) the accompanying financial statement and notes that are contained on pages 55 to 60 are in accordance with the *Corporations Act 2001*, including:

(i) giving a true and fair view of the Company's financial position as at 30 June 2013 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.



Peter J. Dawson
Chair

Daniel L. Johnson
Managing Director

Dated at Urrbrae on this the 17th day of September 2013.

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 2013, 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*.

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 2013 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 Partnership (SA)

Ian Painter
Partner
Adelaide, 17 September 2013

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.

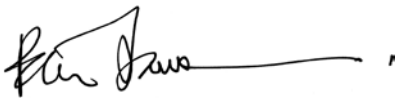
In the opinion of the directors of The Australian Wine Research Institute Limited (the Trustee):

(a) **(i)** the Statements of profit or loss and other comprehensive income give a true and fair view of each Trust's surplus for the year ended 30 June 2013; and

(ii) the Statements of financial position give a true and fair view of each Trust's state of affairs as at 30 June 2013.

(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:



Peter J. Dawson
Chair

Dated at Urrbrae on this the 17th day of September 2013.

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 2013	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**
Income								
Interest	3,863	4,920	3,189	4,054	2,515	3,218	3,425	4,364
Donations and other income	–	347	–	–	–	–	–	–
Total income	3,863	5,267	3,189	4,054	2,515	3,218	3,425	4,364
Expenses								
Advertising	–	–	–	–	–	–	–	–
Audit fees	–	550	–	550	–	550	–	550
Bank charges	–	–	–	–	–	–	–	–
Technical Review contributions	–	–	–	–	–	–	–	–
Sponsorship	–	–	–	–	–	–	–	–
Total expenses	–	550	–	550	–	550	–	550
Profit / (loss) from ordinary activities	3,863	4,717	3,189	3,504	2,515	2,668	3,425	3,814
Other comprehensive income	–	–	–	–	–	–	–	–
Total comprehensive income for the period	3,863	4,717	3,189	3,504	2,515	2,668	3,425	3,814

STATEMENTS OF FINANCIAL POSITION								
As at 30 June 2013	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**
Assets								
Cash at bank	–	–	–	–	–	–	–	–
Investments	124,143	121,298	102,416	100,259	80,686	79,216	110,036	107,637
Receivables	281	363	232	300	182	237	248	322
Total current assets	124,424	121,661	102,648	100,559	80,868	79,453	110,284	107,959
Investments	–	–	–	–	–	–	–	–
Total non-current assets	–	–	–	–	–	–	–	–
Total assets	124,424	121,661	102,648	100,559	80,868	79,453	110,284	107,959
Liabilities								
Sundry creditors	–	1,100	–	1,100	–	1,100	–	1,100
Total current liabilities	–	1,100	–	1,100	–	1,100	–	1,100
Net assets	124,424	120,561	102,648	99,459	80,868	78,353	110,284	106,859
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	107,776	103,059	74,409	70,905	58,353	55,685	106,809	102,995
Surplus for the year	3,863	4,717	3,189	3,504	2,515	2,668	3,425	3,814
Closing balance	111,639	107,776	77,598	74,409	60,868	58,353	110,234	106,809
Total trust funds	124,424	120,561	102,648	99,459	80,868	78,353	110,284	106,859

Appendix 1 - External presentations and talks

Staff	Title of talk	Presented to and where	Date
M. Marangon	How to prevent protein instability of white wines	Webinar to Italian oenologists organised by Vinidea	3 Jul 12
I.L. Francis	Cloves, kerosene and capsicum: the chemistry of wine aroma	Royal Australian Chemical Institute ChemEd 12 National Chemical Education Conference, Immanuel College, Adelaide, SA	
I.L. Francis, P.W. Godden, E.M.C. Robinson	Understanding wine style with spectroscopy		
A.R. Borneman, E.J. Bartowsky, J.P. Affourtit[1], I.S. Pretorius[3], M. Egholm[1], P.J. Chambers	Characterisation of intra-specific genomic diversity in industrial microorganisms by whole-genome sequencing	The Australian Society of Microbiology Conference, Brisbane, Qld	
I.L. Francis	Cloves, kerosene and capsicum: the chemistry of wine aroma	University of South Australia, UniSA College Science Teachers program, AWRI, Urrbrae, SA	4 Jul 12
G.D. Cowey	Sensory evaluation. Wine aromas, flavours, faults and taints and Australian wine show judging	Premium Wine Brands, Barossa Valley, SA	7 Jul 12
C.S. Stockley	Wine's role in society		
I.L. Francis	Aroma chemistry and sensory research	Charles Sturt University/School of Engineering at Changins Switzerland, AWRI, Urrbrae, SA	11 Jul 12
J.M. McRae, A. Schulkin, S. Kassara, H.E. Holt, I.L. Francis, W.P. Pearson, P.A. Smith	Impact of wine tannin structure on astringency perception	26th International Conference on Polyphenols, Florence, Italy	24 Jul 12
M. Krstic	Manipulating quality in the vineyard	University of Melbourne, Advanced Viticulture Techniques Masters Course, Melbourne, Vic	
P.R. Dry	Vineyard characteristics used in assessment schemes: theory and practice	ASVO Seminar – Objective Measures of Grape and Wine Quality, Mildura, Vic	25 Jul 12
R.G. Dambergs	Validation of an industry vineyard assessment system		
J.M. McRae	Impact of wine tannin structure on astringency perception	26th International Conference on Polyphenols, Florence, Italy	
M.L. Longbottom	Objective measures of quality survey summary	WGGA Board, National Wine Centre, Adelaide, SA	1 Aug 12
M. Essling	Phosphorous acid residues – research findings		
N. Scrimgeour	New industry tools – The Grape Portal	Interwinery Analysis Group Seminar, Adelaide, SA	3 Aug 12
E. Wilkes	Wine additives, do you know what you are adding?		
P.R. Dry	Alternative varieties	University of Adelaide, Adelaide, SA	7 Aug 12
G.D. Cowey	Heat stability	AWRI roadshow workshops (A guide to trouble-free packaging), Orange, NSW	
M.G. Holdstock	Cold stability		
A.D. Coulter	Sulfide treatment and wine fining practical		
G.D. Cowey	Packaging preparation		
A.D. Coulter	Controlling microbiological activity		
M.G. Holdstock	Line sanitation and filtration		
G.D. Cowey	Packaging operation		
	Real wine tasting		
A.D. Coulter	Closure choice and post-bottling storage		
M.G. Holdstock	Post-bottling transport		
G.D. Cowey	Heat stability	AWRI roadshow workshops (A guide to trouble-free packaging), Canberra, ACT	9 Aug 12
M.G. Holdstock	Cold stability		

Staff	Title of talk	Presented to and where	Date
A.D. Coulter	Sulfide treatment and wine fining practical	AWRI roadshow workshops (A guide to trouble-free packaging), Canberra, ACT	9 Aug 12
G.D. Cowey	Packaging preparation		
A.D. Coulter	Controlling microbiological activity		
M.G. Holdstock	Line sanitation and filtration		
G.D. Cowey	Packaging operation		
	Real wine tasting		
A.D. Coulter	Closure choice and post-bottling storage		
M.G. Holdstock	Post-bottling transport		
D.L. Johnson	The AWRI 2011/12 annual report presentation	New South Wales Wine Industry Association AGM – Sydney, NSW	13 Aug 12
P.R. Dry	Vineyard characteristics used in assessment schemes: theory and practice	AWRI Webinar	14 Aug 12
C.M. Mayr, M. Parker, P.O. Williamson, I.L. Francis, M.J. Herderich	Glycoconjugates of volatile phenols: their contribution to smoke off-flavours in wines and interaction with human saliva	244th American Chemical Society National Meeting, Philadelphia, Pennsylvania, USA	20 Aug 12
P.O. Williamson, S. Mueller Loose[6], S. Bogomolova[7], I.L. Francis	The role of extrinsic cues, sensory attributes and information on wine preferences of Chinese consumers	Ehrenberg-Bass Marketing Institute, University of South Australia, City West Campus, Adelaide, SA	
W.K. Roget	Effective oxygen management at bottling	AWRI Webinar	21 Aug 12
M. Marangon, D. Gazzola[2], S.C. Van Sluyter[3], A. Curioni[2], E.J. Waters[4], A. Vernhet[5], P.A. Smith	Study of the heat induced aggregation behaviour of wine macromolecules by means of scanning ion occlusion sensing and dynamic light scattering techniques	244th American Chemical Society National Meeting, Philadelphia, Pennsylvania, USA	23 Aug 12
K.K. Forsyth	Green ideas that balance the carbon ledger	Romeo Bragato Conference, Marlborough, New Zealand	
	Come in from the cold – improving winery refrigeration efficiency		
P.R. Dry	Why do bunches get hot – and what does this mean for wine quality?	AWRI roadshow seminar, Toowoomba, Qld	
	Vine balance - how does it affect yield and quality?		
C.A. Simos	Why is managing dissolved oxygen at bottling so important?		
	Features of the AWRI website		
K.A. Bindon	Viticultural management of grape and wine phenolics		
	Grape ripeness and wine composition (Cabernet Sauvignon)		
	Tannin from grape to wine: new insights on a complex system		
P.A. Henschke	Wild ferments – what are the alternatives?		
	Managing H_2S during fermentation – latest research		
J.R. Bellon	Winemaking with non-conventional yeast	AWRI Webinar	28 Aug 12
M. Krstic	The AWRI 2011/12 annual report presentation	Wine Victoria Board and Wine Victoria Regional Council, Melbourne, Vic	29 Aug 12
C.A. Simos	The Advanced Wine Assessment Course – *So do women make better tasters than men?*	The Len Evans Tutorial – Wine Shows in the 21st Century	1 Sep 12
M. Marangon, P.A. Smith	Carrageenan: what have we learned about its use to heat stabilise white wines?	Wolf Blass meeting with CPKelco and Treasury Wine Estates on carrageenan project. Nurioopta, SA	3 Sep 12
M. Essling	How can irrigation management strategies be used to manipulate wine quality?	AWRI Webinar	4 Sep 12
	Why do we need new clones?	AWRI roadshow seminar, Mt Barker, WA	11 Sep 12
	Great wine from grafted vines		

Staff	Title of talk	Presented to and where	Date
P.A. Henschke	Wild ferments – what are the alternatives?	AWRI roadshow seminar, Mt Barker, WA	11 Sep 12
E. Wilkes	Are you selecting the best packaging for your wines?		
	Energy for the future: moving towards on-site renewable biomass and solar technology		
P.A. Henschke	Causes and management of slow and stuck fermentations		
C.A. Simos	Why is managing dissolved oxygen at bottling so important?		
	Features of the AWRI website		
M. Marangon	Protein haze in white wines: new solutions to an old problem	AWRI Webinar	
M. Essling	Terroir – separating fact from fiction	AWRI roadshow seminar, Pemberton, WA	12 Sep 12
	Why do we need new clones?		
E. Wilkes	How to significantly reduce your carbon footprint without spending any money		
	Are you selecting the best packaging for your wines?		
P.A. Henschke	Did you know that DAP can strongly affect the flavour profile and style of wine?		
	Wild ferments – what are the alternatives?		
C.A. Simos	Are my grapes smoke tainted? What are my options?		
	Features of the AWRI website		
V.T. O'Brien	National Livestock Methane Program – AWRI	The National Livestock Methane Program Research Planning Committee	
G.D. Cowey	Heat stability	AWRI roadshow workshops (A guide to trouble-free packaging), Adelaide Hills and Langhorne Creek, SA	13 Sep 12
M.G. Holdstock	Cold stability		
A.D. Coulter	Sulfide treatment and wine fining practical		
G.D. Cowey	Packaging preparation		
A.D. Coulter	Controlling microbiological activity		
M.G. Holdstock	Line sanitation and filtration		
G.D. Cowey	Packaging operation		
	Real wine tasting		
A.D. Coulter	Closure choice and post-bottling storage		
M.G. Holdstock	Post-bottling transport		
C.A. Simos	Features of the AWRI website	AWRI roadshow seminar, Margaret River, WA	
	Why is managing dissolved oxygen at bottling so important?		
M. Essling	Terroir – separating fact from fiction		
P.A. Henschke	Wild ferments – what are the alternatives?		
	Practical strategies for reducing alcohol levels in wine		
E. Wilkes	Winery cost reduction strategies	AWRI roadshow seminar, Margaret River, WA	
	Copper in winemaking: the good and the bad		
P.A. Henschke	Did you know that DAP can strongly affect the flavour profiles and style of wine?		
M. Krstic	Overview of AWRI capabilities and services in Victoria	Bendigo Regional Winemakers – Annual General Meeting, Bendigo, Vic	
M. Essling	Terroir - separating fact from fiction	AWRI roadshow seminar, Swan Valley, WA	14 Sep 12
C.A. Simos	Why is managing dissolved oxygen at bottling so important?		
	Features of the AWRI website		
M. Essling	Why do we need new clones?		
E. Wilkes	Copper in winemaking: the good and the bad		

Staff	Title of talk	Presented to and where	Date
P.A. Henschke	Did you know that DAP can strongly affect the flavour profile of wine?	AWRI roadshow seminar, Swan Valley, WA	14 Sep 12
	Causes and management of slow and stuck fermentations		
E. Wilkes	Winery cost reduction strategies		
M. Krstic	Overview of the AWRI capabilities and services	Business matching meetings, Victorian Government Super Trade Mission, Tianjin, China	17 Sep 12
		Business matching meetings, Victorian Government Super Trade Mission, Nanjing, China	18 Sep 12
		Business matching meetings, Victorian Government Super Trade Mission, Shanghai, China	19 Sep 12
		Business matching meetings, Victorian Government Super Trade Mission, Chengdu, China	20 Sep 12
C.D. Curtin	Practical management of 'Brett' in the winery	AWRI Webinar	
M. Krstic	Overview of the AWRI capabilities and services	Business matching meetings, Victorian Government Super Trade Mission, Shenzhen, China	21 Sep 12
Y. Hayasaka	Australian wine industry and the AWRI research activities	National Research Institute of Brewing, Hiroshima, Japan	24 Sep 12
C.S. Stockley	Alcohol, wine and health research at the AWRI	ICAP Scientific Summit on Alcohol Research, Brussels, Belgium	
D.L. Johnson	The AWRI annual report 2011/12 presentation	Wines of Western Australia AGM, Houghton Winery, WA	28 Sep 12
C.A. Simos	Flavours, faults and taints tasting	WA Cabernet Workshop, Margaret River, WA	30 Sep 12
G.D. Cowey	Heat stability	AWRI roadshow workshops (A guide to trouble-free packaging), Campbell Town, TAS	4 Oct 12
M.G. Holdstock	Cold stability		
A.D. Coulter	Sulfide treatment and wine fining practical		
G.D. Cowey	Packaging preparation		
A.D. Coulter	Controlling microbiological activity		
M.G. Holdstock	Line sanitation and filtration		
G.D. Cowey	Packaging operation		
	Real wine tasting		
A.D. Coulter	Closure choice and post-bottling storage		
M.G. Holdstock	Post-bottling transport		
M. Marangon	Carrageenan: what have we learned about its use to heat stabilise white wine?	Webinar to CPKelco	
E. Wilkes	Cold stability, how to manage and measure it	AWRI Webinar	
R.G. Dambergs	Manipulating Pinot Noir quality through novel winemaking techniques	Pinot Noir Masterclass, Campbell Town, Tas	8 Oct 12
	Managing Pinot Noir quality in the vineyard: crop load and canopy management	Pinot Noir Masterclass, Yarra Valley, Vic	10 Oct 12
	Pruning and canopy management for sparkling grape production		
	Manipulating Pinot Noir quality through novel winemaking techniques		
	Utilising the tannin compartments of Pinot Noir grapes via differing winemaking practices		
	Managing Pinot Noir quality in the vineyard: crop load and canopy management	Pinot Noir Masterclass, Mornington Penisula, Vic	11 Oct 12
	Pruning and canopy management for sparkling grape production		
	Manipulating Pinot Noir quality through novel winemaking techniques		

Staff	Title of talk	Presented to and where	Date
R.G. Dambergs	Utilising the tannin compartments of Pinot Noir grapes via differing winemaking practices	Pinot Noir Masterclass, Mornington Penisula, Vic	11 Oct 12
R. Gawel	Putting the texture back into white wine – the role of white wine phenolics	AWRI Webinar	16 Oct 12
D.L. Capone, M.A. Sefton[8], D.W. Jeffery[8], I.L. Francis	The origin of eucalyptol in wine (1-8 cineole)	Australian Cabernet Symposium, Coonawarra Vignerons Association, Penola, SA	18 Oct 12
C.S. Stockley	The highs and lows of making low alcohol wine	Alcohol in Moderation's 21st Birthday Forum, London, UK	
G.D. Cowey	Sensory evaluation. Wine aromas, flavours, faults and taints and Australian Wine Show Judging	Premium Wine Brands, Barossa Valley, SA	
S. Connew	Background to the request for operational funding for the Hunter Node	Hunter Valley Wine Industry Association Executive Committee meeting, Hunter Valley, NSW	
E.M.C. Robinson	Which new AWRI technologies can add value to your business?	New England Regional Wine Show, Glen Innes, NSW	19 Oct 12
R.G. Dambergs	Analysis and benchmarking of wine tannin with the AWRI tannin portal	Hunter Valley Wine Industry Association, Hunter Valley Gardens, NSW	20 Oct 12
P.A. Smith	Crafting diverse wine styles through an understanding of how grape composition affects wine composition	AWRI Webinar	23 Oct 12
P.R. Dry	Terroir – separating fact from fiction	AWRI roadshow seminar, Mornington Peninsula, Vic	30 Oct 12
	Does soil and vine nutrient status affect wine quality?		
P.A. Smith	Measuring phenolics to add value to your business		
A.D. Coulter	Why is managing dissolved oxygen at bottling so important?		
P.A. Smith	Wine development in bottle – the role of oxygen		
P.A. Henschke	Did you know that DAP can strongly affect the flavour profile and style of wine?		
	Wild ferments – what are the alternatives?		
P.A. Smith	Putting the texture back into white wine – the role of white wine phenolics		
A.D. Coulter	Features of the AWRI website		
P.W. Godden	The Pinot G Style Spectrum: a novel tool to communicate wine style to consumers	AWRI Webinar	
P.R. Dry	Terroir – separating fact from fiction	AWRI roadshow seminar, Gippsland, Vic	31 Oct 12
	How can cultural practices be used to improve fruit set?		
P.A. Smith	Measuring phenolics to add value to your business		
P.A. Henschke	Wild ferments – what are the alternatives?		
A.D. Coulter	What options do you have in cold stabilising your wines?		
P.A. Henschke	Winemaking with non-conventional yeast		
I.L. Francis	Pepper and spice in Shiraz: what influences rotundone levels in wines?		
	What are desirable levels of tropical fruit, cat pee and green flavours in Sauvignon Blanc?		
A.D. Coulter	Features of the AWRI website		
P.R. Dry	Terroir – separating fact from fiction	AWRI roadshow seminar, Yarra Valley, Vic	1 Nov 12
	Does soil and vine nutrient status affect wine quality?		
	Why do bunches get hot – and what does this mean for wine quality?		
P.A. Smith	Viticultural management of grape and wine phenolics		
A.D. Coulter	What options do you have in cold stabilising your wines?		
K.K. Forsyth	Becoming carbon neutral/ How to significantly reduce your carbon footprint without spending any money		
P.A. Henschke	Winemaking with non-conventional yeast and hybrid yeast		

Staff	Title of talk	Presented to and where	Date
P.A. Smith	Grape ripeness and wine composition (Cabernet Sauvignon)	AWRI roadshow seminar, Yarra Valley, Vic	1 Nov 12
A.D. Coulter	Features of the AWRI website		
D.L. Johnson	The AWRI 2011/12 annual report presentation	Wine Tasmania AGM, Hobart, Tas	
	Panel Discussion: Functional Foods & Nutraceuticals: Good For Your Health or Fad?	AusFoodtech 12 Symposium, Melbourne, Vic	2 Nov 12
C.A. Varela	Systems Biology: a new approach to industrial yeast strain development	Systems Bioinformatics Department at the Free University of Amsterdam, The Netherlands	
M.J. Herderich	Wine and food safety risks	APEC Wine Regulators Forum, Auckland, New Zealand	5 Nov 12
C.S. Stockley	Making better wine for health	AWRI Webinar	6 Nov 12
D.L. Johnson	The AWRI 2011/12 annual report presentation	WGGA Executive Committee, Adelaide, SA	7 Nov 12
C.S. Stockley	Wine – its bioactive compounds and health	Food for a Healthy Planet 2, University of Melbourne, Melbourne, Vic	8 Nov 12
C.D. Curtin	Practical management of 'Brett' in the winery – now & into the future	Treasury Wine Estates, Magill Estate, Adelaide, SA	
C.S. Stockley	Making better wine for health	AWRI Webinar	9 Nov 12
P.R. Dry	The potential of Iberian varieties	Australian Alternative Varieties Wine Show, Mildura, Vic	
C.A. Simos	Research, development and extension resources available nationally	Spring Vine Health Field Day, Murrumbateman, NSW	10 Nov 12
J.R. Bellon, P.J. Chambers, C.D. Curtin	Hybrid wine yeast and flavour diversity	Department of Genetics, Stanford University, CA, USA	11 Nov 12
H.E. Holt	Describing wine aromas and flavours	AWRI Advanced Wine Assessment Course, Adelaide, SA	13 Nov 12
S.A. Schmidt	Winemaking at low pH: avoiding stuck fermentations in whites and sparkling wines	AWRI Webinar	
P.R. Dry	Can the production of low alcohol wines start in the vineyard?	Crush Symposium 12, Urrbrae, Adelaide, SA	15 Nov 12
H.E. Holt, I.L. Francis, W. Pearson, D. Blackmore[9], P.R. Clingeleffer[9], R.R. Walker[9]	Sensory properties of Chardonnay and Shiraz wines made from rootstocks differing in capacity for chloride and sodium exclusion		
C.A.Varela, D.R. Kutyna, A.D. Coulter, K.A. Bindon, R. Gawel, C.S. Stockley, R.A. Muhlack, P.R. Dry, I.L. Francis, M.J. Herderich, I.S. Pretorius[3], P.A. Henschke, S.A. Schmidt, A.R. Borneman, P.J. Chambers	Strategies for reducing alcohol levels in wine		
C.D. Curtin, A.G. Cordente, R. Kievit, S. Holt[10], D. Capone, C. Black, K. Pardon, E. King, G. Winter[11], E. Bizaj[12], J. Hixson[8], G. Langhans[8], I.L. Francis, P.A. Henschke, I.S. Pretorius[3], P.J. Chambers	Yeast – little things that have a big impact on wine flavour		
A.G. Cordente	Novel wine yeast with mutations in YAP1 that produce less acetate during fermentation		16 Nov 12
P. Costello, E.J. Bartowsky	Shaping wine flavour through malolactic fermentation		

Staff	Title of talk	Presented to and where	Date
M. Marangon, P.A. Smith	Promising alternatives to bentonite for the protein stabilisation of white wines	Crush Symposium 12, Urrbrae, Adelaide, SA	16 Nov 12
M.P. Day, M.Z. Viviers, S. Kassara, P.A. Smith	Effects of early oxygen exposure during red winemaking		
M.J. Herderich	Summary of ongoing research work on rotundone, a sesquiterpene responsible for peppery aromas in wines	IFV, Toulouse, France	20 Nov 12
C.D. Curtin	Flavour active yeasts	Anchor/Oenobrands Technical Day, Stellenbosch, South Africa	21 Nov 12
M. Marangon	Effective bentonite use and proctase performance review	ASVO Seminar – Efficiency and Sustainability in the Winery, Adelaide, SA	
E. Wilkes	An update on Carboxymethyl Cellulose (CMC) performance		
S. Nordestgaard, T.J. Abbott, D. Rhys[13]	Wine transfers: challenges in reducing numbers and cost		
S. Connew	Chair: 'Challenging Winemaking Norms' session		22 Nov 12
R.A. Muhlack	Automated fermentation management		
M.J. Herderich	Summary of ongoing research work on rotundone, a sesquiterpene responsible for peppery aromas in wines	University Zaragoza, Spain	
P.R. Dry	Wine typicity – does the answer lie in the soil?	Wine Tasmania 12 Field Day, Richmond, Tas	23 Nov 12
A.D. Coulter	Taints and their origins, a taint threshold tasting and taint prevention	Australian Vintage, Buronga Hill, NSW	29 Nov 12
W.M. Hines	Introduction to Proteomics	BioinfoSummer, University of Adelaide, SA	3 Dec 12
N.S. Watson-Haigh	Introduction to Next Generation sequencing		4 Dec 12
	Hands on Next Generation sequencing		
W.M. Hines	Hands on informatics for proteomics		5 Dec 12
N.S. Watson-Haigh	Hands on cellular simulation		6 Dec 12
W.M. Hines	Hands on programming workshop		7 Dec 12
S. Connew	The planned vintage projects for the AWRI Hunter Node	Hunter Valley Wine Industry Association AGM, Hunter Valley, NSW	
R.A. Muhlack	Automated fermentation management	Hunter Valley Wine Industry Association, Hunter Valley, NSW	10 Dec 12
	Juice analysis and grape maturity testing using ATR spectral technology		
R.G. Dambergs	Taming terroir: manipulating red wine phenolic profiles with the maceration process		
J.R. Bellon	Hybrid yeast and flavour diversity	Stanford University Genetics Department, California, USA	11 Dec 12
R.A. Muhlack	Automated fermentation management	National Wine and Grape Industry Centre, Wagga Wagga, NSW	14 Dec 12
	Juice analysis and grape maturity testing using ATR spectral technology		
	Proctase – an alternative to bentonite treatment		
S. Connew	Planned activities for the Hunter Node in 13		
K.A. Bindon	Overview of tannin research in Australia and internationally	AWRI Tannin and Brett Workshop, Mudgee Wine Grape Growers Association Inc. (MWGGAI) AREC Pavilion, Mudgee, NSW	22 Jan 13
	Tannin structure and related sensory effects		
	Green tannins. What are they?		
	Tannin tasting		
G.D. Cowey	Brett perception – results of the AWRI threshold and descriptive studies		
D.L. Johnson	Introduction to the Wine Innovation Cluster	Supreme and Federal Judges Conference, Urrbrae, Adelaide, SA	
C.S. Stockley	Ten key facts you need to know about wine and health		
P.J. Chambers	Genetically modified organisms		

Staff	Title of talk	Presented to and where	Date
K.A. Bindon	Overview of tannin research in Australia and internationally	AWRI Tannin and Brett Workshop, Canberra District Vignerons' Association Inc., Lark Hill Winery, Bungendore, NSW	24 Jan 13
	Tannin structure and related sensory effects		
	Green tannins . What are they?		
	Tannin tasting		
G.D. Cowey	Brett perception – results of the AWRI threshold and descriptive studies		
G.D. Cowey	Brett monitoring, management and control		
N. Scrimgeour	The Tannin Portal	AWRI Tannin Workshop, Limestone Coast Grape and Wine Council Inc. Robe Bowls Club, Robe, SA	12 Feb 13
K.A. Bindon	Viticultural influences on tannins and colour		
P.A. Smith	Tasting. Wynns Trial. Clonal and vintage effects, grape and wine relationships		
J.M. McRae	Tannin structure. Big + little tannins; effects on astringency, hotness		
P.A. Smith	Yeast effects on colour and tannin		
P.A. Smith, S. Bell[14], P. Bissell[15]	Tasting. Comparison of warm versus cool vintages		
K.A. Bindon	Green tannins. What are they?		
P.A. Smith	Summary of tannin research in Australia and internationally		
M. Krstic, A.D. Coulter	Q&A session on smoke taint and its management in the vineyard and winery	Pooley Wines, Richmond, Tas	18 Feb 13
L.J. Halse	Supporting human capital through wellbeing investments	Annual HR Metrics Conference, Brisbane, Qld	
M.G. Holdstock	The avoidance of taints and contaminations during winemaking	The Institute of Masters of Wine, European Seminar 13, Chateau Pey La Tour, Bordeaux, France	19 Feb 13
L.J. Halse	Supporting human capital through wellbeing investments	Annual HR Metrics Conference, Sydney, NSW	
M. Krstic, A.D. Coulter	Q&A session on smoke taint and its management in the vineyard and winery	Joseph Chromy Wines, Relbia, Tas	
E.J. Bartowsky	What does MLF bring to wine besides 'deacidification'? MLF, bacteria and sensory	Oregon Wine Industry Symposium, Portland, Oregon, USA	20 Feb 13
M.G. Holdstock	The avoidance of taints and contaminations during winemaking	WSET Tasting, Bermondsey Street, London, England	21 Feb 13
L.J. Halse	Supporting human capital through wellbeing investments	Annual HR Metrics Conference, Adelaide, SA	
E.J. Bartowsky	Summary of bacterial and malolactic research	Willamette Valley Winemakers Technical Meeting, Dundee, Oregon, USA	22 Feb 13
L.J. Halse	Supporting human capital through wellbeing investments	Annual HR Metrics Conference, Perth, WA	
C.S. Stockley	The Australian Wine Research Institute	OIV Master of Science in Wine Management Seminar, AWRI, Urrbrae, SA	28 Feb 13
P.W. Godden	The impact of closure choice and oxygen on wine Development post-bottling: sulfide development, SO_2 concentration and shelf life		
C.D. Curtin	*Brettanomyces* research at the AWRI		
A.D. Coulter	Smoke taint research at the AWRI		
I.L. Francis	Flavour chemistry research		
C.S. Stockley	Resveratrol's decision tree	OIV Food Safety Expert Group, Paris, France	7 Mar 13
M.J. Herderich	Managing smoke taint in vineyards and wineries		
	Are we there yet – understanding and managing grape and wine quality	ISVV Bordeaux, France	8 Mar 13
C.A. Simos	An overview of The Australian Wine Research Institute	A+ Australian Wine WSET Group visit, AWRI, Urrbrae, SA	18 Mar 13
G.D. Cowey	Simulated flavours, faults, taints and mouth-feel tasting		
P.W. Godden	The impact of closure choice and oxygen on wine development post-bottling: sulfide development, SO_2 concentration, and shelf life		
P.R. Dry	Alternative varieties tasting	Wine and Spirit Education Trust, Coriole Winery, McLaren Vale, SA	20 Mar 13

Staff	Title of talk	Presented to and where	Date
A.R. Borneman	Industrial yeast comparative genomics	School of Chemistry and Molecular Biosciences, University of Queensland, St. Lucia, Qld	20 Mar 13
	A combined systems biology and metabolic engineering strategy to alter yeast metabolism during wine fermentation		
M. Krstic	Connecting science and industry to address future challenges in the grape and wine industries	Australian Institute of Agriculture (Tasmanian Chapter) Annual General Meeting, Velo Wines, Legana, Tas	23 Mar 13
C.A. Varela, S.A. Schmidt, A.R. Borneman, P.J. Chambers	Systems Biology: a new approach to industrial yeast strain development	2nd International Conference and Exhibition on Metabolomics and Systems Biology, Chicago, USA	8 Apr 13
P.O. Williamson	Sensory-consumer research at the AWRI	GWRDC Consumer Insights Network meeting	10 Apr 13
M.G. Holdstock, F.B. Blefari	Simulated flavours, faults, taints and mouth-feel tasting	Magill Estate, Adelaide, SA	11 -12 Apr 13
M. Krstic	Update on smoke taint	Boynton's Feathertop Winery, Porepunkah, Vic	15 Apr 13
D.L. Capone, M.A. Sefton[8], D.W. Jeffery[8], I.L. Francis	Terroir or terpenoid transformation: the origin of 1,8-cineole (eucalyptol) in wine	10th Wartburg Symposium on Flavour Chemistry and Biology, Eisenach, Germany	17 Apr 13
P.J. Costello, E.J. Bartowsky, C.D. Curtin, S. Krieger-Weber, A. Ortiz-Julien	Expanding Chardonnay sensory through malolactic fermentation	61st German Winegrowers´ Congress, Stuttgart, Germany	24 Apr 13
E.J. Bartowsky	Influence of bacteria on wine sensory	Austrian ML School, Vienna, Austria	30 Apr 13
M.L. Longbottom	Climate change in viticulture	Wine Australia 'Women in Wine' function, International Passenger Terminal, Sydney, NSW	
	Terroir – separating fact from fiction		
P.O. Williamson, H.E. Holt	1. Test your nose! Wine aroma compounds 2. Faults and flavours in wine		
M. Marangon	Managing the risk of haze formation in white wines: the mechanism of haze formation	Pontificia Universidad Católica de Valparaíso, Chile	
	Managing the risk of haze formation in white wines: recent alternatives proposed		
	Managing the risk of haze formation in white wines: recent alternatives proposed	Universidad del Bío-Bío, Chillan, Chile	2 May 13
C.D. Curtin	*Brettanomyces* genomics and transcriptomics	Department of Biotechnology, University of Verona, Verona, Italy	3 May 13
	Harnessing yeast strain interactions to improve the quality and complexity of aromatic white wine	Enoforum 2013, Arezzo, Italy	8 May 13
T.E. Siebert, G. Logan[16], M.R. Solomon, S.R. Barter	Spicing up Shiraz: viticultural and winemaking influences on the peppery aroma compound, rotundone	E & J Gallo Winery Research Facility, Modesto, USA	
I.L. Francis, P.O. Williamson	Relationship between chemical composition and preferences of Western and Asian consumers	Enoforum 13, Arezzo, Italy	9 May 13
M.L. Longbottom	Phos acid update	New technologies in grapegrowing and winemaking workshop, Limestone Coast Grape and Wine Council Inc, Treasury Wine Estates, Padthaway, SA	14 May 13
	The Dog Book app		
M. Parker	Are my grapes smoke tainted? What are my options?		
	Authentication		
P.R. Dry	Great wine from grafted vines	AWRI Hunter Valley seminar, Mercure Resort Hunter Valley Gardens, Pokolbin, NSW	
C.A. Simos	Winemaking management strategies for Botrytis and Powdery Mildew		
P.R. Dry	Does soil and vine nutrient status affect wine quality?		
S. Connew	How the AWRI's 'D' activities are adding value to NSW grape and wine producers		
E. Wilkes	Copper in winemaking: the good and the bad		
E. Wilkes	Pepper and spice in Shiraz: what influences rotundone levels in wines?	AWRI Hunter Valley seminar, Mercure Resort Hunter Valley Gardens, Pokolbin, NSW	
P.R. Dry	Do you ignore your vineyard after harvest?		
I.L. Francis, P.O. Williamson	Relationship between chemical composition and preferences of Western and Asian consumers	University of Trás-os-Montes and Alto Douro (UTAD), Vila Real, Portugal	

Staff	Title of talk	Presented to and where	Date
P.R. Dry	Hotter and drier in the vineyard	AWRI roadshow workshops (Adapting to difficult vintages) The Vine Inn, Barossa Valley, SA	15 May 13
G.D. Cowey	Hotter and drier – processing ripe fruit		
M.L. Longbottom	Salinity and sodicity in the vineyard		
G.D. Cowey	Salty juice and wine		
A.D. Coulter	Bushfires and smoke taint tasting		
P.R. Dry	Growing grapes in wet seasons		
M.G. Holdstock	Winemaking in wet seasons		
	Efficiencies in the winery		
A.D. Coulter	Energy use and winery wastewater		
M. Krstic	Practical vineyard and winery group exercise		
P.R. Dry	New varieties for a changing climate tasting		
I.L. Francis, P.O. Williamson	Relationship between chemical composition and preferences of Western and Asian consumers	9th Symposium of Vitiviniculture at Alentejo, Portugal	16 May 13
S. Connew	Update of Hunter Node activities	Hunter Valley Wine Industry Association Winemaking Sub Committee, Brokenwood Wines, Pokolbin, NSW	20 May 13
M. Essling	Why is harvest getting earlier and what can we do about it?	AWRI roadshow workshops (Adapting to difficult vintages), The Artisan's Table, Clare Valley, SA	21 May 13
M.L. Longbottom	Hotter and drier in the vineyard		
G.D. Cowey	Hotter and drier – processing ripe fruit		
M.L. Longbottom	Salinity and sodicity in the vineyard		
G.D. Cowey	Salty juice and wine		
A.D. Coulter	Bushfires and smoke taint tasting		
M. Essling	Growing grapes in wet seasons		
M.G. Holdstock	Winemaking in wet seasons		
	Efficiencies in the winery		
A.D. Coulter	Energy use and winery wastewater		
M.L. Longbottom	Practical vineyard and winery group exercise		
	New varieties for a changing climate tasting		
P.R. Dry	Vine balance – how does it affect yield and quality?	AWRI Langhorne Creek & Adelaide Hills seminar, Langhorne Creek Bowling Club, Langhorne Creek, SA	
M. Parker	Are my grapes smoked tainted? What are my options?		
E.J. Bartowsky	Strategies for a successful MLF		
R. Gawel	Putting the texture back into white wine – the role of white wine phenolics		
P.R. Dry	It's getting hotter – what does this mean for our vineyard management strategies?		
K.A. Bindon	Viticultural management of grape and wine phenolics		
E. Wilkes	Winery cost reduction strategies		
P.O. Williamson	Capsicum, cherry and coconut: the complexity of wine flavour	Loreto College Careers Carousel	22 May 13
M. Krstic, A.D. Coulter	Q&A session on smoke taint and its management in the vineyard and winery	Western Victoria Winegrowers: Gum San Chinese Heritage Centre, Ararat, Vic	
M. Krstic, A.D. Coulter	Q&A session on smoke taint and its management in the vineyard and winery	Yarra Valley Winegrowers, Yarra Glen Memorial Hall, Yarra Glen, Vic	23 May 13
G.D. Cowey	Sensory evaluation. Wine aromas, flavours, faults and taints and Australian Wine Show Judging	Premium Wine Brands, Barossa Valley, SA	24 May 13
M.G. Holdstock, F.B. Blefari	Simulated flavours, faults, taints and mouth-feel tasting	Rockford Wines Cellar door and winemaking team, AWRI, Urrbrae, SA	28 May 13

Staff	Title of talk	Presented to and where	Date
S. Connew	Meeting to discuss regional research priorities for the upcoming year	Mudgee Wine Grape Growers Association Technical Sub Committee, Lowe Wines, Mudgee, NSW	30 May 13
		Orange Region Vignerons' Association Technical Sub Committee, Orange Campus, CSU, NSW	31 May 13
C.A. Varela, D. Kutyna, A.D. Coulter, K.A. Bindon, R. Gawel, C.S. Stockley, R.A. Muhlack, P.R. Dry, I.L. Francis, M.J. Herderich, I.S. Pretorius[3], P.A. Henschke, S.A. Schmidt, A.R. Borneman, P.J. Chambers	Strategies for reducing alcohol levels in wine	Winery Engineering Association Conference WinEng 13, McLaren Vale	5 Jun 13
R.G. Dambergs	Small lot winemaking for cost-effective research		6 Jun 13
M. Marangon	Managing the risk of protein haze formation in white wines		
	Proctase – a viable alternative to bentonite for protein stabilisation of white wines	AWRI Webinar	11 Jun 13
G.D. Cowey	Heat stability	AWRI roadshow workshops (A guide to trouble-free packaging), DEPI, Irymple, Vic	12 Jun 13
M.G. Holdstock	Cold stability		
A.D. Coulter	Sulfide treatment and wine fining practical		
G.D. Cowey	Packaging preparation		
A.D. Coulter	Controlling microbiological activity		
M.G. Holdstock	Line sanitation and filtration		
G.D. Cowey	Packaging operation		
	Real wine tasting		
A.D. Coulter	Closure choice and post-bottling storage		
M.G. Holdstock	Post-bottling transport		
P.R. Dry	Berry sensory assessment in the vineyard for fruit grading – does it work?	AWRI roadshow seminar, Mildura, Vic	13 Jun 13
P.A. Smith	Grape ripeness and wine composition (Cabernet Sauvignon)		
P.R. Dry	Why do we need new clones?		
P.A. Henschke	Did you know that DAP can strongly affect the flavour profile and style of wine?		
	Increasing red and white wine complexity with AWRI's bayanus yeast		
P.A. Smith	Copper in winemaking: the good and the bad		
P.R. Dry	Features of the AWRI website		
I.L. Francis, T.E. Siebert, M.R. Solomon, G. Logan[16]	Pepper and spice in Shiraz: what influences rotundone levels in wines?		
M. Krstic	Overview of rotundone in Shiraz	Woodward Centre, University of Melbourne, Vic	18 Jun 13
C.S. Stockley	Wine-related research perspective	Second year Flinders University and Darwin University medical students (Graduate Entry Medical Program), Flinders Medical Centre, Bedford Park, SA	18 Jun 13
R. Gawel	Crush, macerate, drain and press. The effect of juice processing on polysaccharide content and the mouth-feel of white wine	AWRI Webinar	
M. Krstic	Particle film technology – reducing heat damage to wine grapes	University of Melbourne, Parkville, Vic	19 Jun 13
	Science of sensory perception of wine	Phillips Ormonde Fitzpatrick, Melbourne, Vic	20 Jun 13

Staff	Title of talk	Presented to and where	Date
S. Connew	Update of Hunter Node activities	Hunter Valley Wine Industry Association Winemaking Sub Committee	24 Jun 13
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	64th ASEV National Conference, Monterey, California, USA	24–28 Jun 13
R.A. Muhlack	Fermentation control with computer simulation	AWRI 2013 Webinar program	25 Jun 13
K.A. Bindon, C.A. Varela, H.E. Holt, P.O. Williamson, I.L. Francis, J. Kennedy, M.J. Herderich.	From grape to consumer: relationships between grape maturity, wine composition and wine sensory properties in Cabernet Sauvignon	64th ASEV National Conference, Monterey, California, USA	26 Jun 13
K.A. Bindon	Progress in understanding the relationship between fruit and wine tannin composition	Tannin Symposium, 64th ASEV National Conference, Monterey, California, USA	28 Jun 13

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Workshops organised by AWRI staff

Conducted by	Title of workshop	Held	Date
M. Krstic	Rootstocks – past, present and future	Dromana Estate, Mornington Peninsula, Vic	5 Jul 12
N.S. Watson-Haigh, C.A. Shang[1], M. Haimel[2], M. Kostadima[2], R. Loos[2], M. Schneider[2], N. Deshpande[3], K. Duesing[4], X. Li[4], S. McWilliam[4], P. Moolhuijzen[5], J.N. De Leon Revote[6], S. Tyagi[7]	Next Generation sequencing	Monash University, Clayton, Vic	12- 13 Jul 12
		University of New South Wales, Kensington, NSW	16–17 Jul 12
G.D. Cowey, A.D. Coulter, M.G. Holdstock	AWRI roadshow workshops (A guide to trouble-free packaging)	Orange Agricultural Institute, Training Centre, Forest Road Orange, NSW	7 Aug 12
		Lark Hill Winery Restaurant, Bungendore, NSW	9 Aug 12
M. Krstic	Vine nutrition, soil health and vineyard management	T'Gallant Winemakers, Mornington Peninsula, Vic	14 Aug 12
	Winery operations workshop	Western Victoria Winemakers, Ararat, Vic	29 Aug 12
		Yarra Valley Winegrowers, Yarra Glen, Vic	30 Aug 12
C.A. Simos, F.B. Blefari	Tannin tasting and wine faults and flavours tasting	WA Cabernet Workshop, Margaret River, WA	
G.D. Cowey, A.D. Coulter, M.G. Holdstock	AWRI roadshow workshops (A guide to trouble-free packaging)	Langhorne Creek Football Clubrooms, Langhorne Creek, SA	13 Sep 12
M. Krstic	Spray application field day	Balgownie Estate, Bendigo, Vic	2 Oct 12
G.D. Cowey, A.D. Coulter, M.G. Holdstock	AWRI roadshow workshops (A guide to trouble-free packaging)	The Grange, Campbell Town, Tas	4 Oct 12
N.S. Watson-Haigh	Bioinformatics early career researcher workshop	Australian Centre for Ancient DNA Studies, University of Adelaide, SA	
M. Krstic, R.G. Dambergs, F.B. Blefari	Pinot Noir Masterclass	The Grange, Campbell Town, Tas	8 Oct 12
		Yering Station, Yarra Valley, Vic	10 Oct 12
		Elgee Park, Mornington Peninsula, Vic	11 Oct 12
D.L. Johnson, P.W. Godden, V.T. O'Brien, M.J. Herderich, E. Wilkes	Industry consultation on the AWRI's draft new RDE&C Plan	Premium Wine Brands, Adelaide, SA	15 Oct 12
D.L. Johnson, P.W. Godden, V.T. O'Brien, M.J. Herderich		Yalumba Wine Company, Angaston, SA	16 Oct 12

Conducted by	Title of workshop	Held	Date
D.L. Johnson, P.W. Godden, V.T. O'Brien, M.J. Herderich, C.D. Curtin	Industry consultation on the AWRI's draft new RDE&C Plan	Lion Nathan/St Hallett, Barossa Valley, SA	16 Oct 12
D.L. Johnson, P.W. Godden, V.T. O'Brien, M.J. Herderich, J.M. McRae, M. Krstic		Accolade Wines, Reynella, SA	17 Oct 12
		Treasury Wine Estates, Magill, SA	
D.L. Johnson, P.W. Godden, N. Scrimgeour, R.A. Muhlack, S. Connew	Industry consultation on the AWRI's draft new RDE&C Plan	Hunter Valley, NSW	22 Oct 12
D.L. Johnson, M. Krstic, C.A. Simos		Future Leaders Group, Melbourne, Vic	25 Oct 12
D.L. Johnson, P.W. Godden, V.T. O'Brien, C.A. Simos, R.A. Muhlack		Casella Wines, Yenda, NSW	26 Oct 12
		Griffith, NSW	
		McWilliam's Wines, Hanwood, NSW	
		De Bortoli Wines, Bilbul, NSW	27 Oct 12
D.L. Johnson, P.W. Godden, C.A. Simos, M. Krstic		Rutherglen, Vic	29 Oct 12
		Brown Brothers, Milawa, Vic	
		Nagambie, Vic	
		Rathbone Wine Group, Melbourne, Vic	30 Oct 12
		Bendigo, Vic	
		Mornington Penisula, Red Hill South, Vic	31 Oct 12
		Yarra Valley, Vic	
P.W. Godden, C.A.Simos, M. Krstic		Irymple, Vic	1 Nov 12
		CCW, Berri, SA	2 Nov 12
		Barmera, SA	
D.L. Johnson, P.W. Godden, V.T. O'Brien, C.A. Simos, E. Wilkes, C.D. Curtin		Queensland Wine Industry Association, AWRI, Urrbrae, SA	6 Nov 12
D.L. Johnson, P.W. Godden, N. Scrimgeour, R.G. Dambergs, J.M. McRae		Wine Tasmania, Campbell Town, Tas	9 Nov 12
D.L. Johnson, P.W. Godden, M.J. Herderich, S. Connew, M.L. Longbottom		Langhorne Creek, SA	12 Nov 12
		McLaren Vale, SA	
P.W. Godden, V.T. O'Brien, S. Connew, J.M. McRae		Nuriootpa, SA	13 Nov 12
N.S. Watson-Haigh	Next Generation Sequencing	EMBL-Australia, University of Queensland, Qld	13–14 Nov 12
C.A. Simos, M.G. Holdstock, G.D. Cowey, V.F. Phillips, F.B. Blefari	Advanced Wine Assessment Course	AWRI, Urrbrae, SA	13–16 Nov 12
D.L. Johnson, P.W. Godden, V.T. O'Brien, M.L. Longbottom	Industry consultation on the AWRI's draft new RDE&C Plan	FABAL, Adelaide, SA	14 Nov 12
D.L. Johnson, P.W. Godden, S. Connew, M.J. Herderich, M.L. Longbottom		Gundaroo, NSW	15 Nov 12
P.W. Godden, E. Wilkes, S. Connew, J.M. McRae		Clare Valley Hotel, Clare, SA	20 Nov 12
M. Krstic	Practical Precision Viticulture: extracting value from variation	Seppelts Great Western, Grampians, Vic	22 Nov 12
		Yering Station, Yarra Valley, Vic	
G.D. Cowey	The avoidance of taints and contaminations during winemaking	The Institute of Masters of Wines, Adelaide, SA	27 Nov 12

Conducted by	Title of workshop	Held	Date
N.S. Watson-Haigh	Next Generation sequencing	EMBL-Australia, University of Adelaide, SA	27–28 Nov 12
A.D. Coulter	Taints and their origins, a taint threshold tasting and taint prevention	Australian Vintage, Buronga Hill, NSW	29 Nov 12
C.A. Simos, F.B. Blefari,	Sparkling Wines of the World	AWRI, Urrbrae, SA	
			30 Nov 12
P.W. Godden, V.T. O'Brien, M.L. Longbottom	Industry consultation on the AWRI's draft new RDE&C Plan	Kingston Estate, Riverland, SA	3 Dec 12
P.W. Godden, C.A. Simos, J.M. McRae		Margaret River Campus – Curtin University, Margaret River, WA	6 Dec 12
		Faber Vineyard, Swan Valley, WA	7 Dec 12
S. Connew	Planned activities for vintage 2013 and opportunities for local producers	Bimbadgen Estate, Pokolbin, NSW	10 Dec 12
D.L. Johnson, V.T. O'Brien, P.W. Godden, M.J. Herderich, M. Krstic	Industry consultation on the AWRI's draft new RDE&C Plan	Representatives of WFA, WGGA and Wine Australia, Wine Industry House, Adelaide, SA	
M.J. Herderich, M.L. Longbottom, E. Wilkes, J.M. McRae		Struan House, Naracoorte, SA	11 Dec 12
M. Krstic	Vintage 2030 and beyond – producing quality wines in warmer times.	Coolart Vineyard, Mornington Peninsula, Vic	
G.D. Cowey, K.A. Bindon	AWRI Tannin and Brett workshop	Mudgee Wine Grape Growers Association Inc. (MWGGAI), AREC Pavilion, Mudgee, NSW	22 Jan 13
		Canberra District Vignerons' Association Inc., Lark Hill Winery, Bungendore, NSW	24 Jan 13
G.D. Cowey, P.A. Smith, K.A. Bindon, J. McRae, N. Scrimgeour	AWRI Tannin workshop	Limestone Coast Grape and Wine Council Inc., Robe Bowls Club, Robe, SA	12 Feb 13
M. Krstic, M.Sosnowski[8], W.Pitt[9], F.Constable[10]	Trunk diseases and virus workshop	Healesville Memorial Hall, Healesville, Vic	23 Apr 13
G.D. Cowey, A.D. Coulter, M.G. Holdstock, P.R. Dry, M. Krstic, M.L. Longbottom	AWRI roadshow workshops (Adapting to difficult vintages)	The Vine Inn, Barossa Valley, SA	15 May 13
		The Artisan's Table, Clare Valley, SA	21 May 13
M. Krstic, A.D. Coulter, M. Downey[10], R. James[10], G. Rose[10]	Smoke taint update session	Gum San Chinese Memorial Hall, Ararat, Vic	22 May 13
		Yarra Glen Memorial Hall, Yarra Glen, Vic	23 May 13
		Oxley Shire Hall, Oxley, Vic	24 May 13
M.G. Holdstock, F.B. Blefari	Barossa Wine Assessment Tasting	Richmond Grove, Barossa Valley, SA	5 Jun 13
G.D. Cowey, A.D. Coulter, M.G. Holdstock	AWRI roadshow workshops (A guide to trouble-free packaging)	DEPI, Irymple, Vic	12 Jun 13

[1]Bioplatforms Australia, [2]European Bioinformatics Institute (UK), [3]University of New South Wales, [4]CSIRO, [5]Murdoch University, [6]Monash e-Research Centre, [7]AGRF, [8]SARDI, [9]NWGIC, [10]Department of Environment and Primary Industries (Victoria)

Posters

Author(s)	Title of poster	Presented at	Date
Y. Hayasaka, G.A. Baldock, M. Parker, K.H. Pardon, C.A. Black, M.J. Herderich	Development of smoke diagnostic assays: when the smoke clears, will it end up in the wine bottle?	The 19th International Mass Spectrometry conference, Kyoto, Japan	20 Sep 12
S.A. Schmidt, J. Li[1], R. Kolouchova, A. Forgan, T.M.T. Tran, A.R. Borneman, P.A. Henschke, P.J. Chambers	Understanding the genetic basis of tolerance to low pH and SO_2 in *S. cerevisiae*	COMBIO 12, Adelaide, SA	26 Sep 12
J.R. Bellon, C.M. Ford[2], A.R. Borneman, P.J. Chambers	Novel interspecific *Saccharomyces* spp. wine yeast hybrids: improving wine quality and studying speciation	EMBL Conference Series, Experimental Approaches to Evolution and Ecology using Yeast, Heidelberg, Germany	17–21 Oct 12
T.E. Siebert, S.R. Barter	Determination of the potent flavour compound rotundone in grapes and wine using MDGC-MS and membrane assisted solvent extraction	37th International Symposium on Capillary Chromatography and 10th GCxGC Symposium, Palm Springs, California, USA	12–16 May 13

[1]China Agricultural University, Beijing, China , [2]University of Adelaide

Appendix 2 - Teaching responsibilities (Lectures) of AWRI staff

Institution	Subject number	Subject name	No of lectures	Staff member
University of Adelaide	3045 WT/7048 WT	Advances in Oenology	1	G.D. Cowey
	Biotech 7005	Bioinformatics and Systems Modelling	2	W.M. Hines
	3007WT/7010WT	Stabilisation and Clarification	3	M. Marangon
	Oenology 7003NW	Vineyard and Winery Operations B	4	P.R. Dry
	VITICULT 7038WT	Viticulture Methods and Procedures	1	P.R. Dry
	3520WT	Advances in Wine Science	3	E.J. Bartowsky
	3045WT/3520WT/7048WT/7520WT	Advances in Oenology	4	P.A. Henschke
	3046WT/7046WT	Fermentation Technology	2	P.A. Henschke
	7046WT/3520WT	Fermentation Technology/ Advances in Wine Science	2	I.L. Francis
	Oenology 3007WT/7010WT	Stabilisation and Clarification III	3	A.D. Coulter
	VITICULT 3021WT	Viticulture III/B	2	P.R. Dry
	2001WT	Wine in society	1	C.S. Stockley
	VITICULT 3500WT	Grape Industry Practice, Policy and Communication	Approx 50 hours	C.S. Stockley
	VITICULT 3500WT	Grape Industry Practice, Policy and Communication	1	I.L. Francis
University of Queensland	MICR3003	Molecular Microbiology	4	A.R. Borneman
University of Melbourne	AGRI90043	Advanced Viticulture Techniques	2	M. Krstic
University of Tasmania	KLA316	Agricultural Technology and Innovation	1	R.G. Dambergs

Appendix 3 - Student supervision responsibilities of AWRI staff for 2012/2013

Student	Supervisors	Source of funds
PhD		
Anna Carew	D.C. Close[1], R.G. Dambergs, C.D. Curtin, R. Shellie[2]	UTas
Gareth Hill	K. Evans[1], R. Beresford[3], R.G. Dambergs	UTas and NZ Plant and Food
Catherine Kidman	P.R. Dry	University of Adelaide
Eric Mertes	D.C. Close[1], P. Meesham[1], R.G. Dambergs	UTas
Sam Rees	R. Doyle[4], M. Hardie[1], R.G. Dambergs	UTas
Tracey Siebert	I.L. Francis, M.J. Herderich, M. de Barros Lopes[5]	GWRDC
Angela Sparrow	R.G. Dambergs, D.C. Close[1]	UTas and GWRDC
Patricia Williamson	I.L. Francis, L. Lockshin[5], S. Mueller-Loose[6]	AWRI
Pangzhen Zhang	M. Krstic, M.J. Herderich, K.S. Howell[7], S. Barlow[7]	University of Melbourne Scholarship
Hons		
Max Edgley	D.C. Close[1], R.G. Dambergs	UTas
Ella Thomson	A.R. Borneman	University of Adelaide
Samantha White	J. Jones[1], R.G. Dambergs	UTas
Ryan Zeppel	A.R. Borneman, C.D.Curtin	University of Adelaide, GWRDC Honours scholarship

[1]TIA, [2]UTas Chemistry, [3]NZ Plant and Food Res, [4]UTas Ag Sci, [5]University of South Australia, [6]Aarhus University, Denmark, [7]University of Melbourne

Appendix 4 - Media interviews

Date	Staff member	Discussed	Media
18 Jul 12	G.D. Cowey	Cork versus screwcap	*WhatWine*
27 Jul 12		*Brettanomyces* incidence in Australian wines	Anthony Madigan, *Wine Business Magazine*
9 Aug 12	R.G. Dambergs	BevScan in-bottle wine analysis	ABC *Country Hour*
21 Aug 12	C.A. Simos	Advanced Wine Assessment Course	*Australian & New Zealand Grapegrower & Winemaker*
12 Aug 12	D.L. Capone	Eucalyptol	GWRDC *R&D@Work*
12 Sep 12	G.D. Cowey	Allergies to sulfur dioxide	*Independent Wine Monthly*
2 Oct 12	P.W. Godden	The AWRI's research into alcohol trends of Australian wine	Kellie Arbuckle, *Australian and New Zealand Grapegrower and Winemaker*
3 Oct 12		Pinot G Style Spectrum	Alice Richard, Westwick-Farrow Media, *What's New in Food Technology and Manufacturing* magazine (and website, foodprocessing.com.au)
10 Oct 12	C.A. Simos	Sensory evaluation of wine for eight common wine faults	Frank Smith, Freelance journalist
14 Oct 12	S. Connew	AWRI Hunter Valley Node	John Lewis, *Newcastle Herald*
16 Oct 12	M. Essling	Residual herbicides and restriction on use	Kellie Arbuckle, *Australian and New Zealand Grapegrower and Winemaker*
18 Oct 12	D.L. Capone	*Eucalyptus* flavour in wine	Huon Hooke, *Sydney Morning Herald, Good Living, Gourmet Traveller WINE, Decanter*
29 Oct 12	C.S. Stockley	Health benefits of red wine	Sara Altshul, *Reader's Digest*, UK
31 Oct 12	G.D. Cowey	Packaging Workshops	Kellie Arbuckle, *Australian and New Zealand Grapegrower and Winemaker*

Date	Staff member	Discussed	Media
4 Nov 12	P.R. Dry	Portuguese grape varieties	Jane Faulkner, *The Age*
9 Nov 12		Alternative varieties	Lisa Kingsbury, *ABC Radio*
15 Nov 12		Low alcohol wines in the vineyard	Lisa Kingsbury, *ABC Radio*
21 Nov 12	M.L. Longbottom	Greenhouse gas abatement in viticulture	*ABC Rural Radio*
26 Nov 12	S. Connew	Women in the wine industry	Jeni Port, *The Age*
30 Nov 12	G.D. Cowey	AWRI model, support services and extension	Sarah Jane Evans MW, *BBC Good, Decanter, Harpers, Off Licence News, Imbibe, Square Meal*
	M.J. Herderich	R&D at the AWRI	
	C.D. Curtin	*Brettanomyces*	
	P.A. Smith	Non-volatile aromas, texture, reductive formation	
	N. Scrimgeour	Use of spectroscopy in rapid measurements, tannin portal, PinotG style spectrum	
	P.R. Dry	Alternative varieties	
	I.L. Francis	Cineole and pepper work, yeast and flavour	
5 Dec 12	C.S. Stockley	Role of fructose in breaking down alcohol in the bloodstream	Tony Love, *The Advertiser*
18 Jan 13	C.S. Stockley	Anti-oxidant potential of wine	Rob Kitt, *Courier Mail*, Brisbane
18 Jan 13	C.A. Simos	Smoke taint	Lesley Watson, *Grape Growers and Vignerons*
23 Jan 13	G.D. Cowey	Tannin and Brett	Sam Paine, *Mudgee Guardian*
23 Jan 13	R.G. Dambergs	Sparkling wine	Tamara Glumac, *ABC News*
24 Jan 13	P.W. Godden	MOG in crushers and potential taint	Tory Shepherd, *News.com*
1 Feb 13	M.J. Herderich	Smoke taint in wine	Jasper Clinton, *ABC rural radio*
22 Feb 13	M.L. Longbottom	Rural Industries Research and Development Corporation *Rural Women's Award*	*ABC Rural Radio*
26 Feb 13	W.K. Roget	Developing screwcaps for sparkling wine	Annabel Homer, *ABC Radio*
26 Feb 13			*ABC Darwin*
27 Feb 13	C.S. Stockley	WineHealth2013 and low alcohol wines from a human health perspective	Kirsten Lawson, *Canberra Times*
1 Mar 13	W.K. Roget	Developing screwcaps for sparkling wine	*ABC Newcastle*
1 Mar 13			Sian Cain, *ABC Adelaide 891*
5 Mar 13			Sid Aspery, *dpa, German News Agency*
12 Mar 13	M.L. Longbottom	SA finalist for the Rural Women's Award	Bob Sutherland, *SA Country Women*
25 Mar 13	C.S. Stockley	Wine allergies	Elana McIntyre, *Mediaplane*t
4 Apr 13		WineHealth 2013 conference	Jill Stark, *The Age*
9 Apr 13			Tony Love, *The Advertiser*
11 Apr 13	M.L. Longbottom	Carbon farming futures extension grant	Jacinta Rose, *The SA Grower*
12 Apr 13			*Radio 2SM, Sydney*
17 May 13	C.S. Stockley	Allergens in wine	Chris Coleman, *ABC Statewide Afternoons*
31 May 13	I.L. Francis	Rotundone, eucalyptol and spicy flavour in wine	Tony Love, *The Advertiser*
3 Jun 13	M.L. Longbottom	Extension and outreach project	Don Bursill, *ABC*
24 Jun 13	D.L. Johnson	Testing for 2-4D	ABC TV *Four Corners*
25 Jun 13	I.L. Francis	Wine preferences in China	Pia Akerman, *The Australian*

Appendix 5 - Papers published by AWRI staff recorded during 2012/2013

1434 Bartowsky, E., Costello, P. Using malolactic fermentation to enhance the fruity characters of wine. *ACE Rev. Enolog*. 28 (94): 4–11; 2011.

1435 Bartowsky, E., Costello, P., Krieger-Weber, S., Markides, A., Francis, L., Travis, B. Influence of malolactic fermentation on the fruity characters of red wine: Bringing chemistry and sensory science together. *Proceedings of the XXIIes Entriens Scientifiques Lallemand;* Dubrovnik, April 28, 2011: 25–32; 2011.

1436 Dambergs, R.G., Mercurio, M.D., Kassara, S., Cozzolino, D., Smith, P.A. Rapid measurement of methyl cellulose precipitable tannins using ultraviolet spectroscopy with chemometrics: application to red wine and inter-laboratory calibration transfer. *Appl. Spectrosc.* 66 (6): 656–664; 2012.

1437 Marangon, M., Lucchetta, M., Duan, D., Stockdale, V.J., Hart, A., Rogers, P.J., Waters, E.J. Protein removal from a Chardonnay juice by addition of carrageenan and pectin. *Aust. J. Grape Wine Res.* 18 (2): 194–202; 2012.

1438 Coulter, A. Laccase and rot: Is it there or is it not? *Aust. N.Z. Grapegrower Winemaker* (579): 69–72; 2012.

1439 Cowey, G. How and why identify matter other than grapes. *Aust. N.Z. Grapegrower Winemaker* (580): 77–78; 2012.

1440 Longbottom, M. Mixed cost and quality effects from thinning. *Aust. N.Z. Grapegrower Winemaker* (579): 52; 2012.

1441 Marangon, M., Pocock, K.F., Waters, E.J. The addition of bentonite at different stages of white winemaking and its effect on protein stability. *Aust. N.Z. Grapegrower Winemaker* (580): 71–73; 2012.

1442 Henschke, P.A., Varela, C., Schmidt, S., Torrea, D., Vilanova, M., Siebert, T., Kalouchova, R., Ugliano, M., Ancin-Azpilicueta, C., Curtin, C.D., Francis, L. Modulating wine style with DAP: case studies with Albariño and Chardonnay. *Aust. N.Z. Grapegrower Winemaker* (581): 57–58, 60–63; 2012.

1443 Pretorius, I.S., Curtin, C.D., Chambers, P.J. The winemaker's bug: from ancient wisdom to opening new vistas with frontier yeast science. *Bioeng. Bugs* 3 (3): 147–156; 2012.

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.

1445 Cozzolino, D., Cynkar, W.U., Shah, N., Smith, P. Multivariate data analysis applied to spectroscopy: potential application to juice and fruit quality. *Food Res. Int.* 44 (7): 1888–1895; 2011.

1446 Kroemer, J.O., Nunez-Bernal, D., Averesch, N.J.H., Hampe, J., Varela, J., Varela, C. Production of aromatics in *Saccharomyces cerevisiae*—A feasibility study. *J. Biotechnol.*163 (2): 184–193; 2013.

1447 Curtin, C., Kennedy, E., Henschke, P.A. Genotype-dependent sulphite tolerance of Australian *Dekkera (Brettanomyces) bruxellensis* wine isolates. *Lett. Appl. Microbiol.* 55 (1): 56–61; 2012.

1448 Schmidt, S.A., Jacob, S.S., Ahn, A.B., Rupasinghe, T., Krömer, J.O., Khan, A., Varela, C. Two strings to the systems biology bow: co-extracting the metabolome and proteome of yeast. *Metabolomics* 9 (1): 173–188; 2013.

1449 Bartowsky, E., Costello, P., Francis, L., Travis, B. *Oenococcus oeni* and *Lactobacillus plantarum*: Effects of MLF on red wine aroma and chemical properties. *Pract. Winery Vineyard.* 33 (2): 57–59; 2012.

1450 Curtin, C.D., Borneman, A.R., Henschke, P.A., Godden, P.W., Chambers, P.J., Pretorius, I.S. Advancing the frontline against Brett: AWRI breakthrough offers potential to transform the battle against Brett. *Pract. Winery Vineyard.* 33 (2): 47–48, 50–54, 60; 2012.

1451 Curtin, C., Borneman, A., Chambers, P., Pretorius, S. Winning at snakes and ladders. *Pract. Winery Vineyard.* 33 (2): 55–56; 2012.

1452 Dambergs, R., Sparrow, A., Carew, A., Scrimgeour, N., Wilkes, E., Godden, P., Herderich, M., Johnson, D. Quality in a cool climate – maceration techniques in Pinot Noir production. *Wine Vitic. J.* 27 (3): 18, 20–26; 2012.

1453 Henschke, P., Bellon, J., Curtin, C., Chambers, P. Breeding for success: yeast strain development at the AWRI. *Wine Vitic. J.* 27(3): 35–39; 2012.

1454 Scarlett, N., Bindon, K. Case study of vigour-based zonal vineyard management and phenolic variation in wine *Wine Vitic. J.* 27 (3): 41–43; 2012.

1455 Stockley, C., Teissedre, P-L., Bogan, M., Di Lorenzo, C., Restani, P. Bioavailability of wine-derived phenolic compounds in humans: a review. *Food Funct.* 3 (10): 995–1007; 2012.

1456 Varela, C., Torrea, D., Schmidt, S.A., Ancin-Azpilicueta, C., Henschke, P.A. Effect of oxygen and lipid supplementation on the volatile composition of chemically defined medium and Chardonnay wine fermented with *Saccharomyces cerevisiae*. *Food Chem.* 134 (4): 2863–2871; 2012.

1457 Costello, P.J., Francis, I.L., Bartowsky, E.J. Variations in the effect of malolactic fermentation on the chemical and sensory properties of Cabernet Sauvignon wine: interactive influences of *Oenococcus oeni* strain and wine matrix composition. *Aust. J. Grape Wine Res.* 18 (3): 287–301; 2012.

1458 Bindon, K.A., Bacic, A., Kennedy, J.A. Tissue-specific and developmental modification of grape cell walls influences the adsorption of proanthocyanidins. *J. Agric. Food Chem.* 60 (36): 9249–9260; 2012.

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1461 Varela, C., Kutyna, D.R., Solomon, M.R., Black, C.A., Borneman, A., Henschke, P.A., Pretorius, I.S., Chambers, P.J. Evaluation of gene modification strategies to develop low-alcohol wine yeasts. *Appl. Environ. Microbiol.* 78 (17): 6068–6077; 2012.

1462 Tran, T.M.T., Stanley, G.A., Chambers, P.J., Schmidt, S.A. A rapid, high-throughput method for quantitative determination of ethanol tolerance in *Saccharomyces cerevisiae*. *Ann. Microbiol.* 63 (2): 677–682; 2013.

1463 Cox, C.M., Favero, A.C., Dry, P.R., McCarthy, M.G., Collins, C. Rootstock effects on primary bud necrosis, bud fertility, and carbohydrate storage in Shiraz. *Am. J. Enol. Vitic.* 63 (2): 277–283; 2012.

1464 Carew, A., Smith, P., Dambergs, B. Yeast selection impacts phenolics in Pinot Noir. *Aust. N.Z. Grapegrower Winemaker* (581): 70–72; 2012.

1465 Essling, M. Assessing sun-smart protection. *Aust. N.Z. Grapegrower Winemaker* (581): 36–37; 2012.

1466 Holdstock, M. Constant observation key to avoiding dilemma of stuck ferments. *Aust. N.Z. Grapegrower Winemaker* (582): 66–67; 2012.

1467 Muhlack, R. Reduce vintage costs and improve process control with new ferment simulation tool. *Aust. N.Z. Grapegrower Winemaker* (582): 62–65; 2012.

1468 Bindon, K.A., Smith, P.A. Comparison of the affinity and selectivity of insoluble fibres and commercial proteins for wine proanthocyanidins. *Food Chem.* 136 (2): 917–928; 2013.

1469 Capone, D.L., Sefton, M.A., Jeffery, D.W. Analytical investigations of wine odorant 3-mercaptohexan-1- ol and its precursors. *Qian, M.C., Shellhammer, T.H. (eds.) Flavor Chemistry of Wine and Other Alcoholic Beverages 1104.* Qian, M.C., Shellhammer, T.H. (eds.) Washington, D.C.: American Chemical Society: 15–35; 2012.

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1478 Dry, P. Negro Amaro. *Wine Vitic. J.* 27 (4): p. 65; 2012.

1479 Krstic, M. Precision management technologies prove their value in selective harvesting in Australia's major production regions. *Wine Vitic. J.* 27 (4): 34–36; 2012.

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1481 Coulter, A. Malolactic fermentation issues explored. *Aust. N.Z. Grapegrower Winemaker* (584): 86; 2012.

1482 Essling, M. Strobilurin resistance to powdery mildew in a vineyard. *Aust. N.Z. Grapegrower Winemaker* (583): 46–46; 2012.

1483 Krstic, M. Smoke taint symposium unveils some exciting new developments. *Aust. N.Z. Grapegrower Winemaker* (583): 40–40; 2012.

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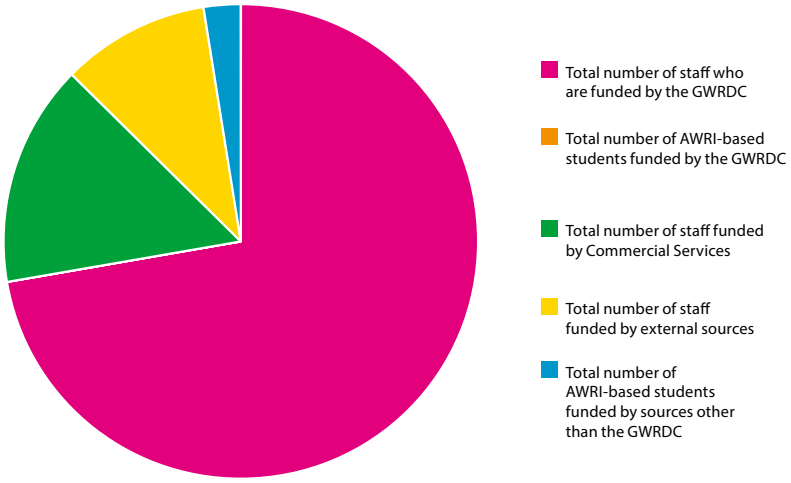


Figure 31. Funding of AWRI staff, excluding overseas students and visiting researchers

Staff of The Australian Wine Research Institute

Front row:

1 Rae Blair
2 Markus Herderich
3 Matt Holdstock
4 Chris Curtin
5 Chris Day
6 Vince O'Brien
7 Eric Wilkes
8 Jacqui McRae
9 Warren Roget
10 Ella Robinson
11 Creina Stockley
12 Christine Mayr
13 Patricia Williamson
14 Marlize Viviers
15 Josh Hixson
16 Dan Johnson
17 Con Simos

Second row:

18 Gayle Baldock
19 Shiralee Dodd
20 Annette Freeman
21 Tina Tran
22 Radka Kolouchova
23 Leigh Francis

Third row:

24 Kevin Pardon
25 Mark Solomon
26 Linda Bevin
27 Jeremy Hack
28 Yoji Hayasaka
29 Dimitra Capone
30 Mango Parker
31 Tracey Siebert

Fourth row:

32 Jane McCarthy
33 Wies Cynkar
34 Melissa Aitchison
35 Esther Kristianto
36 Toni Cordente
37 June Robinson
38 Stella Kassara

Fifth row:

39 Angus Forgan
40 Heather Donnell
41 Emma Kennedy
42 Robyn Gleeson
43 Francesca Blefari
44 Natoiya Lloyd
45 Tadro Abbott
46 Angela Contreras
47 Linda Halse
48 Simon Nordestgaard

Sixth row:

49 Jennifer O'Mahony
50 Sheridan Barter
51 Virginia Phillips
52 Jenny Bellon
53 Anne Lord
54 Fang Tang
55 Danna Li
56 Helen Holt

Seventh row:

57 Mark Smith
58 Cristian Varela
59 Simon Schmidt
60 Heather Tosen
61 Ella Thomson
62 Vilma Hysenaj
63 Sandy Davis
64 Wes Pearson
65 Peter Dry

Eighth row:

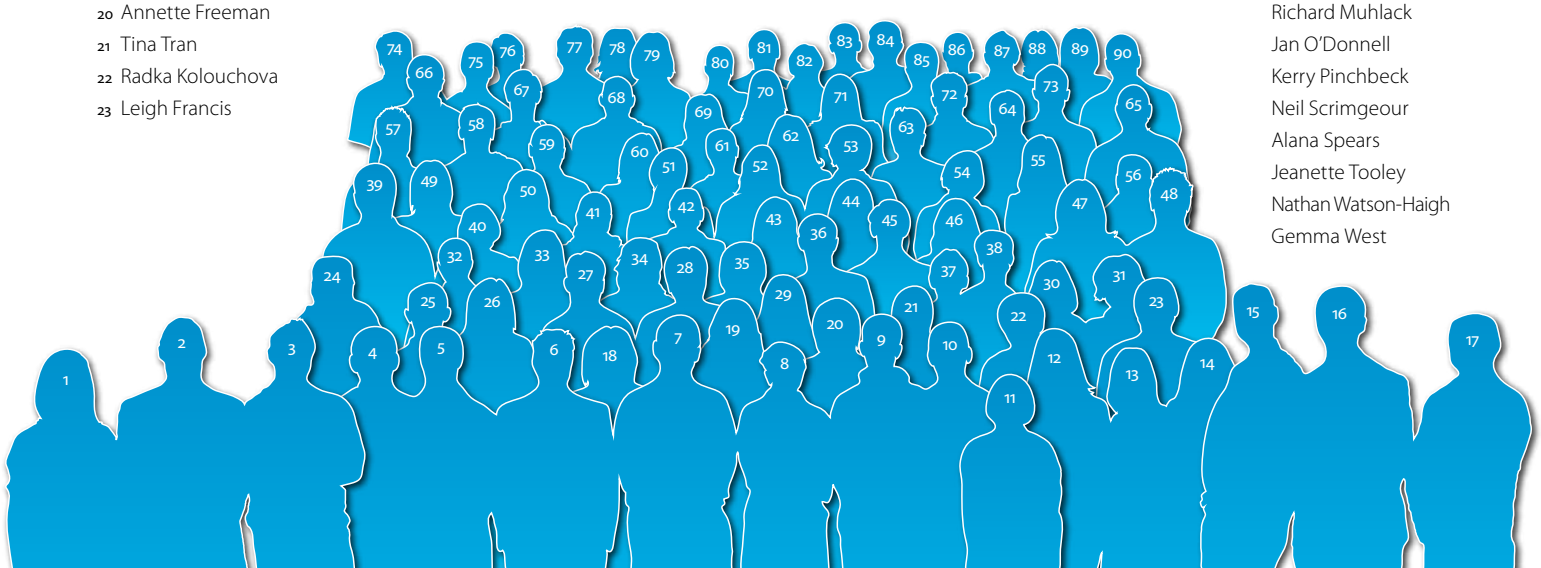
66 Bryan Newell
67 Michael Downie
68 Cory Black
69 Deborah Thornton-Wakeford
70 Pam Solomon
71 Leanne Hoxey
72 Matteo Marangon
73 Paul Smith

Last row:

74 Daniel Tynan
75 Peter Costello
76 Paul Witt
77 Eveline Bartowsky
78 Wade Hines
79 Kate Beames
80 Andrea Francis
81 Tim Reilly
82 Keren Bindon
83 Matthew Cream
84 Alex Schulkin
85 Marcel Essling
86 Randell Taylor
87 Richard Gawel
88 Adrian Coulter
89 Jelena Jovanovic
90 Michael Coode

Absent:

Caroline Abrahamse
Sam Anderson
Slavko Bekavac
Anthony Borneman
Catherine Borneman
Mark Braybrook
Paul Chambers
Samantha Connew
Geoff Cowey
Alfons Cuijvers
Bob Dambergs
Martin Day
Karl Forsyth
Peter Godden
Jody Hay
Paul Henschke
Adam Holland
Pauline Jorgensen
Mark Krstic
Dariusz Kutyna
Mardi Longbottom
Richard Muhlack
Jan O'Donnell
Kerry Pinchbeck
Neil Scrimgeour
Alana Spears
Jeanette Tooley
Nathan Watson-Haigh
Gemma West



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