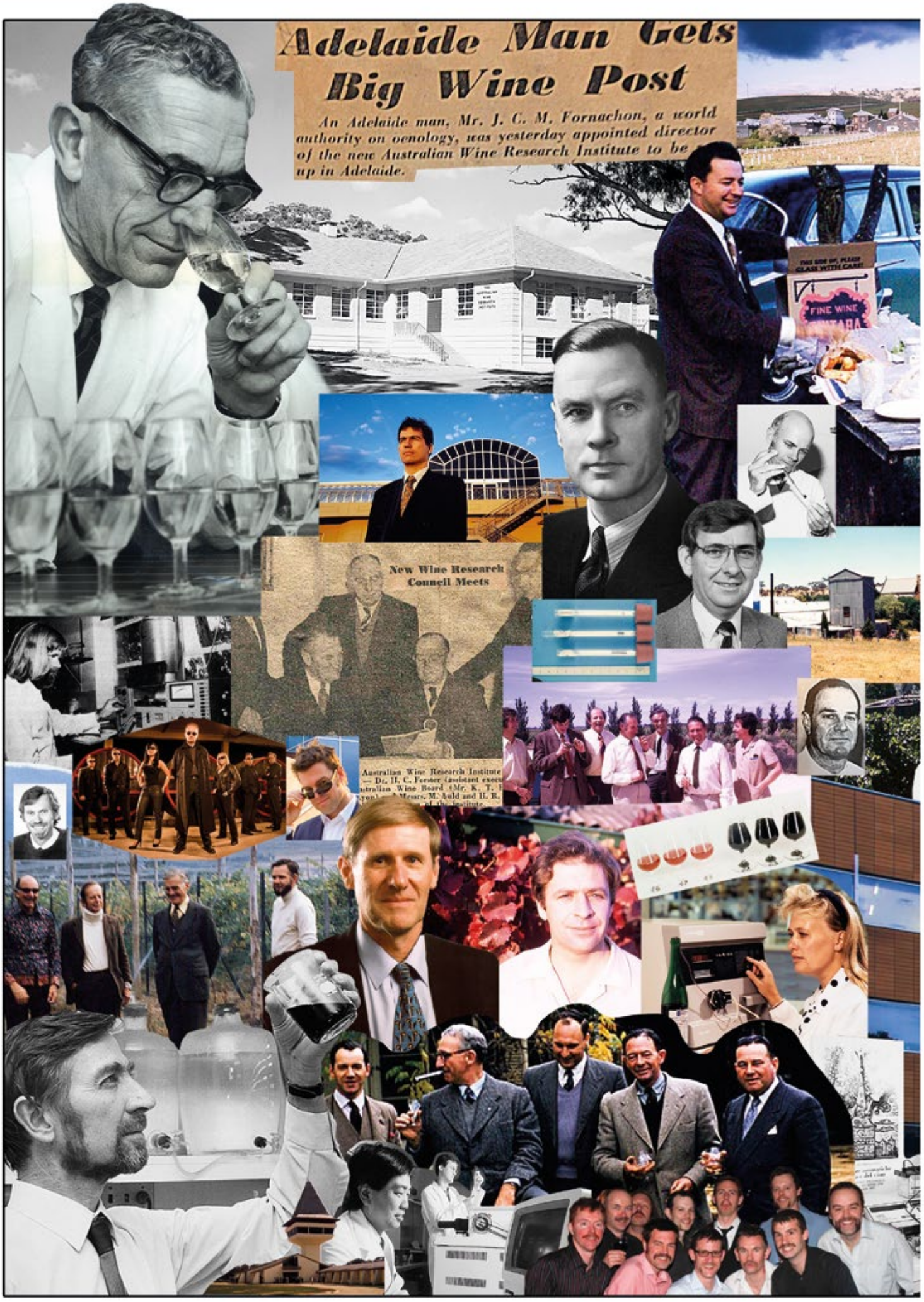
Annual Report 2015
The Australian Wine Research Institute

SUPPORTING AUSTRALIAN WINE FOR 60 YEARS


Adelaide Man Gets Big Wine Post
An Adelaide man, Mr. J. C. M. Fornachon, a world authority on oenology, was yesterday appointed director of the new Australian Wine Research Institute to be set up in Adelaide.
FINE WINE
New Wine Research Council Meets


AUSTRALIAN WINE
styles and tastes

Board members

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

Mr J.C. Angove, BSc
Elected a member under Clause 25.2(c) (until 31 December 2014)
(Levy payer elected Director)

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

Mr J.F. Brayne, BAppSc (Wine Science)
Elected a member under Clause 25.2(c) of the Constitution
(until 31 December 2014)
(Levy payer elected Director)

Mr P.D. Conroy, LLB (Hons), BCom
Elected a member under Clause 25.2(b) of the Constitution
(until 24 May 2015)
(Special Qualifications Director)

Dr J.S. Harvey, BSc (Hons), PhD, MBA, GAICD
Elected a member under Clause 25.2(c) of the Constitution
(until 31 December 2014)
(Levy payer elected Director)

Mr K.R. Horton, BAppSc (Wine Science)
Elected a member under Clause 25.2 (c) of the Constitution
(from 1 January 2015)
(Levy payer elected Director)

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

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

Dr S.C. McNab, BAgSc (Hons) PhD
Elected a member under Clause 25.2 (c) of the Constitution
(from 1 January 2015)
(Levy payer elected Director)

Ms M.J. Retallack, BAppSc (CPM), PGradDip (NRM), Bed Grad Dip (Viti), PCert(Arb), CPAg, GAICD, ARLF
Elected a member under Clause 25.2 (c) of the Constitution
(from 1 January 2015)
(Levy payer elected Director)

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

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

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

The company

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

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

Mission

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

Values

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

- Excellence
- Integrity
- Passion

Behaviours

The behaviours that support those values are:

Excellence

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

Integrity

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

Passion

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

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

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

Registered office

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60th anniversary cover image

The cover image for this 60th anniversary edition of the AWRI Annual Report brings to life the Erlenmeyer flask and wine glass that make up the AWRI logo. With the simple addition of a pair of safety glasses, the elements read as the number 60. This year's cover was designed by Reedcomm Creative Director Geoffrey Reed in collaboration with Art Director Phil Easson, with photography by Jacqui Way.

Contents

61st Annual Report – 30 June 2015
Presented to the Australian grape and wine sector

Chair's report

It's a pleasure to report on my first full year as Chair of the AWRI Board.

It's also a pleasure to do so in a year in which the AWRI celebrates 60 years of active service for the Australian grape and wine sector.

Formed at a time when our sector was much smaller and, in the main, producing a very different style of product, there is no doubt that the AWRI has been instrumental in the rise of Australian wine to its modern position. It has repaid the industry's vision, loyalty and investment many times over and, with a committed team in place and exciting breakthroughs coming in so many scientific disciplines, promises to do more of the same in the years ahead.

My thanks go to all who have contributed to the AWRI's service over the past 60 years. Particular thanks are due to those from within industry who have contributed their time, thoughts, intellect, grapes, wine, market insights and passion to work with the AWRI for the benefit of the Australian wine industry as a whole.

As our wine community devotes its efforts to seek a return to widespread profitability, we should never lose sight of the unique capacity in research, development and extension that has been built over the past 60 years. We must continue to work together to ensure that our future leaders have an even stronger capability to celebrate at the AWRI's 100th birthday in 2055.

To that end, the AWRI is grateful to have the continued support of the wine sector peak bodies, WFA and WGGA, as acknowledged in this extract from their joint Wine Sector Research, Development and Extension Policy:

The AWRI deserves special consideration as the industry focused research and development provider, and should be provided with sufficient funds to undertake core activities and to harness to the maximum extent the resources of all wine industry supporting organisations.

Similarly, Wine Australia is thanked for its support over the past 12 months. The opportunities for enhanced collaboration and efficiency gains presented by the bringing together of the former Wine Australia with the Grape and Wine Research and Development Corporation will take time to be fully realised, but the AWRI Board is encouraged by the positive engagement at the Board and CEO level and the early gains that have been made.

The AWRI has been fortunate to attract committed and talented Council/Board members over the years and the current era is no exception. During the past year we farewelled Mr Paul Conroy (appointed 2006), Mr Jim Brayne (appointed 2009), Mr John Angove (appointed 2010), and Dr John Harvey (appointed 2012). Sincere thanks go to these four gentlemen and to the full Board for their contributions. In their place the AWRI was pleased to welcome Ms Mary Retallack, Mr Kim Horton and Dr Stuart McNab. The process of conducting elections for these directorial appointments was made considerably easier by the introduction of an electronic ballot process, an outcome that was many years in the planning.

The year produced a number of important research and extension outcomes for industry, with interesting findings and exciting opportunities generated across the breadth of the AWRI's capabilities. I encourage you to read the report in detail to determine the innovation and adoption possibilities available to your business. The technical breakthroughs were accompanied by a series of administrative and operational outcomes designed to improve the AWRI's efficiency and service delivery and lower its cost base.

My thanks go to the dedicated AWRI staff, led by Managing Director Dr Dan Johnson, for their continued efforts to support the Australian grape and wine industry through world class research, practical solutions and knowledge transfer.

Louisa Rose
Chair

Managing Director's report

Implementation and execution

Following development of new strategic research and operational plans in 2013/2014, the past year has been devoted to implementation and execution.

The 2013-2018 AWRI Research, Development and Extension plan has now been in force for two years, and it is pleasing to report that activities have been conducted in 44 of the plan's 50 priority project areas. Within each active project progress is assessed against a number of objectives, deliverables and outputs; 88% of the targets in place for 2014/2015 were achieved, on track and/or ahead of schedule, an outstanding result given the inherently unpredictable and uncertain nature of research.

Similarly, the great majority of the projects in the AWRI's business and operational plan are either on track or completed.

These high level outcomes against the organisation's strategic plans reflect the hard work and commitment of the AWRI team and the many funders, supporters and collaborators, both in the research community and in industry, with which the AWRI interacts.

Wine Australia

The year saw the first operating year of the Australian Grape and Wine Authority, to be known as Wine Australia from 1 July 2015. Productive linkages have been forged between the AWRI and Wine Australia that befit the organisations' roles as peak RD&E body and peak RD&E investor, and I thank the Wine Australia Board and management for their efforts and continued support.

The AWRI turns 60

The 60th anniversary of the AWRI's establishment took place during the year. A celebratory wine education event was held for AWRI staff and a dinner was hosted for past and present AWRI Directors and Councillors. It was humbling to be able to celebrate this milestone with so many of the people whose service has contributed to the development of the Australian wine industry, including three previous Managing Directors and five former Chairs of the AWRI Board/Council. In addition, substantial effort was made towards publication of a set of scientific reviews covering subjects of relevance to grape and wine producers; publication is expected in late 2015. Finally, a commemorative Barossa Shiraz wine was made during the 2015 vintage that it is hoped will be in excellent shape to drink at the AWRI's 75th birthday in 2030!

The circumstances surrounding the AWRI's establishment 60 years ago offer an interesting basis for reflection. Combining first hand accounts and historical documents it is apparent that the genesis was the winding back of an Australian Government Export Bounty and the associated provision in 1947 of a £500,000 trust for the benefit of the Australian wine sector. The application of that trust, a substantial sum at the time, was the subject of much industry debate. Some two years after the trust was established, the wine sector sought the Australian Government's permission to use £300,000 for a series of market development initiatives; however the request was denied. A further two years later, in 1951, the sector successfully sought to invest the trust in the establishment and maintenance of its own research institute.

The AWRI was formally incorporated as a private company limited by guarantee on 27 April 1955. The Federal Act of Parliament enabling its creation was finalised on 31 May 1955, with all £500,000 being made available, of which £100,000 was approved for use on the original AWRI building.

The inaugural AWRI Chairman, Mr Michael Auld, had been a longtime advocate of the need for and value of research. Reporting on the AWRI's establishment, the South Australian newspapers quoted Mr Auld as saying:

"We aim to set up an institute comparable, in principle if not in size, with those of the wine industries of France, Spain, Portugal, Germany and California."

"The new research will take in viticulture – types of grapes to be grown, soil, treatment of vines and vine diseases – as well as the winemaking side."

Inspired by this vision, and the pioneering work of the AWRI's first Director, Dr John Fornachon, Australia has developed a significant global presence in grape and wine research, with the AWRI a key industry-owned asset at its core.

It is fascinating to contemplate the deep roots of our industry's desire for collective investments in both market development and research. In any case, the Australian wine sector would look very different now without the work of the AWRI over those 60 years. Some pictures and clippings from the early years of the AWRI's establishment are found elsewhere in this report.

Industry capability base

A high performance research capability takes a long time to build. The AWRI today stands on the shoulders of giants from the past 60 years and is mindful of preserving and cultivating that legacy, but also cannot stand still. While traditional capabilities such as analytical chemistry, microbiology, and engineering remain strong, new services and capabilities also became available during the year.

- The viticulture team reached critical mass and established important new projects and partnerships such as those with:
  - » Wine Grape Growers Australia to support the sector's biosecurity arrangements;

  - » the Winemakers Federation of Australia to manage the next phase of Entwine, the sector's national umbrella environmental assurance scheme; and
  - » SARDI to jointly appoint a Viticulture Scientist, Dr Paul Petrie.
- Advice was provided to a number of regions on consumer-orientated and luxury branding principles.
- New or renewed projects commenced in the areas of wine and health, lower ethanol wine production and wine authentication, three topics identified in last year's annual report as being priorities for attention in 2014/2015.
- Analytical services were offered for agricultural crops outside of the grape and wine sector, and new platforms were developed for analysis of metal ions in wine and identification of yeast species present in wild fermentations.
- Education platforms expanded to include a new one-day training course for wine judges that simulates the wine show judging environment.

Staff turnover in the past 12 months was low (2.6%) and average service term increased to 7.2 years, figures that highlight the value of a stable funding environment and positively reflect on the AWRI's workplace culture.

Technical trends

As with previous years the nature of the industry's technical support needs in the past year were reflected in the volume, timing and nature of enquiries answered by the AWRI helpdesk team. It was one of the earliest, if not the earliest, vintages on record for many wine regions in Australia. It was also a compressed vintage in many regions, which put pressure on vineyard and winery equipment and infrastructure.

As with every vintage, there were viticultural and weather-related challenges, but overall the warm and dry conditions that led to the early vintage contributed to excellent grape and wine quality across the majority of regions.

Throughout the year a total of 4,708 information requests, helpdesk enquiries and problem investigations were addressed, and the AWRI Commercial Services laboratories completed analyses on more than 22,000 samples. More than 1,900 enquiries and requests for assistance were addressed by the helpdesk, with greater than 80% answered within 24 hours.

The majority of the winemaking enquiries received were from wine companies and suppliers closely aligned with the wine industry, with the remaining queries made up from government organisations, students, legal personnel and journalists. A total of 204 queries turned into investigations where samples were requested and further analysis performed (on 1,152 samples) to identify the problem and how it could be remediated. Geographically, the source and proportion of the winemaking enquiries received were broadly aligned with the volume of wine-grape production of Australian states/territories.

Viticultural enquiries

During the year, the viticulture team responded to 487 viticulture-related enquiries. More than 20% of these were related to agrochemicals. The next three most common topics for queries were vineyard pests, general viticulture and sustainability. Other queries covered smoke taint, vineyard nutrition, weather and specific varieties.

Agrochemical queries varied across a range of themes such as managing residues in wine, appropriate withholding periods for certain markets, resistance management and specific options for pest problems. Fungal pests made up about two-thirds of the pest-related queries with most of the remainder being about insect issues. Trunk disease appears to be a growing problem as vineyards get older and this was reflected in queries from a range of regions on this topic. The number of queries about sustainability and weather monitoring has also grown in recent years.

Winemaking enquiries

The winemaking team responded to 1,265 enquiries in 2014/2015. The queries covered a range of subjects but the most common query topic was smoke taint, following the bushfires that occurred in South Australia, Western Australia and Victoria in January and February. Since a range of factors can influence the likelihood of a smoke event causing smoke taint in wine it is not an easy task to assess the level (if any) of damage to fruit following a fire event or to predict what will happen once the fruit is made into wine. Analytical data from testing volatile phenols and their non-volatile glycoside precursors give the best indication as to whether or not fruit has been exposed to smoke. Sensory and chemical analysis of small-scale ferments can assist in assessing the likely impact on final wines; however, this does take additional time to complete.

For vintage 2015 the majority of analytical results were found to be similar to, or only slightly higher than, levels that might be expected for non-smoke exposed vineyards. However, in the case of fruit destined for sparkling winemaking, even results slightly higher than background were cause for serious concern, given that the slightest hint of smoke characters can have a significant impact on the sensory profiles of sparkling base wines. Added to this, winemakers reported that they found it very difficult to conduct sensory assessments for smoke taint on small-scale ferments made from fairly unripe fruit destined for sparkling base. Consequently, although the risk of smoke taint development was considered to be low for many of the samples tested, smoke-exposed fruit destined for sparkling wines was the most at risk of being rejected.

Another topic the team encountered regularly was possible contaminations caused by burst hydraulic oil lines. It can be challenging to determine analytically whether or not a sample has been contaminated, as hydraulic oil is typically present in trace amounts. The AWRI has developed a method where the suspected hydraulic oil is first tested for a unique marker (typically an antioxidant), and if one can be identified, the potentially contaminated wine is tested for that marker (provided it is not naturally present in wine). Testing throughout this vintage and previous vintages has shown that not all hydraulic oils have unique markers, so not all cases of contamination can be identified analytically.

Other enquiries that prompted a moderate or high number of investigations included the identification of hazes and deposits, microbiological instabilities (>30% of which were related to 'Brett'), the determination of the nature and origin of sensory faults and other taints and contaminants, and the authentication of wine samples that were suspected to be the subject of substitution.

Regulatory enquiries

There were 150 regulatory-related enquiries during 2014/2015. One repeated request has concerned appropriate wine for vegetarians and vegans and information on vegetarian or vegan-friendly wine labelling.

Other regulatory queries related to: the concentration and potential toxicity of phthalates in wine as well as likely phthalate sources; the concentrations and sources of manganese and other elements in Australian wine; permitted additives and processing technologies; and ingredient and nutritional labelling.

Past and present Managing Directors of the AWRI: Sakkie Pretorius, Dan Johnson, Terry Lee, Peter Høj

Project highlights

Many of the AWRI's current research projects have been underway for two years and the results are beginning to flow. A complete list of highlights is published elsewhere in this report but some worth particular mention are listed below.

- Monoterpene glycosides were shown to contribute flavour through in-mouth release of monoterpenes. This was demonstrated in two sensory studies as well as laboratory experiments with saliva. The results highlight that flavour released in-mouth from glycosides can contribute to differences in perception of wine between individual consumers.

- Thiol compounds were shown to be much more important contributors to the flavour of Chardonnay wines than had been previously thought. Thiols are known for their contribution to 'tropical fruit' flavour, especially in Sauvignon Blanc wines. In a consumer sensory study of Chardonnay wines average consumer liking was strongly positively related to the intensity of 'passionfruit' aroma and fruit flavour and only a small minority of consumers preferred wines with low 'tropical fruit' attributes. Thiol precursors in grapes and thiol concentrations in wine can be significantly modified through harvesting and winemaking practices, giving winemakers practical tools to influence their desired style of Chardonnay.

- Investigations have shown that the compound isobutyl methoxypyrazine is the greatest contributor to 'green' flavour in Shiraz and Cabernet Sauvignon wines. Dimethyl sulfide can also be important, while other putative targets appear to be of lesser importance. While Shiraz is considered to be a variety that cannot biosynthesise methoxypyrazines, Shiraz stalks may contain this compound. Consumer liking data of Cabernet Sauvignon wines revealed that the attributes 'green stalks' or 'vegetal' were of lesser importance in driving consumer preference, while 'red berry' flavour and low astringency were appreciated by most consumers. Results suggest that controlling what is described as 'green tannin' may be more important than minimising 'green capsicum' or 'grassy' aroma attributes.

- Filtering Cabernet and Shiraz wines through cross-flow, lenticular and/or 0.65 µm and 0.45 µm membrane filters does not alter the concentration or composition of wine macromolecules (polysaccharides and tannins). This is an important finding for industry as it shows that filtration is unlikely to affect wine texture (although sensory results are still pending – expected mid next year). The changes between pre- and post-cross-flow filtration show that larger particles, most likely microorganisms, are removed during cross-flow but there are no measurable differences in macromolecules.

- Genome sequences and assemblies have been generated for more than 200 wine yeast strains. The strains studied include commercial strains and non-commercial isolates collected from numerous wineries in Australia and overseas since the 1940s, representing a rich source of diversity for strain development. To put these strains in context around 100 are being characterised for a broad range of properties that are important for successful wine fermentation.

- A weather station network was established across NSW, leading to implementation and dissemination of a fortnightly VineWatch bulletin to inform NSW growers.

- A total of 74 events were delivered across Australia by the extension and research teams, a record in terms of both the number of events and the number of participants. The breadth of content offered is considerable and reflects on the diversity of knowledge and information offered by the AWRI, from wine faults and flavours sessions, to seminars and workshops in various formats, symposiums and the Advanced Wine Assessment Course.

Financial performance

One particularly pleasing administrative result of the past year was satisfaction of the requirements for a charitable exemption from payroll taxes in South Australia. This outcome, the result of several years of work by a small team, permanently lowers the AWRI's cost structure allowing the organisation to deliver even greater value to industry for the same investment. The exemption ruling was accompanied by a reimbursement of some prior year payroll tax payments.

In addition the organisation had a strong financial result in many departments, in some cases the realisation of many years of hard work. The performance of AWRI Commercial Services is particularly notable. For the first time, the laboratories processed an average of over ninety samples each working day, which represents a 38% increase on the average throughput for the last three years. This increase has been achieved without increasing staff numbers in the laboratory and highlights the efficiencies that have been introduced over the past five years.

As a result of the strong performance, it is pleasing to note that the AWRI Board's target of an uncommitted reserve equivalent to six months of trading has been reached. In addition, two strategic reserves have been created within the AWRI's financial statements, one to assist in attracting research grants to the wine sector that would otherwise not be accessible and the other to support strategic investments in the AWRI's information technology infrastructure. Furthermore, a number of new or expanded research projects can be now be undertaken in the year ahead. These are very exciting developments for the industry as a whole.

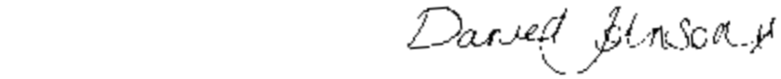
Looking ahead

Our industry continues to face extremely tough trading conditions. Although attention is periodically directed towards green shoots in some markets, a material change will take some time to be realised. Momentum is building for consolidation among producers and indeed industry representative bodies, and major reforms on topics like taxation are in advanced stages.

While addressing these broader industry trends there remains the need to look beyond the here and now. Time and again it has been demonstrated that the companies that perform best on the other side of a difficult trading period are those that invest in innovation during the difficult times. Our industry's collective investments in both market development and RD&E are essential pillars of the improved trading platform that the industry seeks. RD&E in particular is reliant on continuity – the capability itself and specific research projects cannot be turned on and off like a tap. Momentum is gained very slowly and lost quickly. Preserving our world class RD&E model is of paramount importance in the efforts to streamline our industry bodies and representative structures.

Internally, the year ahead will bring a continued focus on implementing active projects and commencing a small number of additional projects and partnerships. It will also bring the usual extensive planning work that accompanies an Australian Wine Industry Technical Conference, the next being scheduled for July 2016.

As always I am deeply indebted to the contributions of the AWRI Board under the leadership of Louisa Rose and to the tireless excellence, passion and integrity of the AWRI staff.



Dan Johnson
Managing Director

Past and present Chairs of the AWRI: Doug McWilliam, John Stocker, Robin Day, Louisa Rose, Philip Laffer, Peter Dawson

L to R: Mark Watson, Mary Retallack, Brian Schmidt, Dan Johnson, Louisa Rose (Chair), Brett McKinnon, Toby Bekkers, Liz Riley, Stuart McNab, Kim Horton

Board notes

Chair
Ms L.E. Rose

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

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

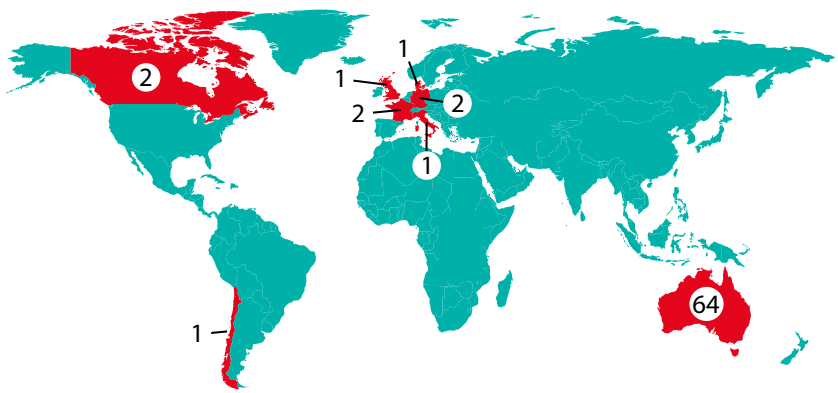
Meetings
Ordinary General Meeting
The 60th Ordinary (Annual) General Meeting was held on 2 December 2014.

Extraordinary General Meeting
An Extraordinary General Meeting was held on 18 August 2014.

Board
The Board of the AWRI met on the following dates: 16 September 2014, 2 December 2014, 24 February 2015 and 26 May 2015.

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

Appreciation
The activities at the AWRI benefit from collaborations from individuals and organisations from the following different countries: Australia, Canada, Denmark, France, Germany, Italy, Chile and the United Kingdom. The assistance and cooperation from partners across the globe are gratefully acknowledged.



Highlights of the year 2014/2015

General

60th birthday celebrated

The AWRI celebrated its 60th birthday on 27 April 2015. To mark the occasion a wine education event was held for all staff at the National Wine Centre and a dinner was hosted at the Mortlock Chamber of the State Library of SA for all past and present Directors and Councillors.

Commemorative wine made

As part of the AWRI's 60th birthday celebrations, a commemorative 2015 Barossa Shiraz wine has been made by Peter Godden. The fruit chosen was a blend of six sub-regions – Ebenezer, Greenock, Krondorf, Lyndoch, Marananga and Nuriootpa – in equal proportions, and all from old vines. The wine will be subject to regular comprehensive analysis over its development and a good proportion of it will be stored for consumption at the AWRI's 75th birthday.

Concessional tax status achieved

The AWRI has been granted a charitable exemption under payroll taxation legislation in South Australia, lowering its costs and allowing it to deliver even more value for its industry stakeholders in the future.

Biggest year yet for AWRI Commercial Services

For the first time, the Commercial Services laboratories processed over twenty thousand samples (22,491) in a year, an average of more than ninety samples per working day. This represents a 38% increase on the average throughput for the last three years and includes samples from 120 new customers. The increased performance has been achieved without increasing staff numbers in the laboratories and highlights the efficiencies that have been introduced over the past five years.

Expanded service offering

AWRI Commercial Services has introduced a range of new equipment and capabilities that will expand the services available to Australian grape and wine producers. A new inductively coupled plasma mass spectrometer (ICP-MS) has been commissioned that will greatly extend the range of metals that can be tested in-house. This technology has applications across research, wine production and export certification. A new metagenomics service allows winemakers to understand the microbial species present in their ferments. A new laboratory information system, currently under development, will allow customers to track the progress of their samples, access results as soon as they are available and provide much greater flexibility in ordering tests.

New Director election process

An electronic ballot process was used for the first time in October 2014 to elect Directors to the AWRI Board. This simplified the voting process for levy payers and greatly improved the efficiency of administering the election.

Environment and sustainability

Increased understanding of nitrous oxide emissions from Australian vineyards

Research measuring emissions of nitrous oxide (N_2O, a potent greenhouse gas) from Australian vineyards has confirmed that emissions are consistent with those measured in vineyards in California and are much lower than those from other horticultural crops. The overall results reflect the efficiency of water and nitrogen use in Australian winegrape production. Use of a native grass as a midrow cover crop has been shown to reduce N_2O emissions from a vineyard in McLaren Vale.

New workshops on greenhouse gas emissions management

Six workshops focusing on greenhouse gas emissions in the wine industry were delivered. Keynote speakers Professors Tim Flannery and Will Steffen from the Australian Climate Council led discussions of climate trends likely to affect the grape and wine industry. The workshops also presented the results of recent work investigating options for GHG mitigation in vineyards and wineries. Regionally tailored workshops will continue across Australia in 2015/2016.

Consumers, customers and markets

Expanded export assistance

Information on analytical requirements for export is now available for regional trading blocs such as the European Union as well as for 39 individual countries, and information on allowable additives and processing aids is now available for 18 individual countries.

Aspergillopepsin enzymes approved

The AWRI applied to Food Standards Australia New Zealand (FSANZ) to amend the Australia and New Zealand Food Standards Code to include the enzymes Aspergillopepsin 1 and 2, which can be used as alternatives to bentonite for protein stabilisation of wine. The application was successful, and the change was gazetted on 4 December 2014. That approval not only allows wines which have been protein stabilised using the enzymes to be sold throughout Australia and New Zealand, but was a necessary first step to gaining approval in other parts of the world. Wines treated with these enzymes can now also be exported to Argentina, Canada, Chile, Georgia, South Africa, the USA, the European Union and China.

Research on wine in society

Results from a study designed to analyse the price sensitivity of at-risk alcohol consumers in a representative sample of the Australian population suggested that wine consumption appears to be less influenced by the price of wine than by other factors such as health, family and friends.

Improving products and processes

Robotic technology used for MLF research

A robotic liquid handling system and miniaturised wine fermentations in 96-well microplates were used to screen a large number of AWRI malolactic bacteria strains under different conditions in red and white wines. The robot was able to prepare and inoculate multiple combinations of bacteria strain and wines, and then determine malic acid concentrations in thousands of samples over the course of the fermentation. From these trials several interesting candidate Australian *Oenococcus oeni* strains have been identified for further lab- and pilot-scale winemaking trials.

Importance of thiol compounds in Chardonnay discovered

Thiol compounds were shown to be much more important contributors to the flavour of Chardonnay wines than had been previously thought. Thiols are known for their contribution to 'tropical fruit' flavour, especially in Sauvignon Blanc wines. In a consumer sensory study of Chardonnay wines average consumer liking was strongly positively related to the intensity of 'passionfruit' aroma and fruit flavour and only a small minority of consumers preferred wines with low 'tropical fruit' attributes. Thiol precursors in grapes and thiol concentrations in wine can be significantly modified through harvesting and winemaking practices, giving winemakers practical tools to influence their desired style of Chardonnay.

Fate and formation of important volatile sulfur compounds

Key precursors to the volatile sulfur compounds H_2S, methanethiol (MeSH), ethanethiol (EtSH) and dimethyl sulfide (DMS) have been identified. The next stage of this project will compare the roles of yeast fermentation, metals and storage conditions on formation and degradation of undesirable sulfur aromas.

Efficient malolactic fermentation (MLF)

Benchmarking experiments established that nutrient additions can have a major positive impact on MLF efficiency, reducing the time to completion by up to five weeks. This is dependent, however, on the matrix of the wine, the bacteria used and the specific nutrient.

Peter Godden

Measuring oxygen in the winery

Five different sensors were evaluated for their ability to measure oxygen in must and wine. Results showed that the chemo-luminescence probes are suited to in-line dissolved oxygen (DO) measurements during must transfer or pump-over. 'Mini-DOT' sensors can be used to monitor DO inside a press or tank.

Practical tools to aerate ferments

Aeration of must is widely used to enhance fermentation performance, especially in red wine fermentations. A Venturi injector was trialled in a medium-sized winery and was shown to be very effective at high pump-over flow rates, giving up to 40% air saturation directly after the device. On a smaller scale, air-draw tubes gave constant and low DO pick-up, achieving 2-9% air saturation. Both approaches present viable alternatives to the classic method of aeration through 'cracking the fitting' which may cause pump cavitation and potentially burn out the pump rotor.

Consumer response to 'green' flavour in red wines

Investigations have shown that the compound isobutyl methoxypyrazine is the greatest contributor to 'green' flavour in Shiraz and Cabernet Sauvignon wines. Dimethyl sulfide can also be important, while C6 alcohols and aldehydes were shown to have less impact on 'green' flavours. While Shiraz is considered to be a variety that cannot biosynthesise methoxypyrazines, it is possible that Shiraz stalks may contain this compound. Consumer liking data of Cabernet Sauvignon wines revealed a minority of consumers (24%) appreciated wines with 'eucalypt'/'mint' flavour. The attributes 'green stalks' or 'vegetal' were less important in driving consumer preference, while 'red berry' flavour and low astringency were appreciated by most consumers. Results suggest that controlling what is described as 'green tannin' may be more important than minimising 'green capsicum' or 'grassy' aroma attributes.

In-mouth release of flavours confirmed

Sensory analysis showed that flavourless monoterpene glycosides can contribute to wine flavour through the release of flavoured monoterpenes in the mouth. The ability of glycosides in water to impart flavour was confirmed in a formal study using a panel of 39 assessors. Just under half the judges consistently perceived 'fruity'/'floral' flavour on tasting pure geraniol glucoside, and 64% of the judges could consistently perceive a 'smoky' flavour after tasting pure guaiacol glucoside. This highlights that flavour released in-mouth from glycosides could contribute to differences in perception of wine between individual consumers. An additional sensory study in model wine showed this flavour release to be relatively subtle at wine-like concentrations, although still significant for a subset of the panel.

Filtration does not affect macromolecules important for texture

Filtering Cabernet Sauvignon and Shiraz wines using cross-flow filtration, followed by lenticular filters and then 0.65 µm and 0.45 µm membrane filters did not alter the concentration or composition of wine macromolecules (polysaccharides and tannins). These results suggest that filtration is unlikely to affect wine texture. Sensory analysis of samples from the trial will be conducted in 2015/2016.

Understanding the genetic basis for fungicide resistance

Next generation sequencing has been applied to investigate the prevalence of genetic variants associated with fungicide resistance in powdery mildew. Initial results showed that the specific genetic variants that correlate with high levels of resistance were readily detected and quantified in the majority of the populations tested. The new sequencing method is a major step towards applying genetic tests to assess sensitivity of powdery mildew towards fungicides on a population basis.

Lowering alcohol without losing tannin

One of the ways of reducing alcohol in wine is to harvest grapes earlier but this can lead to less texture and colour in the wine. A way around that may be to add enzymes. Through use of enzymes, a lower alcohol Shiraz wine was produced from earlier harvested grapes that had the same tannin concentration as a wine made from later harvested grapes. The sensory impacts are still to be investigated to confirm that the texture is similar to wine made from later harvested grapes.

Genomics of wine yeasts

Genome sequences and assemblies have been generated for more than 200 strains of wine yeast. The strains studied include commercial strains and non-commercial isolates collected from numerous wineries in Australia and overseas since the 1940s, representing a rich source of diversity for strain development. Around 100 of these strains are being characterised for a broad range of properties that are important for successful wine fermentation.

Extension and adoption

Wide range of events delivered

AWRI staff were involved in organising 74 events during 2014/2015. These included roadshow seminars and workshops, greenhouse gas mitigation workshops, tailored sensory training, field days and the Advanced Wine Assessment Course.

Helpdesk queries answered

Helpdesk team members responded to 1,902 technical queries on a range of winemaking, viticulture and regulatory topics, with more than 80% answered within 24 hours. Weather-related issues and smoke taint were the most common query topics during vintage 2015.

Winemaking investigations

A total of 1,152 individual samples were submitted and analysed as part of 204 investigations carried out during the year. A high proportion of the investigations were related to taints and contaminations, followed by investigations of sensory issues and hazes and deposits in wine.

Improvements to the 'Dog book'

Now in its 23rd year of production, the publication *Agrochemicals registered for use in Australian viticulture* ('Dog book') continues to underpin best practice in agrochemicals usage and to facilitate the export of Australian wine. The design of the 'Dog book' was changed in 2014/2015 to more easily distinguish the recommendations section from the registered products section. Efforts were also made to highlight to growers the importance of recognising the correct growth stage and following label directions accurately.

Skills development for NSW

The NSW Department of Primary Industries (NSW DPI) commissioned the AWRI to design, coordinate and deliver a Skills Development Program to the NSW wine-grape industry during 2014/2015. Activities included installation of a new weather station network, dissemination of a fortnightly viticultural bulletin, delivery of a series of workshops and conduct of industry surveys and field trials.

Victorian node renewed

The AWRI Victorian node will continue for a further three years to deliver extension services to grapegrowers and winemakers across Victoria. In 2014/2015 the key outcomes for the Victorian node included the delivery of 18 extension events.

eBooks launched
The library launched a collection of eBooks for Australian levy payers. The new eBook platform allows users to download eBooks to their computers or mobile devices. The collection currently contains 46 eBooks covering winemaking, grape and wine biochemistry, wine chemistry, viticulture, wine economics and wine marketing.

Library information requests increased by 36%
Requests for information from the John Fornachon Memorial Library increased by 36% to a total of 1,812 requests. Over 2,600 articles were supplied in response to these requests.

Webinars delivered
The AWRI's fourth webinar series was held during the year, featuring 22 webinars with more than 342 attendees. Approximately half of the webinars were delivered by AWRI staff and half by invited researchers and industry experts.

Face-to-face interactions
Throughout the year AWRI staff gave 326 external presentations, coordinated 74 events, conducted 69 media interviews, authored 5 posters, presented 31 lectures to university students and supervised or co-supervised 10 students.

Industry-focused publications
Six AWRI reports and six columns on alternative varieties were published in the *Wine and Viticulture Journal*. Twelve 'Ask the AWRI' columns covering topical issues from the AWRI helpdesk were published in the *Australian & New Zealand Grapegrower & Winemaker*. New technical literature published from around the world was abstracted in six issues of *Technical Review*. Grapegrowers and winemakers were alerted to topical issues in 16 *eBulletins* issued through the year. Updates of AWRI activities were provided in six issues of *eNews*, emailed directly to producers.

Social media engagement continued
The AWRI's presence on Twitter grew by more than 450 during the year to 2,819.

Service capabilities and foundational datasets

Record vintage for WIC Winemaking
A total of 420 ferments were completed during vintage 2015, more than double the number processed in the previous year.

New methods to study wine protein
Nanoparticle tracking analysis (NTA) and dynamic light scattering (DLS) techniques have been used to study the impact of matrix components (ionic strength, phenolic compounds, polysaccharides and sulfate) on the stability of white wine proteins.

Consumer recruitment system improved
An improved registration and electronic consumer recruitment procedure was developed by the sensory team, so that a greatly increased number of qualified consumers are now on the AWRI database. The system has been used to recruit more than 350 consumers for three major studies.

Metabolomics capabilities continue to expand
During 2014/2015, new HPLC-MS methods were developed that allow the detection of sulfur compounds and their precursors in wine and the identification and quantification of corynetoxins in grains. The facility received record revenue during the year.

Culture collection services for researchers and industry
The AWRI wine microorganism culture collection (AWMCC) received 427 yeast and bacterial strains from researchers and wineries, all of which were checked for purity, had their identity determined and were prepared for cryogenic storage. In addition, 55 uncharacterised microbial strains currently in the collection were identified. During the year the AWMCC distributed more than 700 microbial strains to researchers and industry.

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

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Extract by Staff, Adelaide Advertiser, Adelaide man gets big wine post, 15 October 1955. This work has been licensed by CAL. Except as permitted by the Copyright Act, you must not re-use this work without the permission of the copyright owner or CAL.

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Staff

The number of AWRI staff employed in a full-time, part-time and casual capacity as at 30 June 2015 was 116 (92.12 full-time equivalents). When the number of AWRI-based students (both from Australia and overseas) and visiting researchers is added, the total increases to 120. Approximately 72% of AWRI staff were funded by Wine Australia in 2014/2015.

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

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

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

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

Kate Beames, AWITC Conference Manager

Corporate Services

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

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

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

Alfons Cuijvers, MLaw *UniAntwerp*, Human Resources Coordinator

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

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

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

Deborah Thornton-Wakeford, Receptionist

Jennifer O'Mahony, Receptionist

Research

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Amanda Agius, BAppSc *UniSA*, Technical Officer (concluded 30 June 2015)

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

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

Simon Dillon, BSc (Hons) *Flinders*, Technical Officer (started 15 September 2014)

Radka Kolouchova, AssDip *Tech-CollFoodTech*, Technical Officer

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

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

Joanna Verwey, Dip (Lab Tech) *TAFE*, Technical Officer (started 26 February 2015)

Jelena Jovanovic, Project Officer

June Robinson, Laboratory Assistant

South Australian Metabolomics Facility

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

Jeremy Hack, Bioinformatician

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

Vilma Hysenaj, BSc, Master (Pharm Chem), PhD (Food Chem) *UniGenova*, Post Doctoral Research Scientist (started 3 November 2014)

Casual Sensory Panel

Peter Baldwinson, Brian Beggs, Penelope Elliot, Philippa Hall, Sonya Henderson, Brad Hocking, Gurinder Khera, Lynette Lee, Mary Likos, Catherine Milne, Ralph Osborne, Vivianne Rees, Sue Robinson, Loretta Royal, Heather Smith

Industry Development and Support

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

Peter Dry, BAgSc, MAgSc, PhD *UniAdel*, Emeritus Fellow (since 30 September 2014)

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

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

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

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

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

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

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

Michael Coode, BAppSc (Wine Sci) *CSU/DeakinU*, MWineBus *UniAdel,* Winemaker (concluded 1 May 2015)

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

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

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

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

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

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

Virginia Phillips, Project Coordinator

Industry Engagement and Application

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

Commercial Services

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

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

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

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

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

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

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

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

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

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

Heather Tosen, BSc *UniAdel*, Scientist

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

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

Daniel Tynan, DipAppSc (Chem Tech) *UniSA*, Laboratory Technician (concluded 30 June 2015)

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

Elyce Batchelor, DipFoodTechnol, Cert II Food Processing *TAFE*, Laboratory Technician (started 18 February 2015)

Erin Kearsley, BTech *Flinders*, Laboratory Technician

Oliver Lovat, BTech (Foren and Analyt Chem) *Flinders,* Laboratory Technician

Candice Newton, Cert II Sampling and Measuring, Cert III Lab Operations, Cert IV OHS *TAFE SA*, Laboratory Technician (started 14 July 2014)

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

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

Marco Schoeman, BSc (Biotechnol) *UniAdel*, Laboratory Technician (started 1 June 2015)

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

Robyn Gleeson, Customer Service Officer

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

Students

Yevgenia Grebneva, *TechUniDresden, Germany,* occupational trainee (20/4/15-30/10/15)

Lisa Hartmann, *UniAdel,* Honours student

Sabrina Reschke, *UniBonn, Germany*, occupational trainee (7/10/14-15/6/15)

Florian Sengler, *Geisenheim, Germany*, undergraduate student (6/5/14-30/9/14)

Jing Wu, *UniBordeaux, France*, PhD student (1/5/15-2/6/15)

Ryan Zeppel, *UniAdel,* PhD student

Nora Zibi, *UniErlangen-Nurnberg, Germany*, occupational trainee (3/11/14-15/6/15)

Visiting Researchers

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

Ulrich Fischer, *Dienstleistungszentrum Ländlicher Raum (DLR), Neustadt, Germany* (13/5/13-31/8/14)

Staff activities

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

Eveline Bartowsky serves on the Joint Editorial Board of the *Journal of Applied Microbiology* and *Letters in Applied Microbiology*. She is an Associate Editor of the *American Journal of Enology and Viticulture* and the *Australian Journal of Grape and Wine Research* and an editor of *Annals of Microbiology*. She also serves on the Editorial Review Board of the *Journal International des Sciences de la Vigne et du Vin*, *Acetic Acid Bacteria*, and *Frontiers in MicroBioTechnology* journals. Eveline is an Affiliate Lecturer, University of Adelaide; a member of the Australian Wine Industry Technical Conference Planning Committee; and served as a member of the program committee for Crush 2014 – the grape and wine science symposium.

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.ayeast-group.org/). He is a member of the Editorial Board of *Microbial Cell*. Paul is also Chair of the organising committee for the Yeast: Products and Discovery conference to be held in Adelaide in December 2015 and is a member of the organising committee for Bioflavour 2015, International Conference on Flavour and Fragrance Biotechnology to be held in Frankfurt, Germany in September 2015.

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

Chris Day is a Director and Treasurer of the Australian Wine Industry Technical Conference.

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

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

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

Richard Gawel served as a member of the Industry Advisory Group of Horticulture Australia Ltd.

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

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

Paul Henschke is an Associate Editor of the *Australian Journal of Grape and Wine Research* and is a member of the Editorial Review Boards of *Food Microbiology* and *Mitteilungen Klosterneuburg*. He is an Affiliate Professor of the University of Adelaide and Fellow of the Australian Society for Viticulture and Oenology. He is member of the local organising committee of the Yeast: Products and Discovery conference to be held in Adelaide in December 2015.

Markus Herderich is a Director of the Australian Wine Industry Technical Conference; member of the Metabolomics Australia Executive Management Group; and member of the Wine Innovation Cluster Research Group. He is also an Affiliate Associate Professor, University of Adelaide; a member of the Policy Advisory Board of the *Journal of Agricultural and Food Chemistry;* a member of the Winemakers' Federation of Australia Wine Industry Technical Advisory Committee; a delegate and expert for the Organisation International de la Vigne et du Vin; and a co-organiser of the symposium *Advances in functional food and flavor chemistry* at PacifiChem2015.

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

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

Mark Krstic is a member of the National Wine Innovation and Extension Network; member of the National Wine Research Network; Associate Editor of *Wine and Viticulture Journal*; Honorary Senior Fellow at the University of Melbourne; Coordinator of the Victorian Viticultural Association; member of the Australian Wine Industry Technical Conference Planning Committee; and member of the Standards Australia Committee for the Australian Standard for Grapevine Propagation.

Natoiya Lloyd is a member of the program committee for Crush 2015 – the grape and wine science symposium to be held in Adelaide in November 2015.

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

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

Vince O'Brien is a member of the Winery Engineering Association Conference Planning Committee; the Winemakers' Federation of Australia Wine Industry Packaging Committee; CSIRO's Adaptive Value Chains Project Advisory Group; and Primary Industries and Regions SA's functional and luxury value chains advisory group.

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

Paul Petrie is an Affiliate Senior Lecturer at the University of Adelaide; a Board member of the Australian Society of Viticulture and Oenology; chair of the *Australian Journal of Grape and Wine Research* Advisory Committee; a member of the Australian Wine Industry Technical Conference Planning Committee; chair of the program committee for Crush 2015 – grape and wine science symposium; and a member of the Charles Sturt University wine industry course advisory committee.

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

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

Creina Stockley is an Affiliate Senior Lecturer, University of Adelaide and the Coordinator of the Wine Science course *Grape Industry Practice, Policy and Communication* for the School of Agriculture, Food and Wine. She is a member of the Winemakers' Federation of Australia Wine Industry Technical Advisory Committee and Wine and Health Working Group. She is a delegate and expert for the Organisation International de la Vigne et du Vin and served as the President of Commission IV Safety and Health and a member of the Steering Committee. She is also a member of the editorial board of the *International Journal of Wine Research, International Journal of Food and Fermentation Technology* and the *Austin Journal of Cardiovascular Disease and Atherosclerosis,* as well as a charter member of the International Scientific Forum on Alcohol Research, a member of the Advisory Board of the International Surveillance System on Mediterranean Diet (Spain), a member of the Scientific Board of the (European) Wine Information Council and a member of the European Food Safety Authority Expert Database. Creina is also a member of the Scientific Committee for the WineHealth 2015 International Wine and Health Conference.

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

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

	Project		Status at 30 June 2015
Theme 1: Environment and sustainability			
1.1	Reduce inputs and environmental footprint across the value chain	1.1.1 Improving winery energy efficiency	Active
		1.1.2 Capitalising on the carbon economy	Active
		1.1.3 Improving the environmental and economic performance of the Australian wine supply chain	Active
		1.1.4 Assisting industry to adopt renewable energy technologies	Inactive
1.2	Capture the full value of clonal resources for key Australian varieties	1.2.1 Assessing diversity and clonal variation of Australia's grapevine germplasm	Active
1.3	Reduce the economic and environmental impact of pests and diseases and the techniques used to manage them	1.3.1 Understanding genetic variation in grapevine diseases and the genetic basis for pesticide resistance	Active
		1.3.2 Improving the consistency of description and measurement of disease	Active
		1.3.3 Regional benchmarking of viticultural spraying practices	Inactive
Theme 2: Consumers, customers and markets			
2.1	Identify and secure new market opportunities through consumer insights	2.1.1 Identifying and securing new market opportunities through consumer insights	Active
		2.1.2 Genetics of odour perception and wine preferences	Inactive
2.2	Build and safeguard brand Australia	2.2.1 Collecting and disseminating information regarding agrochemicals registered for use and maximum residue limits in Australian viticulture	Active
		2.2.2 Origin verification and detection of counterfeit Australian wines	Active
		2.2.3 Informing wine consumers through understanding issues of wine consumption, health and nutrition	Active
		2.2.4 Increasing Australia's influence in market access, safety, regulatory and technical trade issues	Active
2.3	Improve market access through anticipation and removal of trade barriers and regulatory constraints	2.3.1 Emergency response capability	On hold
Theme 3: Improving products and processes			
3.1	Objective measurement and target setting of grape and wine style	3.1.1 Identification and origin of volatile compounds responsible for important sensory attributes	Active
		3.1.2 Assessment of relationships between grape chemical composition and grape allocation grade	Active
		3.1.3 Flavour precursors: contribution to wine aroma, in-mouth sensory properties and flavour release	Active
		3.1.4 Factors affecting wine texture, taste, clarity, stability and production efficiency	Active

	Project	Status at 30 June 2015
3.2 Optimise primary and secondary fermentation for effective production of targeted wine style	3.2.1 Are there regional micro-organisms, and can they be harnessed to produce regionally distinct wine styles?	Active
	3.2.2 Enhanced winemaking outcomes and wine style diversification through provision of fit-for-purpose yeast starter cultures	Active
	3.2.3 Defining the nutritional drivers of yeast performance and matching yeast to must	Active
	3.2.4 Efficient and reliable malolactic fermentation to achieve specification wine style	Active
	3.2.5 Safeguarding and realising the potential of the Australian wine microbial germplasm collection	Active
3.3 Novel products and effective processes	3.3.1 Technologies and strategies for the production of lower alcohol wine	Active
	3.3.2 Influencing wine style through management of oxygen during winemaking	Active
	3.3.3 Capturing and re-using aroma compounds entrained in fermentation gases	Inactive
	3.3.4 Developing simplified sparkling winemaking processes which reduce production costs while replicating the flavour and textural properties of wines produced using traditional methods	Inactive
	3.3.5 Development and application of process analytical technologies for effective winemaking process control	Active
	3.3.6 Producing less processed, allergen-label-free, wines	Inactive
3.4 Reduce cost of production	3.4.1 Novel products utilising existing winery capital equipment, surplus grapes and winery waste	Active
	3.4.2 Reducing wine movements during production	Active
	3.4.3 Evaluating alternatives to barrel maturation	Active
	3.4.4 Identifying cost reduction opportunities by mapping the grape and wine value stream	Active
3.5 Reduce the economic impact of taints and faults	3.5.1 Fault and taint remediation strategies and technologies	Inactive
	3.5.2 Ensuring the continued efficacy of *Brettanomyces* control strategies for avoidance of spoilage	Active
	3.5.3 Formation and fate of positive and negative sulfur compounds	Active
3.6 Deliver sound product to the marketplace	3.6.1 Maximising quality during bulk wine transport	Active
Theme 4: Extension and adoption		
4.1 Drive productivity, sustainability and profitability through facilitating rapid adoption of R&D outcomes	4.1.1 The staging and conduct of extension programs	Active
	4.1.2 Specialised technical troubleshooting and responsive helpdesk services for the Australian wine sector	Active
	4.1.3 Library service	Active
	4.1.4 Communication with stakeholders	Active
	4.1.5 Development of web and mobile-based extension tools	Active
4.2 Align supply chains with industry needs	4.2.1 Evaluating and enabling adoption of new technologies	Active
4.3 Enhance national outreach and promote regional engagement	4.3.1 Tailored regional research, development, adoption and extension through regional nodes	Active
4.4 Improve intellectual capital available to the Australian wine industry	4.4.1 Contributing to undergraduate and postgraduate education programs of relevance to the Australian wine industry	Active
Theme 5: Service capabilities and foundational datasets		
5.1 Service capabilities and foundational datasets	5.1.1 Enhancing data capture and integration for re-use and data mining	Active
	5.1.2 Chemistry, sensory, chemometrics and development capacity	Active
	5.1.3 Efficient management and administration	Active
	5.1.4 International scientific exchange program	Active

PROGRESS REPORTS

John Fornachon, the first director of the Australian Wine Research Institute, judges an entry in the wine section of the Sydney Royal Easter Show at the Showground in 1958
(Photo: Fairfax Syndication)

Environment and sustainability

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

Reduce inputs and environmental footprint across the value chain

Staff

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

Collaborators

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

Capitalising on the carbon economy – Greenhouse gas abatement in viticulture

Background

Nitrous oxide (N_2O) is a potent greenhouse gas (GHG) with a 100-year global warming potential 298 times that of carbon dioxide. N_2O emissions from agricultural soils, especially those that receive nitrogen fertiliser, contribute significantly to the total pool of atmospheric GHGs. The purpose of this project was to establish baseline levels of N_2O emissions from vineyards in a range of Australian wine regions and to assess the potential of different cover crops to mitigate N_2O emissions and increase carbon sequestration in soil. In addition to field experiments, the project included presentations and workshops designed to raise the awareness of GHG mitigation strategies among grape and wine producers. This project was funded by the Department of Agriculture (DA) as part of the 'Action on the Ground' program.

Vineyard trials

Five on-farm trial sites, in the Hunter Valley, Margaret River, Murray Darling, Eden Valley and McLaren Vale regions, were established in 2012 to evaluate regional differences in N_2O emissions from vineyards. N_2O emissions from the Australian vineyards studied ranged between median values of 0.6 and 9 g N_2O expressed as N per hectare per day. These values are low compared to the typical values from other crops, such as dairy pasture (22 g N_2O-N/ha/day) or broccoli (72 g N_2O-N/ha/day), and reflect the efficiency of water and nitrogen use in Australian wine-grape production.

There is limited scope to make significant reductions in the already low levels of N_2O emissions from vineyards. However, there may be an opportunity to reduce the total GHG emissions using alternative cover crop species or, in vineyards which use high volumes of organic nitrogen, by changing management practices.

Experiments at McLaren Vale compared the use of native Wallaby grass (*Austrodanthonia*) grown in the vineyard midrow with rye grass. N_2O emissions during the growing season (spring and summer) were found to be significantly lower from the Wallaby grass midrow cover crop than the rye grass in the same vineyard. Furthermore, the low growth habit of the Wallaby grass meant that there was less requirement for slashing compared to the rye grass. This presented a further opportunity to reduce GHG emissions by using fewer tractor passes per season.

At Margaret River, N_2O emissions were measured from a vineyard before and after the application of compost. The peak N_2O emission (800 g N_2O-N/ha/day) measured from the compost two days after application was significantly higher than any other N_2O measurement from that vineyard. This represented both a significant contribution of GHGs to the atmosphere and an opportunity to more efficiently use the nitrogen being applied to the vines in the form of compost.

The measurement phase of the project is now complete. Results have been presented at a range of extension events across Australia and continue to be extended as part of the Extension and Outreach project outlined below.

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

Background

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

Extension delivery

Six face-to-face workshops have been held across Australia. The first three of these were aimed at key influencers in the wine industry who can act as extension multipliers in their regions. Special guests including Professors Tim Flannery and Will Steffen from the Australian Climate Council presented at these workshops. The 'key influencer' workshops are now being followed by a series of 34 regional workshops which cover the practical application of research outcomes, up-to-date information about the ERF and the new Australian Wine Carbon Calculator and benchmarking tool, a critical new addition to Entwine Australia. Three regional workshops were held during 2014/2015, with the remainder to be delivered in 2015/2016. The project webpage has been updated with links, fact sheets, videos and presentations related to GHG emissions in viticulture and winemaking – making the page the 'go-to' source for information on GHGs and the grape and wine industry.

Capture the full value of clonal resources for key Australian varieties

Staff

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

Collaborators

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

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

Background

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

Understanding genetic variation in Chardonnay

As described in a previous report, a reference sequence is being created from one of the 15 Chardonnay clones sourced for this project. Work on the assembly of this reference sequence continued during the year. Once completed, sequence data for 14 other Chardonnay clones will be mapped onto this reference genome. This will allow the identification of bases, insertions and deletions that differ among different clones. While the reference Chardonnay genome is being completed, the genome of Pinot Noir (one of Chardonnay's parents) has been used as a reference.

Understanding of the genetic differences among clones will be combined with knowledge about their different behaviour in the vineyard and winery. This will include both chemical and sensory data from a winemaking trial of ten different Chardonnay clones, completed in an earlier phase of this project.

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

Staff

Dr Anthony Borneman, Dr Markus Herderich.

Collaborators

SARDI (Dr Barbara Hall, Dr Suzanne McKay).

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

Background

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

Mapping resistance alleles in grapevine powdery mildew

Next generation sequencing has been applied to investigate the prevalence of genetic variants associated with fungicide resistance in powdery mildew from four hundred individual population samples across four vineyards (two vineyards sampled in 2013/2014 and two vineyards sampled in 2014/2015). Initial results show that the specific genetic variants at the cyp51 locus that correlate with high levels of azole resistance were readily detected and quantified in the majority of the populations tested. Azoles are a group of fungicides commonly used to control powdery mildew in vineyards. Further work is now needed to associate the prevalence of these genetic markers with the potential for loss of field efficacy.

Mardi Longbottom

Consumers, customers and markets

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

Build and safeguard brand Australia

Staff

Dr Anthony Borneman, Dr Martin Day, Marcel Essling, Dr Markus Herderich, Dr Mardi Longbottom, Anne Lord, Dr Creina Stockley, Dr Tina Tran, Dr Eric Wilkes.

Collaborators

Department of Agriculture (John Power, Gary Fan); CropLife Australia (Osman Mewett); Department of Colorectal Medicine and Genetics at The Royal Melbourne Hospital (Prof. Finlay Macrae); Nufarm Australia Ltd (Ben Coombe); University of Adelaide (Prof. Anne Taylor); Wine Australia (Andreas Clark, Steve Guy); Wine Grape Growers Australia (Lawrie Stanford); Winemakers' Federation of Australia (Paul Evans, Tony Battaglene, Peter Gniel, Melissa Cheesman-Faull).

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

Background

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

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

Up-to-date information

The project team reviewed 197 Sanitary and Phytosanitary notifications from the World Trade Organization and 27 gazettes issued by the Australian Pesticides and Veterinary Medicines Authority (APVMA).The outcomes of these reviews included changes to MRLs applicable to numerous markets including Brazil, Canada, the European Union and the United States. The APVMA gazettes highlighted issues such as the cancellation of the herbicide diuron and the future registration of fluopyram for *Botrytis* and powdery mildew. The changing status of diuron had been forecast and the impact on the grape sector was minimal due to the phasing out of the chemical from the 'Dog book' the previous season.

Each year, post-harvest, the project team reviews the latest information on agrochemicals by liaising with regulators, chemical manufacturers, suppliers and end-users. Best practice recommendations are then incorporated into a new version of the 'Dog book'. In total, 10,000 copies of the 2015/2016 'Dog book' were produced and distributed by direct mail to all levy payers, via regional association networks, AWRI roadshow events, chemical retailers and an insert in the *Australian & New Zealand Grapegrower & Winemaker*. Further updates were made to the online search portal and the smart phone agrochemical app and an electronic version of the publication was made available through the AWRI website. The 'Dog book' was expanded to include information on active constituents and new products. One significant change was the inclusion of a product containing fluazinam for the control of the trunk disease Eutypa (caused by the fungus *Eutypa lata)*. The design of the booklet was also changed to distinguish the recommended products section from the registered products section by printing the latter in black and white. A push was also made to highlight to growers the importance of recognising the correct growth stage and following label directions accurately. Two *eBulletins* were also issued to provide timely information on agrochemical issues and alerts.

Pamela Solomon


Oliver Lovat and Tim Reilly

Improving grape sector practices and spray options

The project team consulted with APVMA and Wine Australia on spray drift reduction strategies that will be suitable for the viticulture sector. Early adoption of technologies that reduce drift will prepare the grape and wine industry for a future where spray application buffer zones could potentially reduce agrochemical options in the vineyard. The AWRI is also continuing to support the establishment of a maximum residue limit (MRL) for phosphorous acid (phos acid) in key export markets.

Origin verification and detection of counterfeit Australian wines

Background

Wine is periodically the subject of substitution or counterfeiting. While some cases can be easily detected, such as those involving spelling errors on labels, other cases suggest that an increasingly sophisticated approach to addressing counterfeiting is required. Efforts to establish the authenticity of wine samples have been underway for many years, particularly in Europe, with mixed success. This project aims to protect brand Australia and individual producer brands by: developing a robust way to quickly ascertain the provenance of an unknown wine sample (using inherent product compositional attributes such as ratios of metal isotopes and elemental content); building an elemental database (and/or validating existing databases) of wines of known origin (both Australian and international); and validating the use of rapid spectral techniques to compare counterfeited wines against a known reference wine.

Setting the baseline

To be able to assess the capability of different techniques to distinguish wine from different regions, a clear understanding of the underlying natural variability is vital. To this end 190 wines (half red and half white) from a range of defined Australian regions have been collected in collaboration with Wine Australia. These wines will be analysed for isotopic and metals profiles as well as spectral parameters. The data will be compared to data from a reference set of international wines to investigate the ability of the chosen methodologies to identify region of origin.

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

Background

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

National Wine Foundation projects

Two projects funded by the National Wine Foundation were completed during the year. The first, entitled *An investigation into the price sensitivity of 'at risk' alcohol consumers,* was designed to analyse the price sensitivity of at-risk alcohol consumers in a representative sample of the Australian population in the period 2013/2014. The project used data from the Spring South Australian Health Omnibus Survey, which surveyed 2,908 individuals aged 15 years and over. Respondents were asked about their level of wine consumption and any factors influencing changes in consumption. Results of the survey showed that regular consumers of light to moderate amounts of wine, particularly those aged over 55 years, were generally stable in the amount of wine that they drank from year to year. Levels of wine consumption were found to be less influenced by the price of wine than by other factors over the previous 12 months. Changes and choices in wine consumption of previously identified at risk groups for alcohol-related harms, that is, youth and older adults as well as excessive and heavy drinkers, were most influenced by the factors 'health', 'family and friends' and 'employment', for example, before price.

The findings about levels of wine consumption from the state-based survey were found to be consistent with those from the Australian Institute of Health and Welfare's 2010 National Drug Strategy Household Survey (AIHW NDSHS). Approximately one third (29.3%) of participants drank wine at least once per week. Of these, 8.1% of participants drank wine approximately daily (≥ 5 days/week). This observation was confirmed in a third study, the 2013 data from the triennial AIHW NDSHS for alcohol consumption that suggests that 6.5% of all alcohol consumers drink daily. The most common number of standard drinks usually consumed by participants was two standard drinks (33%) (where ≥ two standard drinks/day is the lifetime risk guideline as defined by the National Health and Medical Research Council in 2009), followed by up to one drink (30%) and then three to four drinks (27%).

The second project entitled *Analysis of the health and social benefits of wine in moderation was* a literature review and critical analysis of the specific health and social benefits of moderate wine consumption as defined by the NHMRC guidelines of 2009. Its primary aim was to provide evidence-based information to educate, and thus empower, the public to make consumption choices away from abusive alcohol amounts and patterns.

The critical analysis has culminated in a series of individual review papers on specific relationships between wine consumption and each of cardiovascular disease, diabetes, cancers and cognitive decline/dementia. When overall or all-cause mortality is considered, there is solid evidence that moderate consumption of wine (equivalent to no more than 20 g alcohol/day) is lower risk than heavier consumption for the general population. When overall or all-cause mortality is considered, there is

some evidence that moderate consumption of wine is lower risk than abstinence for the general population. However, the AWRI does not recommend that abstainers start drinking wine to achieve a health benefit. The reduced risk in all-cause mortality from moderate wine consumption is based on a significant reduction in risk for overall cardiovascular disease, a reduction in risk for diabetes and dementias, a mixed relationship for cancers and a linear increase in risk of accidents and injuries associated with moderate wine consumption. If the focus is on alcohol-related cancer, however, then the risks associated with moderate wine consumption become more complex. The evidence is solid that wine consumption increases the risk of some but not all cancers. Some evidence suggests that wine does not contribute to, or may decrease the risk of, other cancers. The increases in risk of some cancers with wine consumption may be dose-dependent or there may be a threshold dose above which risk increases. It is not definitive that any consumption of wine causes all types of cancer. Considerably more clinical data need to be generated in large human studies.

Review of international alcohol guidelines

A summary and comparative review of international alcohol drinking guidelines and associated public health policy changes and directions has been undertaken. Recommendations on alcohol drinking levels considered 'minimum risk' for men and women exist in many countries globally. Official guidelines on alcohol consumption are usually produced by a government, public health body, medical association or non-governmental organisation to advise on levels of alcohol consumption considered 'safe', 'responsible', or 'low risk'. While the definition of moderate consumption is relatively consistent in the medical literature based on a definition above which the risk of all-cause mortality increases (approximately 20 g alcohol/day for both men and women), there are some significant differences between countries' definitions. For example, the definition for moderate daily consumption ranges from 8 g alcohol/day in Grenada and Guyana to 70 g alcohol/day in the Basque region of Spain for both men and women. In Australia, the definition for moderate daily consumption is 20 g alcohol/day for both men and women. In addition there is no consistency on the sizes of standard drinks across countries, which generally reflects differences in cultures and customs. A report summarising the review has been prepared for consideration by the Australian wine sector.

Other projects

The collaborative project entitled *Resveratrol in the chemoprevention of colorectal neoplasia* funded by Cancer Australia continued during the year. The project is investigating whether grape-derived resveratrol, administered in a moderate amount of red wine, reduces the risk of developing bowel cancer in human subjects. Plasma samples were analysed by the SA Metabolomics Facility for resveratrol and its primary metabolites. Results showed that resveratrol from wine is indeed absorbed into the body in measurable amounts. Analysis of further biological samples will be undertaken at the Royal Melbourne Hospital. The AWRI's component of this project is now complete, apart from providing support for the production of a final report and associated publications.

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

Background

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

Scientific and technical advice

Scientific and technical advice and assistance to the Australian wine industry were provided for a number of issues including the occurrence of certain heavy metals in Australian wine. Trace amounts of heavy metals naturally result from soil and groundwater being taken up by vines but can be considered barriers to trade in export markets such as China. The levels observed in wines including those exported from Australia were well below any regulatory limits established by other countries including that by the Organisation International de la Vigne et du Vin (OIV). The presence of phthalates in wine was also investigated and the AWRI participated in OIV-led inter-laboratory ring tests that evaluated methods for the analysis of phthalates in wines. Phthalates were not detectable in any of the Australian wines analysed. Other market access issues investigated included adverse allergenic reactions to wine and the analysis of allergens in wine and associated labelling in different exports markets. The AWRI databases *Analytical requirements for the export or Australian wine* and *Permitted additives* and *Processing aids for winemaking and wine importing countries* were updated. In addition to information for regional trading blocs, the former database currently contains information specific to 39 individual countries, and the latter for 18 individual countries.

Organisation de la Vigne et du Vin

The project team continued to participate at the OIV as members of the DA-led Australian delegation, together with representatives of the Winemakers' Federation of Australia (WFA). Creina Stockley served as President of the OIV's Health and Safety Commission IV and also continued as a member of two OIV working groups — *Taskforce on additives*, and *Taskforce on allergens*.

The *Taskforce on additives* is currently preparing scientific and technical dossiers on additives and processing aids not currently permitted for winemaking by the Codex Alimentarius Commission via its *Proposals for New and/or Revision of Food Additive Provisions*. Countries that do not have or only have limited regulations for wine and winemaking often defer to the provisions of the Codex Alimentarius Commission. In addition, numerous draft OIV proposals were reviewed through participation in the Technology, Methods of Analysis, Specifications of Oenological Products, Food Safety and Consumption, Nutrition and Health expert groups and their electronic working groups.

The role of the *Taskforce on allergens* is to coordinate analytical and clinical research on the potential for residual protein in protein-fined wine and its significance for human health. This research has been undertaken by Australia, France, Germany and Italy. During 2013/2014, the *Taskforce on allergens* finalised the code *Good fining practice for wine to be applied after the use of proteinaceous [allergenic] wine fining agents [casein and egg white]*, which was adopted at the 2014 General Assembly and incorporated into European Commission regulations. This code supports the good winemaking practices of the Australian wine industry that advocate further fining and filtration after protein fining to reduce the risk of an allergic reaction to wine from residual egg, fish and milk protein.

Additional information was prepared and presented to support the Australian-initiated draft resolutions and dossiers on agar, dimethylpolysiloxane, potassium carbonate and protease enzymes to the OIV expert groups as although these processing aids are permitted in Australia they not yet permitted for winemaking under OIV regulations.

Improving products and processes

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

Objective measurement and target setting of grape and wine style

Staff

Amanda Agius, Alice Barker, Sheridan Barter, Dr Keren Bindon, Dr Cory Black, Dr Dimitra Capone, Michael Coode, Dr Wies Cynkar, Dr Leigh Francis, Richard Gawel, Dr Yoji Hayasaka, Dr Markus Herderich, Stella Kassara, Dr Jacqui McRae, Dr Agnieszka Mierczynska-Vasilev, Mango Parker, Wes Pearson, Alex Schulkin, Tracey Siebert, Mark Solomon, Dr Paul Smith, Joanna Verwey (from 26 February 2015), Patricia Williamson.

Visiting scientists and students

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Collaborators

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

Background

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

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

A sensory-compositional study of Viognier and Chardonnay wines has highlighted two lactones that are associated with 'apricot' or 'peach' flavour, and especially the 'apricot' character of Viognier. For 'peach' flavour, a number of yeast-derived acetate esters were indicated as important. A further lactone compound which has previously been little studied in wine has been indicated as a potent white wine flavour compound.

A consumer preference test with 90 consumers evaluating six wines (four Viognier, two Chardonnay) showed that 'peach' flavour was not an important factor driving liking in this study, either positively or negatively. The well-liked wines for most consumers were less viscous, had stronger 'citrus' and 'tropical fruit' flavour and had higher acidity, with the preferences of a smaller group of consumers being related to 'overall fruit flavour' intensity and aftertaste rather than specific flavour types. In this study, wines with stronger 'apricot' flavour were not well liked by two-thirds of the consumers. However, these wines also had relatively high ratings for 'honey' and 'viscosity' which may have been the main negative drivers rather than 'apricot'.

A study of wines made from a set of Chardonnay juices sourced from across Australia, as well as a survey of commercially produced Chardonnay wines, found an unexpectedly high concentration of the potent thiols that are known to contribute to 'tropical fruit' flavour, especially in Sauvignon Blanc. In the survey of commercial wines, all had a concentration of the thiol 3-mercaptohexanol (3-MH) above the reported sensory detection threshold of 60 ng/L, with some up to 2,600 ng/L, a level comparable to that found in some highly aromatic Sauvignon Blanc wines. The juice precursors to these compounds were similarly high in many samples. A sensory study of unwooded Chardonnay wines made under controlled winemaking conditions from juices sourced from vineyards all across Australia showed that juices from the Adelaide Hills, Margaret River and Mount Barker in Western Australia gave wines with relatively high 'tropical fruit'/'passionfruit' flavour, with a juice from the South Australian Riverland also producing a wine with strong 'tropical fruit' flavour. The 'passionfruit' attribute was most strongly related to the compounds 3-MH and 3-MHA (3-mercaptohexyl acetate), while 'box hedge' aroma was also linked to 4-MMP (4-mercapto-4-methyl pentan-2-one). The aroma attribute 'flint' was

Tracey Siebert

related to the concentration of another sulfur compound, benzyl mercaptan, and this is one of the first reports directly linking the 'struck flint' character to this compound. Results to date indicate that substantial flavour in Chardonnay can be contributed by thiols. Consumer acceptance data was obtained from 156 consumers, assessing six Chardonnay wines, selected on the basis of major differences in 'tropical fruit' aroma/flavour. The liking of the consumers was strongly related to the intensity of 'passionfruit' aroma and 'fruit flavour'. Two clusters of consumers (60%) gave higher liking scores to the wines with higher 'passionfruit' aroma, with one cluster (22%) not appreciating the wine with stronger 'box hedge' aroma. Only a small minority of consumers (18%) preferred wines with low 'tropical fruit' attributes.

'Pepper' aroma in Shiraz

Several studies in model systems have provided good insight into the key mechanisms for the formation of the pepper compound rotundone in the grape berry. Results have shown a clear effect of light and air on formation of rotundone from a precursor, with a faster formation but lower final concentration of rotundone in the presence of light. With full sunlight, rotundone formed quickly but then started to decrease after three days. With 50% shade, rotundone formed more slowly for six days, plateaued for seven days, and then decreased slowly over three weeks. With no light, the rotundone formed slowly and then remained stable. This supports observations that the more shaded bunches or berries in a Shiraz vineyard have higher levels of rotundone, most likely due to reduced degradation in the lower light conditions.

Analysis of a subset of Grampians Shiraz grape samples from the 2015 season has been completed as a continuation of investigations into within-vineyard variation of rotundone using precision sampling. The concentration range for rotundone was found to be 9 to 101 ng/kg, which compares to 95 to 885 ng/kg in the same vines in 2012 and 3 to 19 ng/kg in 2013, again demonstrating the large vintage variation in rotundone concentration. The results confirm that the specific vines targeted across the seasons in low, medium and high rotundone zones of a single vineyard gave similar relative amounts of rotundone.

'Green' flavour in red wines

The contribution of specific aroma compounds to 'green' flavour in Shiraz and Cabernet Sauvignon is an important practical issue for wine producers. GC-olfactometry investigations have shown that the major 'green' compounds in Shiraz and Cabernet Sauvignon are those that have been previously identified, with isobutylmethoxypyrazine (IBMP) being of greatest importance. Further chemical analyses have revealed that dimethylsulfide can also be an important contributor to the 'green' aroma. C6 alcohols and aldehydes, on the other hand, appear to contribute less to 'green' flavour than had been previously believed. In Shiraz wines with 'green' sensory characteristics, IBMP was found at moderate concentrations, and was absent in the wines that did not exhibit 'green' aroma. This was a surprising result because Shiraz is believed to be a variety that cannot biosynthesise methoxypyrazines. It is possible, however, that the stalks may contain this compound. In a related study, fermentation of Adelaide Hills Shiraz grapes with stalks led to elevated concentrations of IBMP in wine, well above the sensory threshold. It may be that commercial whole bunch fermentation with stalks, or pre-fermentation cold soak, can cause extraction of this compound and may result in 'green' characters in Shiraz. C6 compounds were also found in much greater quantities in a treatment where grape leaves were added to the must compared to a minimal skin contact treatment.

To gain a better understanding of 'green' flavour a set of Cabernet Sauvignon wines was subjected to descriptive sensory profiling and volatile and non-volatile compositional analysis. The wines were found to have a range of 'vegetal' flavour scores, with variation in 'eucalypt', 'mint', 'herbal' and 'cooked tomato' characters, as well as in 'astringency' and 'acid taste'. To gain a winemaker perspective on 'green' flavours a projective mapping ('napping') study was completed using a panel of 20 experienced winemakers. The winemakers grouped the wines on the basis of 'green' aroma characters as well as tannin/mouth-feel attributes.

A consumer liking study on six of the wines, selected to encompass the range of 'green' attributes, was completed with 113 consumers. The largest group of consumers preferred wines with lower astringency and bitterness, with the 'green stalks' or 'vegetal' attributes of the wines not so important in driving preference. 'Red fruit' and 'fruit aftertaste' were positive drivers for liking for these consumers. A minority of consumers very much appreciated wines with 'eucalypt'/'mint' flavour (24% of the sample tested). The results indicate that controlling what might be considered 'green tannin' may be more important than minimising 'green capsicum' or 'grassy' attributes. The positive liking scores for an Adelaide Hills wine which was low in astringent/bitter attributes and dominated by 'red fruit' flavour mirrors results obtained in other red wine consumer studies by the AWRI, including a major study conducted in China in 2008, showing the attraction to many consumers of 'red berry' flavour in a wine with a soft mouth-feel.

Cory Black

Studies were conducted during the 2015 vintage on volatiles arising from vegetation growing close to vineyards. Pine or cypress trees were found to deposit needles into the grapevine canopy and even within bunches, which meant some were incorporated into the must. Clear evidence was found of needles entering the fermenter in the winery, and winemakers indicated a 'pine' flavour could be perceived in the finished wine. Known pine volatiles such as alpha- and beta-pinene were found in volatile traps placed close to the trees in the vineyards. Whether the direct aerial transfer of volatiles is an important mechanism is not yet known; to address this question final analysis of samples, including tree leaf matter, grape leaves, stalks and berries, is underway.

Assessment of relationships between grape chemical composition and grape allocation grade

Background

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

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

Establishing practical markers of grape quality and their impacts on wine style.

For Cabernet Sauvignon, Shiraz and Chardonnay grapes from 2014, moderate to good prediction of grape quality grades was possible using multivariate data analysis based on partial least squares (PLS) modelling of grape chemistry measurements and winery quality assessments. The important variables that were higher in higher grades varied between varieties, but included some amino acids, UV-Vis absorbance measures, tannin, precursors to the varietal thiol 3-MH and glycosyl-glucose. For all three varieties, predictive modelling using discriminant analysis was better than 85% correct in predicting grape quality grade using fruit chemistry data only. Discriminant analysis using UV-Vis spectra from grape extracts, MIR spectra from juice and NIR spectra from homogenates was able to predict grape quality grade with better than 90% accuracy. Clear clustering of grape samples by region was observed for all samples from the Riverland, McLaren Vale and Margaret River when the UV-VIS spectral scans of fruit extracts were used, which indicates spectroscopy may be useful for fruit streaming purposes.

In 2015 fruit batches for each of four style categories for each of Shiraz and Chardonnay were sourced from multiple vineyards and the trial was extended beyond the assessment of grape chemical composition to also include winemaking. The aim of this extension is to establish the relevance and predictive power of the identified grape compounds to forecast grape quality and wine style categories.

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

Background

A critical aspect of wine quality from a consumer perspective is the overall impression of the wine in the mouth. Wine flavour is driven by volatile compounds (including ethanol), and also by non-volatiles such as sugars, salts, acids and phenolic compounds including tannins, polysaccharides and proteins. Overall flavour is also potentially derived from non-volatile precursor compounds, such as glycosides

(compounds joined to sugars) or amino acid conjugates that can be broken down in-mouth, thereby releasing volatile aromas. The individual wine components alone are not sufficient to achieve a desirable in-mouth perception; this can only be obtained through the interaction of multiple components.

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

Volatile aroma compounds are released from grape-derived precursors by saliva

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

Monoterpenes can contribute important flavour from in-mouth release

Using a large panel of assessors, the release of flavour from a synthetic geraniol glucoside and from glycosides isolated from Gewurztraminer wine in a water system was confirmed. Both glycoside samples were rated significantly higher than the control in 'fruity'/'floral' flavour.

In earlier studies it was observed that not all individuals can perceive a flavour upon tasting these glycosides. In this study, approximately half of the judges could consistently and repeatably discriminate between the samples containing monoterpene glycosides and water. When the same judges were tested with a synthetic guaiacol glucoside, close to 65% could consistently perceive a 'smoky' flavour. This highlights the possibility that flavour released in-mouth from glycosides may contribute to differences in perception of wine between individual consumers.

The relative effects of glycoconjugates and free volatiles in Riesling and Gewurztraminer were assessed in a more challenging, but more realistic, model wine system at wine-like concentrations using a time-intensity methodology. The panel consisted of a screened group of assessors who had previously demonstrated that they could perceive flavour from these compounds in the water system described above. When combinations of the glycoconjugates and volatiles were tested at concentrations closely comparable to those found in Riesling and Gewurztraminer wines, monoterpene glycosides were found to enhance the duration and intensity of the perceived flavour. A third of the judges were most responsive to the flavour from the glycosides, and for this subgroup, the glycosides isolated from Riesling contributed significant flavour, with the combination of Riesling volatile aroma compounds and the precursors giving the longest duration of aftertaste compared to the volatiles alone. This result means that at wine-like concentrations, with the influence of ethanol and wine pH, release of monoterpenes from glycoside precursors is relatively subtle, but likely to be an important source of flavour and flavour persistence for varieties such as Riesling. It may be that the effect is larger for wines of lower alcohol or higher pH, and more pronounced for some consumers.

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

Background

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

The following specific aspects are being investigated in this project:

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

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

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

Typical methods for investigating the formation and properties of colloids in wine (i.e. macromolecular aggregates with particle sizes in the nanometre range) are quite complicated and have mainly been developed for applications in areas other than wine science. They are, however, fundamental to determining how colloids influence the results from many processes in wine production including extraction, settling, clarification, filtration and stability in the bottle. To improve existing methods and tailor them to applications in the wine industry, collaborations in this project have recently been strengthened through Dr Agnieszka Mierczynska-Vasilev's adjunct position at UniSA's Future Industries Institute and Dr Paul Smith's position at Flinders University, gaining access to a wide range of cutting-edge physical chemistry characterisation equipment.

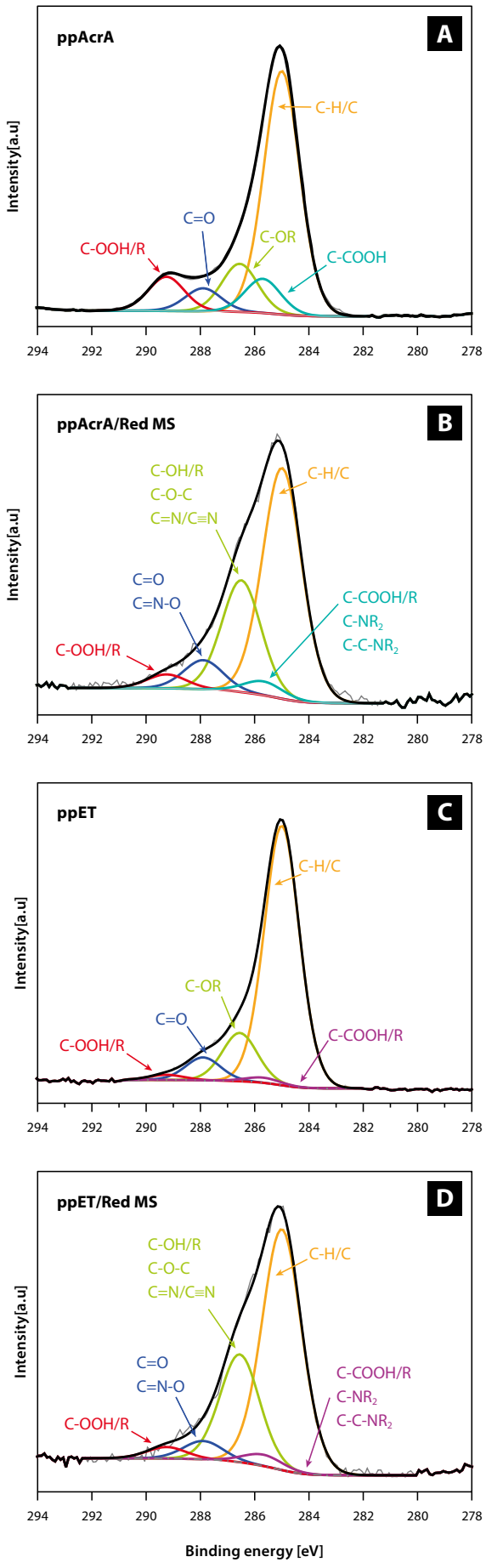

Figure 1. XPS profiles showing (A) acrylic acid and (C) ethanol-coated surfaces without wine and the same surfaces [acrylic acid (B) and ethanol (D)] after red wine adsorption

In exploratory studies plasma polymerisation has been used to create surfaces of varied properties (e.g. polarity or charge) to explore how wine molecules and colloids interact with them. Quartz crystal microbalances (QCM) allowed study of the surface-binding characteristics of different types of colloids (e.g. polar or hydrophobic) in wine without disturbing them through complex isolation and handling. X-ray photoelectron spectroscopy (XPS) analysis has been used to determine the surface composition of polymer surfaces with and without wine deposited on them. Atomic force microscopy (AFM) has been used to provide topographical images of those surfaces. In essence, all these methods support the characterisation of the wine components that bind to a particular surface. This is critical to understanding processes such as filter fouling, binding to tanks and fittings and interactions with processing aids (e.g. bentonite).

Figure 1 shows an example of the spectra for bare and wine-bound surface samples obtained by XPS. This method gives information about the types of bonds that are present in the molecules bound to a surface and allows better understanding of what types of molecules they are (e.g. proteins, polysaccharides, polyphenols or a mixture). One outcome of this work was the recognition that tannin bound up with polysaccharide in 'complexes' may account for approximately 20% of total tannin in red wine and that these complexes are not affected by filtration, and would therefore be expected to remain in finished wine after filtration.

Figure 2 shows example of an AFM image of red wine adsorbed onto two different surfaces. These AFM images of the adsorbed layers allow an estimation of the amount of wine adsorbed on the surface which allows an assessment of, for example, how resistant a surface is to fouling. This gives insight into the types of surface coatings that may be useful in a wine industry setting.

Surface Plasmon Resonance (SPR) has been used to characterise surface layers that form between tannins and proteins. Isothermal Titration Calorimetry (ITC) has been used to assess the binding strength of macromolecules, and showed that the binding strength of tannins with proteins decreases as wine tannins age. This may account for the softening of red wine tannins with age.

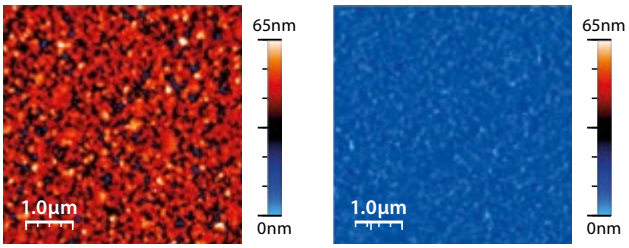

Figure 2. AFM images of red wine adsorption on: (A) acrylic acid and (B) ethanol-coated surfaces

Impact of juice clarification on macromolecules and phenolics in white wine

A broad laboratory-scale scoping study compared the effects on wine polysaccharides and phenolics of different levels of juice solids obtained by gravity settling using enzymes, bentonite or without the aid of a clarifying agent. Wines made from higher solids juices resulted in wines with higher polysaccharide concentrations. Subsequent analysis of the molecular weight distribution and monosaccharide composition of the polysaccharides indicated that yeast-derived mannoproteins were the main contributors to the elevated polysaccharide levels. The relative abundance of arabinogalactans and rhamnogalacturonans (polysaccharides derived from grape solids), which are thought to influence fullness and hotness in wine, was influenced in a complex manner by solids content and the clarification method used to achieve it.

The study also showed that the total phenolic content of wines made from juices clarified either naturally or with the assistance of enzymes

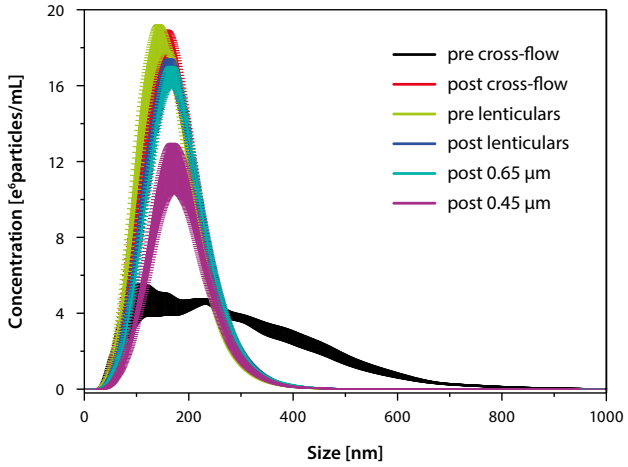

Figure 3. Measurement of particle size and concentration in 2013 Cabernet Sauvignon at various stages of filtration: cross-flow, followed by lenticular filtration and then 0.65 µm and 0.45 µm membrane filtration

were similar to those made from full solids. This result was consistent with results obtained using juices sourced from small commercial wineries made during the 2015 vintage. However, the laboratory-scale study also found that an intermediate solids level resulted in lower total phenolics than either full or low solids. The results suggest that the final concentration of grape-derived polysaccharides and phenolics in wine is the net result of the ease of their extraction from grape cell walls, settling time, and losses due to fining effects from other grape components.

Molecular drivers of texture and taste

Contemporary interpretations of wine complexity and overall quality generally include the contribution of mouth-feel/texture which includes the stylistic attributes of viscosity, oiliness, creaminess and astringency/dryness, and the more negatively perceived attributes of bitterness and hotness. Previously it has been shown that white wine polysaccharides, particularly those in the medium molecular weight range (15-90 kDa), can suppress alcohol hotness and increase viscosity in model and white wine. Trials were conducted to assess if red wine polysaccharides could have a similar positive effect on red wine mouth-feel. Whole polysaccharides were extracted from a red wine and fractionated into three fractions based on molecular weight using preparative size exclusion chromatography. Formal sensory assessment of the fractions in model wines of varying pH and alcohol levels showed that the alcohol hotness was reduced by medium molecular weight red wine polysaccharides. These results were consistent with the previous work on white wine. Work to establish the monosaccharide composition of the red wine polysaccharide fractions is underway.

Improved understanding of white wine protein haze

A set of unstable wines (vintage 2015) has been collected for use in the development of a predictive haze model, and for exploring alternatives to the industry-standard heat test that are faster and more accurate. These wines were analysed for a range of wine components and the results compared to the haze potential determined by the heat test. As part of this project a new rapid HPLC method for profiling proteins in wines has been developed and MS analysis has confirmed the identity of the previously uncertain peaks, validating the rapid analytical method for separating wine proteins.

Evaluation of bentonite alternatives continued, with experiments comparing two bentonites and three novel resins. The most viable of the three resins was found to be sulfonated silica, although the active concentration required was five times that of bentonite. Larger quantities of the novel protease BcAP8 (described previously) have been isolated and purified for use in fermentation trials and will be benchmarked against bentonite and two known proteases, bromelain and aspergillopepsin. Experiments have begun using colloid characterisation techniques to measure the impact of different polysaccharides on protein stability. An investigation of the impact of the matrix components phenolics, ionic strength and sulfate on the stability of a chitinase protein is also underway.

Impacts of filtration on wine macromolecules

A range of red wines were filtered using cross-flow filtration, followed by lenticular filters and then 0.65 µm and 0.45 µm membrane filters. Cross-flow filtration was shown to remove some larger particles while all other levels of filtration (lenticular filtration, 0.65 µm and 0.45µm membranes) had negligible effect on macromolecules, as shown in Figure 3. Analysis at the next time point will show if macromolecules re-form complexes post-filtration and with wine ageing.

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

A collaboration was started with Dr Cassandra Collins and PhD student Dylan Grigg at the University of Adelaide looking at vine age impacts on wine colour during ageing. Another activity with Drs Anna Carew and Fiona Kerslake (TIA) was initiated to look at the interactive effect of leaf removal in the vineyard and microwave maceration on wine colour development. Two papers have been published on the changes in polymeric pigment structure during ageing (Bindon et al. 2014a, 2014b) and this methodology underpins current research on wine colour development during ageing.

Earlier harvesting of grapes is one option to achieve lower alcohol wines but the practice is limited by losses in colour and texture. Two collaborations with PhD students on projects based at the University of Adelaide were initiated to investigate ways to retain colour and texture in wines made from earlier harvested grapes. PhD student Sijing Li investigated the role of enzymes, mannoprotein and tannin additions on wine colour and texture. Through enzyme application, she was able to produce a lower alcohol Shiraz wine from earlier harvested grapes with the same tannin concentration as a wine made from later harvested grapes. However, since enzyme application also significantly modifies polysaccharide concentration and composition, she is further investigating the sensory implications. Another PhD student, Olaf Schelezki has begun a project using earlier-harvested grapes as blending options in the production of lower alcohol wines, and the AWRI is assisting with the analysis of grape and wine tannins.

Further studies have focused on evaluating yeast strains and maceration processes during winemaking as tools to alter wine macromolecule concentration and composition. In wine made in the 2014 vintage it was found that the choice of yeast strain resulted in highly variable polysaccharide and tannin concentrations. At the end of primary fermentation, the two yeasts which yielded highest wine tannin concentrations (1.5 g/L) resulted in wine with the lowest (0.45 g/L) and highest (0.66 g/L) polysaccharide concentrations respectively. It was found that high wine polysaccharide concentration in the case of one yeast was due to the release of pectic polysaccharides rich in galacturonic acid and arabinose from the grapes. This has implications for wine sensory properties, since larger tannins may exert reduced astringency when they are associated with polysaccharides. Based on leads from this trial, in 2015 an experiment was performed to investigate the interactive effect of maceration time (7 vs 30 days), macerating enzyme and yeast strains ('high-tannin' vs 'low-tannin' yeast) on wine macromolecules in 50 kg Shiraz ferments.

1 Bindon, K.A., McCarthy, M.G., Smith, P.A. 2014a. Development of wine colour and non-bleachable pigments during the fermentation and ageing of (*Vitis vinifera* L. cv.) Cabernet Sauvignon wines differing in anthocyanin and tannin concentration. *LWT-Food Sci. Technol.* 59(2): 923-932.

2 Bindon, K., Kassara, S., Hayasaka, Y., Schulkin, A., Smith, P. 2014b. Properties of wine polymeric pigments formed from anthocyanin and tannins differing in size distribution and subunit composition. *J. Agric. Food Chem.* 62(47): 11582-11593.

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

Staff

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

Background

Wine is a complex beverage that is comprised of thousands of metabolites that are produced through the action of yeasts and bacteria in fermenting grape must. To ensure a robust and reliable fermentation, most commercial wines are now produced through the inoculation of freshly crushed grapes with large amounts of the major wine yeast *Saccharomyces cerevisiae*. However, there is a growing trend towards the use of classical, uninoculated or 'wild' fermentations in which only those yeasts and bacteria that are naturally associated with the vineyard or winery perform the fermentation. This generally results in a far more complex progression of non-*Saccharomyces* fungal species, with *S. cerevisiae* only becoming dominant much later in the fermentation process. The varied metabolic contributions of these non-*Saccharomyces* species have been shown to impart desirable taste and aroma attributes to wild ferments when compared to their inoculated counterparts.

Metagenomic analysis of wild ferments

In order to map the microflora of spontaneous fermentation, metagenomic techniques have been used to monitor the progression of fungal species during a collection of wild fermentations from around Australia. Both amplicon-based internal transcribed spacer phylotyping and shotgun metagenomics were used to assess community structures, with the isolation, sequencing and *de novo* assembly of individual strains of the dominant wine-associated species also being performed in order to aid the analysis. Results so far support the view that uninoculated ferments begin with a diverse ecosystem of fungal species, but converge on the wine yeast *S. cerevisiae* as the fermentations progress. Notable differences have been seen between regions, vineyards and wineries and these can be broadly defined by the resulting microbial composition of the wild ferments. Accordingly, this study confirms that differences in these resident microflora between vineyards and wineries form part of the unique 'terroir' where grapes are sourced from and a wine is made, and may play a key role in defining unique regional expression of wine characteristics.

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

Background

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

Benchmarking yeast strain impact upon wine composition

The fermentation characteristics of approximately 100 genome-sequenced yeast strains have been evaluated. More than 600 fermentations have been completed in chemically defined and real grape juice, with the resultant wines analysed for key yeast-derived wine flavour compounds. Significant variation has been observed for most flavour compounds analysed, and some non-volatile components such as succinic acid and glycerol. Correlations have been established between genomic datasets and a strain's ability to produce the 'rose' aroma compounds 2-phenyl ethanol (2-PE) and 2-phenylethyl acetate (2-PEA). Similarly, correlations have been established for the production of volatile sulfur compounds. These datasets enhance knowledge of commercially available wine yeast strains and provide the basis for ongoing development of novel fit-for-purpose starter cultures.

Boosting floral aromas in red and white wines

Novel yeast mutants that produce high levels of 2-PE and 2-PEA were derived from a popular commercial wine yeast and had their genomes sequenced. This analysis revealed key mutations in a small number of genes that are important for the biosynthesis of 'rose'-like floral aromas. In addition, one of the novel mutants was used to make pilot-scale Shiraz and Chardonnay wines. Importantly, the mutant displayed fermentation characteristics indistinguishable from its parent; the resulting wine will undergo sensory assessment in the coming year. The ability for winemakers to specifically 'dial up' the floral aromas in their wine through choice of yeast will provide them with a readily applied and immediate option to shape wine style.

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

Background

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

Defining yeast strain relationships through whole genome sequencing

With so many yeast strains available, both commercially and within collections (for example, the AWRI wine microorganism culture collection, AWMCC), a major goal was to evaluate wine yeast genetic diversity. This was achieved through the use of whole genome sequencing and subsequent comparative genomic analysis. Draft genome sequences are now available for 200 wine yeast, comprising *S. cerevisiae*, *S. uvarum* and hybrids of *S. cerevisiae* with non-*cerevisiae Saccharomyces* yeast including *S. eubayanus*, *S. paradoxus* and *S. kudriazevii*. The strains sequenced included commercial and non-commercial yeast. Non-commercial strains were accessed from the AWMCC and represent isolates collected from numerous wineries, both in Australia and overseas, since the 1940s. Many of these have not been previously characterised. Older wine yeast isolates provide some historical context to the relationships between the various wine yeasts in this study and offer a potential untapped source of diversity for strain phenotypic assessment.

The shared genomic differences of the wine yeast in this work, compared to the lab yeast S288c, form the primary comparative dataset used to inform relationships between strains. Overall, the comparison showed a high level of genetic similarity between wine strains, consistent with a historically recent point of divergence. Of the 200 strains sequenced, 54 (27%) form a group with a large degree of similarity to strain EC1118. *S. cerevisiae* EC1118 is a robust workhorse yeast, isolated many years ago in France from secondary champagne fermentation. Within the larger comparison, small and tightly defined subgroups are evident, speaking to the influence of domestication through strain selection and breeding on the generation of increased levels of genetic divergence. Subgroups within the larger EC1118 group show particularly high levels of genetic divergence and evidence of breeding and selection. For example, seven strains are interspecific hybrids arising from crosses of non-*cerevisiae* strains with an EC1118-like parent. Surprisingly, there are fewer identical strains in circulation than were expected prior to commencing this work.

Parallel phenotypic assessment using barcoded strains

Information about relationships between strains obtained through comparative genomic analysis was used to select strains that are representative of the broader diversity of all wine yeast. This subset of wine yeast has been individually barcoded using a short molecular element that can be used to identify strains in mixed culture environments. The barcoded wine yeast collection allows parallel evaluation of multiple yeast strains in a single ferment and is now being used to assess strain fitness in a variety of environments that reflect the natural compositional variation in winery-produced grape juice.

Efficient and reliable malolactic fermentation to achieve specification wine style

Background

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

Caroline Bartel

Characterisation of MLF genomics and performance

Draft genome sequences of 169 wine bacteria have been assembled, comprising 158 *O. oeni*, 8 *Lactobacillus* spp., 2 *Pediococcus* spp. and 1 *Gluconobacter oxydans*. In addition, 66 *O. oeni* strains were screened for MLF robustness at low pH, high alcohol and low temperature in red and white wines. A spectrum of phenotypic traits has been observed. For example, several strains that show relatively high tolerance to low pH in white wine are less tolerant to the same stress in red wine, and strains exhibiting tolerance to alcohol in red wine do not necessarily show the same tolerance in white wine. Seven *O. oeni* strains that display the desirable stress tolerance phenotype while representing two distinctively different genotypes have been identified and are currently been trialled.

A potential application of this project is the identification of strains in the AWMCC that are of known provenance, have desirable traits and are genetically distinct from commercial strains. Winemakers interested in enhancing regional identity of their products could choose isolates from their region to conduct their MLFs.

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

Background

The AWMCC originates from early microbiological investigations in Australian wines by John Fornachon in the 1940s and the earliest days of the AWRI. Since that time ongoing additions to the AWMCC from wineries and researchers across Australia have led to the development of a repository that houses the Australian wine industry's microbial germplasm heritage. The AWMCC currently holds more than 2,600 yeast and more than 1,000 bacterial strains, with an electronic database used to record information about each strain and to manage their movement (deposition and supply) and intellectual property.

In its large collection of microbes, the AWMCC holds reference strains, research strains and a large number of Australian indigenous yeast and bacterial isolates. Many of these have yet to be identified and characterised for what they can bring to winemaking. This largely untapped

Mark Smith and Martin Day

resource has the potential to provide Australian winemakers with novel yeast and bacterial winemaking strains for efficient and reliable fermentations; it also offers a means to shape unique wine styles or to more fully express regional characters.

Identification, storage and distribution of microbial strains

In 2014/2015 427 yeast and bacterial strains were submitted to the AWMCC from researchers and wineries. All strains submitted were checked for purity, had their identity determined and were placed into cryogenic storage at -80°C. An additional 55 strains already present in the AWMCC were identified. During the year the AWMCC received a large number of requests for yeast and bacterial strains, resulting in 732 microbial samples being distributed from cryogenic stocks.

Reducing the risk of loss of the microbial germplasm collection

To reduce the risk the loss of this valuable microbial germplasm resource, such as in the event of a disaster (e.g. fire), the collection has been duplicated. This back-up duplicate microbial collection is stored in a secure off-site location.

Novel products and effective processes

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Technologies and strategies for the production of lower-alcohol wine

Background

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

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

Harnessing the potential of non-conventional yeasts for lower-alcohol wine production

A *Metschnikowia pulcherrima* strain and a *Saccharomyces uvarum* strain have been identified as able to produce wine with reduced ethanol concentration when sequentially inoculated with a wine strain of *S. cerevisiae*. When used in combination both strains enabled an additional reduction of wine ethanol concentration compared to the same must fermented with either strain alone. While wines fermented with *M. pulcherrima* alone showed certain volatile compounds likely to affect wine aroma negatively, wines fermented with *S. uvarum* or a combination of both strains did not show these potentially detrimental compounds.

Given the great diversity of non-conventional yeasts it is not surprising that some have the potential to oxidise grape sugars, through biosynthetic pathways *S. cerevisiae* is not able to utilise, and therefore decrease ethanol concentration in wine. Through screening of nearly 50 different non-*Saccharomyces* yeasts, one *Torulaspora delbrueckii* strain and one *Zygosaccharomyces bailii* strain were identified as suitable for the production of wine with reduced ethanol content when provided with minimal aeration. A proof-of-concept sequential inoculation study of these strains in a synthetic grape juice observed ethanol reductions of 1.5% v/v and 2.0% v/v respectively in the final wine compared to a *S. cerevisiae* fermented control.

Influencing wine style through management of oxygen during winemaking

Background

Effective management of oxygen during winemaking can help to create diverse wine styles, appealing to a range of consumers. Many approaches to oxygen management are currently practised; however understanding of the impact of oxygen management practices has largely been confined to those employed post-fermentation, during bottling and relating to the effects of closure selection on post-bottling development. The effects of oxygen management during the process of winemaking (from crushing through fermentation) are less well understood, with the limited information that exists relating mostly to the management of fermentation efficiency and reliability.

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

Impact of rate, length and timing of oxygen addition during fermentation

The effect of oxygen addition, both its quantity and timing, was explored in a series of laboratory fermentation trials. The primary finding was that fermentation performance and wine chemistry were predominantly influenced by the total amount of oxygen consumed by the fermentation, not the duration over which it was delivered. Ferments that received a large amount of oxygen in a short period and those that received a small amount over a longer period, with equivalent overall consumption, exhibited similar performance and chemical profiles.

Specifically it was observed that:

- volatile acids such as acetic, octanoic, and decanoic acids, normally associated with negative sensory attributes in wine, were reduced with increasing oxygen dose
- branch chain acids and their associated esters, such as 2-methyl butanol and ethyl-2-methyl butanoate increased proportionally with oxygen treatment
- the concentrations of branch chain esters in particular were modulated around their aroma thresholds and therefore may change sufficiently to influence sensory qualities
- significant stripping of oxygen by CO_2 occurred, with oxygen uptake rates inversely proportional to CO_2 production rates, at least at low oxygen input concentrations.

The extent of must aeration at the time of inoculation, which can be influenced by tank filling operations, had minimal impact on fermentation performance and production of yeast-derived volatile compounds. This suggests that variations in must oxygen concentration at the time of inoculation are unlikely to have an effect on wine sensory attributes.

In addition to investigations on the effects of total oxygen consumption, the effect of oxygen addition timing was also explored. From a fermentation performance perspective, oxygen additions when ferments had reached 80% to 60% of initial sugar had the biggest impact, which is consistent with the work of others. Fermentation duration was still reduced by treatment at 40% initial sugar, but was substantially longer than observed for the earlier treatments. No difference in fermentation duration was found between ferments treated at 20% initial sugar or no oxygen treatment. The effects on wine chemistry largely mirrored those on fermentation performance, with exposure of fermentations to oxygen at 80% of initial sugar having lower concentrations of medium chain fatty acids and later additions showing increasing concentrations of these acids.

In summary, laboratory experiments demonstrated that oxygen additions between 80 to 60% of initial sugar for a period of 2 to 48 hours, depending on the concentration and flow rate of gas used, have maximal impact on fermentation outcomes and that these parameters can be modulated to shape the extent of the effect.

Winemaking trials

Two important pilot-scale (500 L) vintage trials were conducted over the first two years of the project, focusing on oxygen exposure in white wine. The first trial in 2014 investigated the effect of passive oxygen additions during white winemaking, that is the oxygen that gets into wine during pressing and handling but is not actively bubbled into the juice or ferment. By separating the very early oxygen exposure that occurs at pressing from the later exposure which happens through different ways of handling juice or wine after pressing until the end of fermentation, it was possible to find out at which stage oxygen has the greatest effect. In the trial two pressing modes (inert and aerobic) and two forms of post-pressing handling (reductive or oxidative) were used to create four distinct wines, allowing the effects of oxygen timing to be closely examined. Analysis of aromatic compounds and phenolic composition showed that oxygen exposure during the phase when grapes are first burst open by pressing, as a controlled proxy for mechanical harvesting or crushing, is significantly greater than the oxygen exposure during post-pressing handling. Sensory analysis of the wine from this trial showed important differences, with colour and 'tropical' fruit aromas being statistically different. Analysis of chemical data indicated variations in certain aroma compounds (methanethiol, methional, furfural, benzaldehyde, ethyl propanoate and ethyl octanoate) were significantly impacted only through the very early oxygen exposure during pressing, while other compounds (glycine, glutamic acid, tyrosine, 2-methylpropyl acetate, and hexyl acetate) were only affected by oxygen introduced through oxidative handling. A number of other amino acids and volatile esters were influenced by both pressing mode and handling.

The vintage 2015 trial examined the effect of oxygen additions during active fermentation. Short (2 hours) and long exposure (20 hours) treatments were applied when sugars had dropped to 80% of their initial concentration and a long exposure treatment was applied when sugars had dropped to 20% of initial level. Results so far indicate that both early and late additions (20 hours) increased fermentation rate which should also have an impact on the fermentation volatiles. This will be validated by sensory and chemical analysis over the coming year.

Several optical-based dissolved oxygen (DO) measurement tools were used in both the pilot-scale experiments and a large commercial winery. It was found that process-grade probes in specialist housings are best suited for DO measurement during pump-overs or transfers due to their fast equilibration and response time and that they have appropriate configuration for use in a commercial winery. Hand-held meters are equally adaptable to measuring in-tank DO during racking operations. Techniques for introducing oxygen into an active ferment were also assessed. A Venturi injector was trialled in industry and proved a simple and effective device.

Development and application of process analytical technologies for effective winemaking process control

Background

Commercial winemaking operations devote significant resources to ferment management. Current management practices involve sampling and analysis requirements across the vintage period. This typically includes daily monitoring of Baume levels and subsequent testing and/or tasting of samples. In-line sensors offer an opportunity for the wine industry to reduce labour and analysis costs and exert greater control of ferments, by having immediate access to more ferment data. They also offer the potential to reduce the frequency and impact of slow or stuck ferments. This should result in improved product consistency, better resource use, greater throughput, reduced risk of quality downgrades and lower costs. This project assessed the suitability of commercially available sensors for use in monitoring wine fermentations.

Technology review and vintage trials

A review was conducted to identify viable commercial sensors with the greatest potential for application in wine fermentations. Four sensor technologies were chosen to be tested in field trials during vintage 2015:

- Liquiphant vibrating fork (Endress & Hauser)
- Fermetrol probe (Psitec)
- Micro-LDS sensor (Integrated Sensing Systems, US)
- VS-3000 (VitalSensors Technologies, US).

The field trials were carried out at Petaluma Wines (Adelaide Hills, SA) and De Bortoli Wines (Riverina, NSW). At Petaluma, three sensors were located in a 6.5 kL fermenter used for white fermentations. At De Bortoli, four sensors were mounted in a bypass loop configuration on a 200 kL tank used for red fermentations.

A number of technical challenges were encountered in the red ferment trial, with the presence of ferment solids seriously affecting measurement for some of the sensor technologies. These issues meant that quantifiable data could not be collected from the red ferment trial. The white ferment trial was more successful, with the three sensors (Liquiphant, Fermetrol and Micro-LDS) able to be assessed across a number of ferments. Based on that trial, the micro-LDS sensor was deemed to be the most effective, although all three sensors exhibited process-related issues that may hinder their implementation on a broader scale across the industry.

The attempted trial at De Bortoli highlighted that the red fermentation medium is much more challenging to monitor and that additional process integration considerations will be required. Even with the cleaner white fermentation media, processing steps, such as the addition of bentonite, can impact on sensor performance and need to be taken into account.

Cost-benefit analysis

A cost-benefit analysis (Table 1) was carried out to identify the potential payback period for wineries of different sizes considering investment in this type of technology. This analysis was based on assumptions that one of the selected ferment sensor technologies could be successfully implemented into the fermentation process and potential technical barriers could be addressed. Operating expenses included power requirements for the sensors and maintenance (cleaning) costs after each ferment. For the purposes of financial modelling, the cost of each sensor was set at $2,000, with auxiliary costs of $250 per sensor. All three sensor technologies that were formally rated through 2015 vintage trials are available

commercially at around this price. Operational savings were calculated to include reduced analytical costs, reduced frequency of tank sampling and reduced impact of problematic ferments on must or wine quality.

Table 1. Summary of payback period for implementation of ferment sensors in wineries of different sizes

Winery size	Crush (t)	Total initial investment ($)	Operating expenses ($ p.a.) initial year	Operational savings ($ p.a.) initial year	Payback period (years)
Small	<500	22,500	272	15,367	2.79
Medium	500-2,500	56,250	672	36,542	2.36
Large	2,500-50,000	112,500	1,338	118,084	1.66
Huge	>50,000	225,000	2,665	461,168	0.76

The analysis shows that the payback period for wineries reduces as the winery size increases, primarily due to the overall impact on reducing wine/must quality downgrades by minimising the impact of problematic ferments. Initial capital expenditure outlay, including auxiliary equipment (piping connections, communications wiring etc.) for the very large wineries is, however, significant. The time and effort required to undertake installation and commissioning of these sensor technologies should not be underestimated, especially where there is a requirement for capture, conversion, communication and storage of raw output data from the sensors and potential integration of this with existing process control systems.

Reduce cost of production

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

Background

Methane from ruminant animals contributes approximately 10% of Australia's GHG emissions. There is potential to reduce these emissions by supplementing livestock feed with tannins or tannin-containing feed, which have been shown to reduce the production of methane. Grape marc has been suggested as a possible source of tannin able to be used for this purpose. This project applied the AWRI's existing expertise in tannin chemistry to gain a thorough understanding of the tannin in grape marc, and apply this knowledge to achieve reduced methane emissions and productivity improvements in the livestock industry. Funded by the DA through its 'Filling the Research Gap' program, this project was managed by Meat and Livestock Australia as part of the National Livestock Methane Program.

Grape marc fermentation and outcomes

Laboratory-based experiments were conducted to simulate the fermentation that occurs in an animal's rumen, which converts feed material into energy that can be used by the animal. Different forages supplemented with different rates of grape marc were assessed for their impact on fermentation. High proportions of grape marc (50 and 75%) generally resulted in reductions in the amount of material that fermented (measured through gas and fatty acid production), suggesting they would cause reductions in animal performance (e.g. milk yield, weight gain or wool growth) if used as animal feed. Forages with lower rates of grape marc inclusion (25% or lower) allowed for a greater extent of fermentation in most cases. Hay-based ferments behaved differently, likely because of hay's low energy and protein content. Supplementation of hay with high rates of grape marc increased energy and protein content and hence improved the amount of material that fermented. For each forage investigated, the optimum type of grape marc to be included was different, although all that proved beneficial possessed high tannin concentrations and lower fat contents. Subsequent experiments highlighted small, extractable tannin molecules with certain structural characteristics as the most potent in reducing methane emissions without inhibiting the overall fermentation performance.

Results from the previously reported experiment supplementing cattle feed with grape marc showed reductions in animal performance (milk yield) that overshadowed any anti-methanogenic impact of grape marc tannin. However, the different feeds used in this experiment had different energy content, so the reduction in milk yield from the feeds containing the lower energy grape marc were not unexpected.

In a more recent experiment using sheep, two distinct grape marc parcels were supplemented at 10, 20 and 30% of the total feed ration in such a way as to achieve diets of equivalent energy contents to that of the control. The results showed that grape marc can be added to a ruminant diet without negative impacts on animal performance (in this case, weight gain). The experimental section of this project was completed and a final scientific milestone report was submitted in May.

The overall findings from this work are that tannin from grape marc has the potential to modulate ruminant digestion and reduce methane emissions, but the feeding scenarios need to be adapted to the low energy content of the grape marc. Maintenance feeding during the summer-autumn feed gap when livestock energy requirements are low is likely to be the most suitable time to incorporate grape marc into animal feed. This is also a time when other feed sources are scarce.

Using grape marc as a feed additive in commercial settings

Background

Grape marc has been identified as a potential feed additive for the livestock industry able to improve productivity and reduce methane emissions. In order for grape marc to be widely used in the livestock industry, some practical barriers regarding storage and distribution need to be overcome. This project commenced in September 2013, building on the work investigating grape marc tannin described above. Funded through the DA 'Action on the Ground' program, this project aims to address the practicalities of feeding grape marc to livestock. Specific areas of focus are: preventing mould formation during storage


Darek Kutyna

and feed-out; developing effective large-scale storage solutions that preserve both tannin and nutritional content for year-round feeding; and integrating storage solutions and mould inhibition into realistic on-farm practices that can be applied and refined during feeding trials.

Use as a feed additive

A number of different mechanisms for large-scale storage of grape marc were assessed for their ability to maintain the nutritional value and tannin concentration of marc over an extended time frame, while minimising mould formation. All of the methods trialled were found to be effective, which means that there is flexibility for users to choose the method that best suits their farming system in terms of economics, ease of use and requirements for specialised machinery.

A pilot trial using grape marc as an additive in a feedlot system was successful, prompting the initiation of an extensive 100-day feeding trial. Two unique grape marc parcels have been stored at Tullimba Feedlot (University of New England) using grain bags, and will be fed to beef cattle alongside a control diet. The primary objectives are to assess the daily methane emissions, feed intake and feed use efficiency (intake against weight gain).

Genomics innovation initiative

Background

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

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

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

Biosynthesis of raspberry ketone

The production of raspberry ketone by *S. cerevisiae* has been successfully achieved through the introduction of four heterologous enzyme activities into the yeast genome. Laboratory-scale fermentations in Chardonnay juice showed that this recombinant yeast strain is capable of producing raspberry ketone at levels far above the sensory threshold, while retaining the ability to efficiently complete fermentation. Further work is underway to maximise raspberry ketone yield through further modifications to yeast metabolism.

Sc2.0 international collaboration

Work is in progress on the synthesis of the chromosome allocated to the Macquarie/AWRI partnership. The AWRI's focus is on additional work needed to ensure that the new knowledge gained about yeast through the project has relevance to yeasts used in industries such as wine, beer, sake, baking or biofuels.

Reducing wine movements during production

Background

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

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

Laboratory studies of lees removal

Following collection and analysis of a range of lees samples during vintage 2014, the principal task has been the construction of a laboratory apparatus to study tank configurations that might allow for the removal of lees without the clear juice or wine channelling through it. The apparatus that has been constructed allows for different tank bottom designs to be fitted (e.g. 5° back to front sloped wine tank, 55° sloped cone beer tank) and for lees to be pumped out at controlled speeds. The apparatus also has heating, cooling and inert gas services. Experiments using this apparatus to assess a range of wine process lees samples in conjunction with different tank fittings are ongoing.

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

Background

As part of its mission to support the profitability of the Australian wine sector, the AWRI, together with the South Australian Government's Department of State Development, the McLaren Vale Grape Wine & Tourism Association and Scholle Packaging, established a design thinking program to showcase the development of business initiatives that engage consumers on attributes other than price. One of the business concepts, the VALO program, was then selected to progress through to a tangible outcome.

VALO

The VALO program is centred on the creation of an iconic wine from the McLaren Vale region. The wine will be made from a selection of the best barrels from vintage 2014, packaged in a three-litre glass amphora designed by celebrated Australian artist Nick Mount and closed with an innovative magnetic seal. A series of immersive and exclusive wine experiences will be created that are closely associated with the crafting of the VALO wine. The overall intent of the VALO program is to build regional brand equity for McLaren Vale.

Reduce the economic impact of taints and faults

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

Background

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

Can *Brettanomyces* become more tolerant of sulfite?

Several *Brettanomyces* strains that differ in their inherent tolerance to sulfite have been exposed over several months to increasing concentrations of this common wine preservative. In each case, a population of cells has been able to grow at sulfite concentrations greater than the original parent strain, or population, could tolerate. The manner in which these experiments have been conducted in the laboratory is analogous to conditions that might be faced by *Brettanomyces* populations in barrel, where sulfite concentrations drop over time before periodic increases when wines are topped. Further work is now required to confirm that individual clonal cells from these populations are more sulfite-tolerant, and if they are, how stable the trait is. In addition, genomic sequencing will be applied to gain an insight into the mechanisms that may be responsible for developing sulfite tolerance by *Brettanomyces*.

Formation and fate of positive and negative sulfur compounds

Background

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

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

A new way to measure sulfur compounds

A new HPLC-MS method for the analysis of thiols and disulfides in wine has been developed and validated which quantifies a wider range of VSCs than previous methods. The new method also allows for a comparison between the VSCs present in the headspace of wine and the VSCs present in the liquid phase to gain better insight into the fate of VSCs in wine and to possibly predict the way a wine will age in bottle. The new HPLC-MS method will be used in upcoming projects where the formation and fate of hydrogen sulfide (H_2S) and other VSCs will be followed through the winemaking process and during storage of bottled wine.

Understanding the source of sulfur compounds

Drawing upon fermentations conducted in the AWRI's research on yeast, quantitative data on the production of low molecular weight sulfur compounds and volatile thiols has been obtained for 99 yeast strains in synthetic grape juice. A large range of concentrations was observed for H_2S, methyl thioacetate (MeSAc), ethyl thioacetate (EtSAc), 3MH, and 3MHA. This analysis revealed one strain that produced exceptionally high levels of all measured VSCs. Semi-quantitative data were also obtained for 4MMP, which was shown to correlate with 3MH. These studies have been reproduced in real grape juice and analysis to date indicates a strong correlation between VSC results from model studies and fermentations with grape juice.

Twenty strains producing high or low concentrations of VSCs were screened for carbon-sulfur (C-S) lyase activity. C-S lyase activity was found to be significantly correlated with 3MH release, although some strains with low C-S lyase activity also produced high levels of 3MH in the model ferments and vice versa, suggesting that in some strains C-S lyase activity is not the major limitation. Analysis of genomic datasets for these strains revealed that C-S lyase activity correlated with certain alleles (versions) of the known 4MMP-releasing gene IRC7.

Another approach to identifying genes important to thiol release from cysteine conjugates, and H_2S release from cysteine, has involved construction of strains expressing different pyridoxal 5'-phosphate (PLP)-dependent enzymes at high levels. This has been achieved for six of the highest priority candidates by replacing their native promoters. None of these strains produced higher levels of sulfide in the presence of cysteine as a sole sulfur source. Another known thiol-releasing enzyme (Str3p) was, however, shown to have cysteine desulfhydrase activity, able to release H_2S from cysteine.

The fate and formation of H_2S and other VSCs

The formation of important volatile sulfur compounds that negatively affect wine aroma has been studied in red wine, white wine and model wine, and key precursors to H_2S, methanethiol (MeSH), ethanethiol (EtSH) and dimethylsulfide (DMS) have been identified. Overall nine possible precursors have been investigated, as well as the wine conditions that may promote the release of the compounds associated with reductive aromas. These wine conditions include the effect of various metal concentrations in wine (Cu, Al, and Zn), the effect of wine pH and the interaction between wine pH and Cu in modulating the formation of VSCs. From the experiments conducted it is clear that S-methylmethionine (SMM) is a major precursor for DMS and that Al and Zn may increase the formation of DMS from SMM. The major precursors for MeSH are dimethyldisulfide (DMDS) and MeSAc, with Cu playing an important role in the release of MeSH from both DMDS and MeSAc. Both MeSAc and EtSAc act as key precursors to their

Simon Nordestgaard

corresponding thiols (MeSH and EtSH) with lower pH associated with significant increases in thiol formation from these precursors. The major contributing factor to the formation of H_2S in wines remains elevated residual Cu concentration.

Copper is not just copper

Copper in wine can exist in a number of oxidation states and in complexes with a range of other wine compounds. Results from recent trials have indicated that the form copper is in can have a major effect on the development of VSCs. This applies also to other metals involved in VSC formation. In a collaborative project with Dr Andrew Clarke at Charles Sturt University on metal ion speciation, several methods to quantify the different copper species in wine have been investigated. Methods have been developed to distinguish between Cu(I) and Cu(II) in white wine. In addition, experiments have demonstrated that the complexes that Cu forms with other wine compounds are likely to be as important, if not more so, than the oxidation state of Cu(I) and Cu(II) at a given point in time.

The interaction of copper and sulfur dioxide

Three wines from the 2014 vintage were used in trials looking at the impact of timing of $CuSO_4$ and SO_2 additions as commonly used in wineries to understand their possible contribution to the formation of VSCs. A Chardonnay wine was sourced immediately after its primary fermentation was complete. The remaining two wines were finished Chardonnay and Shiraz wines which were treated with hydrogen peroxide to allow the adjustment of SO_2 content. The experiment with the first Chardonnay wine showed that early copper addition in the presence of yeast lees resulted in the copper being removed from the wine when it was racked off lees. Late addition of copper resulted in an elevated residual copper concentration post-bottling. The second Chardonnay wine showed an increase in the concentration of MeSH when no copper was added. The Shiraz wine also showed an increase in MeSH when no copper was added, while the addition of copper resulted in an increase in H_2S concentrations. These wines will continue to be analysed as they mature in bottle; however it has been noted that VSC formation has been significantly modified for the wines treated with hydrogen peroxide, perhaps as a result of the unintentional modification of other wine components involved in the process. The work was extended in the 2015 vintage using a Shiraz and a Cabernet Sauvignon wine collected immediately after primary fermentation and before sulfite was added.

Isolating copper from the VSC formation process

Given the role of metals in the formation of VSCs and the difficulties in producing wines free of metals, it is important to understand if their impact can be modulated by the addition of strong chelating compounds to deactivate the metals. Two wines were sourced from commercial wineries in the 2014 vintage and were treated with a series of known metal chelating compounds. So far, analysis for volatile sulfur compounds seven months post-treatment has shown that only one chelator is effective when used at five times the concentration of copper and iron present.

Deliver sound product to the marketplace

Staff

Tadro Abbott, Dr Simon Nordestgaard, Dr Eric Wilkes.

Maximising quality during bulk wine transport

Background

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

Sampling program and oxygen ingress studies

A sampling program involving 44 containers of Chardonnay and Shiraz Cabernet wine being transported from Australia to the United Kingdom was completed in 2015. Containers were sent in batches in different seasons of the year via three different shipping routes (direct, transhipped in Malaysia, transhipped in Colombia). Both flexitanks (polyethylene tanks that convert a standard 20-foot shipping container into a 24,000 L liquid tank) and ISO tanks (stainless steel transport tanks) were employed. Chemical and sensory analysis were performed and transport temperatures were logged.

A full-scale study of oxygen ingress into flexitanks with and without oxygen/taint barrier films was also performed. In this study oxygen data loggers were installed inside flexitanks that were then filled with deoxygenated water, adjusted to pH 3 with hydrochloric acid and dosed with dimethyl dicarbonate (to inhibit microbial growth). These loggers were used to measure oxygen ingress directly as opposed to relying on laboratory studies of oxygen transmission through plastic films that do not represent the physical configurations used in reality (i.e. including joins and openings). A final report covering all project activities will soon be made available to Australian Wine Grapes Levy payers via the AWRI helpdesk.

Extension and adoption

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

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

Staff

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Collaborators

Bureau of Meteorology (Darren Ray, Kevin Smith, Gary Allan, Agata Imielska, Felicity Gamble); Institute of Masters of Wine, UK (Annette Scarfe, Jane Skilton, David LeMire); New South Wales Department of Primary Industries (Assoc. Prof. Greg Dunn, Dr Deborah Hailstones); state and regional wine industry associations.

The staging and conduct of extension programs

Background

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

Roadshow seminars and workshops

Roadshow seminar content is prepared through various activities across the AWRI, augmented by presentations from WIC partners and other research and development organisations across Australia. The AWRI, WIC members and other organisations submit updated topics based on their research findings. Specific topics are selected by each regional association hosting a roadshow to form a program tailored to the needs and interests of that region. This interaction provides an important indication of areas of interest or concern to specific regions, informing the development of future research, development and extension activities. Roadshow workshops are presented by subject experts and are tailored to deliver practical advice to address current industry concerns, technical issues or challenges. The workshops are interactive in nature and involve tastings, diagnostic tests and practical exercises. The current workshop 'Adapting to difficult vintages' was developed following analysis of the calls received by the AWRI helpdesk and from feedback received at previous workshops. This workshop provides participants with strategies to adapt to weather extremes in a changing climate, and incorporates presentations delivered by the Bureau of Meteorology featuring the tools available to farmers and grapegrowers.

During the year, 17 days of roadshow seminars and 10 days of roadshow workshops were held in the following Australian winemaking zones and regions: Adelaide Hills, Pyrenees, Bendigo, Gippsland, Geelong, Great Southern, Hunter Valley, Langhorne Creek, Tasmania, Limestone Coast, Macedon Ranges, Pemberton, Margaret River, Mornington Peninsula, New England, Riverina, Riverland, Murray Darling, Swan District and Yarra Valley. These events included two smoke taint seminars that were delivered in response to bushfires that occurred in WA and SA.

In order to maximise attendance, events are publicised via a range of mechanisms including the Australian Grape and Wine Events Calendar, the AWRI website, social media, state and regional association websites and local press. In addition, staff liaise with the local associations to coordinate local promotional efforts within the regions, including discussion at local association meetings, direct email notification and often placements in print media. A total of 488 participants attended seminars across the 17 events, and a total of 222 participants attended the 10 workshops this year.

Electronic events and communications

The AWRI webinar series complements other extension events and is considered an effective method for disseminating information and knowledge to people located across multiple regions at one time. A comprehensive program of 21 webinars was presented by AWRI staff and external experts during 2014/2015.

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

Advanced Wine Assessment Course

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

At each course, the top performing participant (based on statistical analysis of scores, verbal skills and group interaction) is named dux of the course and given the opportunity to participate as an associate judge at a national wine show. In 2014/2015, the winners of the dux prize for AWAC 33 and 34 (Lim Hwee Peng and Rose Kentish) were offered associate judge positions at the Royal Adelaide Wine Show and the winner of the dux prize for AWAC 35 (Jessica Ferguson) was offered an associate judge position at the Royal Queensland Wine Show.


Chris Day

Tailored tasting events

For the third consecutive year, the AWRI teamed up with the Barossa Grape and Wine Association to offer a 1.5-day 'Wine Assessment Tasting' in June 2015. From the twelve participants, six were selected as associate judges for the 2015 Barossa Wine Show. This partnership is working well as a mechanism to identify and develop talent at a regional level. A taints and faults clinic was delivered to cellar door sales staff at Rockford Wines and an educational tasting was held at the Jacob's Creek Visitors centre for staff of Pernod Ricard Winemakers.

Collaborations with Wine Australia

The AWRI continues to support the promotion of Australian wine, and was invited by Wine Australia to participate in the Vancouver International Wine Festival, which featured Australia as the theme country in February. The AWRI provided a booth with a wine education focus, presenting common wine aromas, both positive and negative, including 'Brett', cork taint, 'pepper' and 'eucalypt' characters. The booth had a high profile with both trade and consumers, and received very positive feedback. The AWRI also supported Wine Australia's 'Aussie Wine Month – City Cellar Door' in May, an event that attracted more than 1,500 consumers, by staging the AWRI 'aroma bar' and showcasing examples of wine aromas, wine taints and faults. Both events were staffed by the AWRI and featured static displays as well as tastings based on key AWRI R&D outcomes.

Institute of Masters of Wine

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

Research to Practice

The Research to Practice (RtP) training model provides practical, themed, user-pays training sessions for the wine sector. AWRI staff and external providers contribute to the design and delivery of the programs. Six sessions, attended by 145 participants, were presented during 2014/2015 (see Appendix 2 for details).

NSW DPI Extension

Background

The NSW Department of Primary Industries (NSW DPI) commissioned the AWRI to design, coordinate and deliver a Skills Development Program to the NSW wine-grape industry during 2014/2015. The objective of this program was to develop the skills of NSW wine-grape industry participants, empowering them to manage their vineyards autonomously. As such, the program was not focused on the extension of research outcomes or the provision of advisory services, but instead aimed to build the capacity of industry to resolve issues and implement innovation. This was achieved through programs that highlighted practical management options (Research to Practice workshops, videos), taught technical skills (biometrics workshops) and provided objective measures of performance (benchmarking).

Pest and disease early warning

A network of ten weather stations was installed across Mudgee and the Riverina. Data from these stations were sent to a central server and made available via the AWRI website. Fortnightly 'VineWatch' bulletins were published throughout the year, providing timely and relevant information to wine-grape growers in those regions. Each bulletin contained local weather conditions, vine phenology, pest and disease updates and other local information provided by the team on the ground in those regions. A detailed survey was sent out across NSW to collect information about the incidence and severity of pests and diseases in NSW wine-grape growing regions and the typical management practices used for their control.

Workshops

A team of experts presented 'Vine Health' field days in four regions: Murray Valley, Mudgee, Riverina and Canberra. 'Grapevine nutrition in a changing climate' workshops were also held in Orange, the Hunter Valley and Canberra. A 'Mulch and compost' workshop was held in the Riverina to present the results of an existing vineyard experiment in that region. A field display of different mulches and composts was included in the workshop and three videos were produced on this topic.

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

Background

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

Over 1,900 enquiries were received during 2014/2015 (Table 2). A database of all queries allows trends and spikes to be monitored, and appropriate responses coordinated and implemented as required. More than 80% of enquiries received during the year were answered within 24 hours.

Table 2. Enquiries received by the AWRI helpdesk in 2014/2015

	Number of enquiries
Winemaking	1,265
Viticulture	487
Regulatory	150
Total	**1,902**

Winemaking enquiries

The majority of the winemaking enquiries received during the year were from wine companies and suppliers closely aligned with the wine industry, with the remaining queries originating from government organisations, students, legal practitioners and journalists. Approximately 20% of winemaking-related enquiries resulted in investigations, with samples requested and further analysis performed to identify the problem and recommend a process for remediation. The sources of winemaking enquiries received were generally aligned with the proportional volume of wine-grape production by state/territory, with the exception being NSW where the enquiries were just over half the proportional volume of wine-grape production (Figure 4).

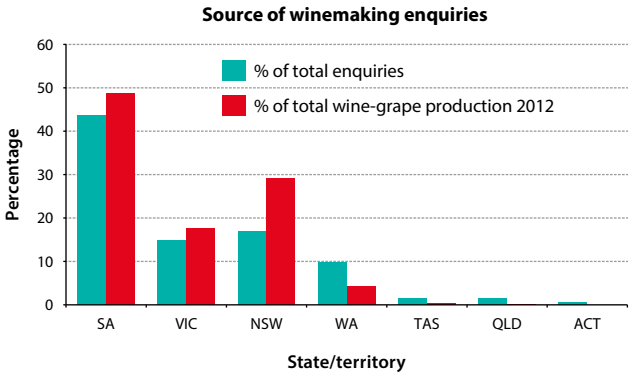


Figure 4. Winemaking enquiries received by the AWRI helpdesk in 2014/2015 by state/territory, compared to wine-grape production

The type and number of enquiries received by the helpdesk varied considerably, largely dependent on the time of year. Vintage 2015 was one of the earliest, if not the earliest on record for many wine regions in Australia. It was also a compressed vintage in many regions, which put pressure on vineyard and winery equipment and infrastructure. As with every vintage, there were viticultural and weather-related challenges, but overall the warm and dry conditions that led to the early vintage contributed to excellent grape and wine quality across the majority of regions.

During January and February, bushfires occurred in South Australia, Western Australia and Victoria, creating significant concern among growers and winemakers about smoke taint. A number of factors can influence the likelihood of a smoke event causing smoke taint in wine. These include the intensity and duration of smoke exposure; climatic conditions; and the growth stage of the particular grape variety at the time of exposure. This range of factors means that it is not an easy task to assess the level (if any) of damage to fruit following a fire event or to predict what will happen once the fruit is made into wine. Analytical data from testing volatile phenols and their non-volatile glycoside precursors give the best indication as to whether or not fruit has been exposed to smoke. Sensory and chemical analysis of small-scale ferments can assist in assessing the likely impact on final wines; however, this does take additional time to complete.

For vintage 2015 the majority of analytical results were found to be similar to, or only slightly higher than, levels that might be expected for non-smoke exposed vineyards. However, in the case of fruit destined for sparkling winemaking, results even slightly higher than background were cause for serious concern, given that the slightest hint of smoke characters can have a significant impact on the sensory profiles of sparkling base wines. Added to this, winemakers reported that they found it very difficult to conduct sensory assessments for smoke taint on small-scale ferments made from fairly unripe fruit destined for sparkling base. Consequently, although the risk of smoke taint development was considered to be low for many of the samples tested, smoke-exposed fruit destined for sparkling wines was the most at risk of being rejected.

Every year a number of wineries contact the AWRI helpdesk requesting assistance in dealing with possible contaminations caused by burst hydraulic oil lines. It can be challenging to determine analytically whether or not a sample has been contaminated, as hydraulic oil is typically present in trace amounts. The AWRI has developed a method where the suspected hydraulic oil is first tested for a unique marker (typically an antioxidant), and if one can be identified, the potentially contaminated wine is tested for that marker (provided it is not naturally present in wine). Testing throughout this vintage and previous vintages has shown that not all hydraulic oils have unique markers, so not all cases of contamination can be identified analytically. Wines where there is evidence or suspicion of hydraulic oil contamination do not meet the requirements of the Australian and New Zealand Food Standards Code (Standard 4.5.1) and it is suggested by the AWRI that such wines should be considered unsaleable. The AWRI recommends regular preventative maintenance on critical machinery such as machine harvesters to minimise the risk of hydraulic oil contaminations.

Viticultural enquiries

During the year, the viticulture team responded to 487 viticulture-related enquiries. More than 20% of these were related to agrochemicals. The next three most common topics for queries were vineyard pests, general viticulture and sustainability. Other queries covered smoke taint, vineyard nutrition, weather and specific varieties.

Agrochemical queries varied across a range of themes such as managing residues in wine, appropriate withholding periods for certain markets, resistance management and specific options for pest problems. Fungal pests made up about two-thirds of the pest-related queries with most of the remainder being about insect issues. Trunk disease appears to be a growing problem as vineyards get older and this was reflected in queries from a range of regions on this topic.

The number of queries about sustainability has grown in recent years. Questions about climate change and the Federal Government's Emissions Reduction Fund reflect the AWRI's involvement in the 'Opportunities in a new climate' Extension and Outreach project. Soil carbon and biochar have been of interest to growers as have the tools for weather forecasting provided by the Bureau of Meteorology such as MetEye. The workshop topic 'Adapting to difficult vintages' is likely to be contributing to the increase in interest in weather monitoring.

Regulatory enquiries

There were 150 regulatory-related enquiries during 2014/2015. One repeated request has concerned appropriate wine for vegetarians and vegans and information on vegetarian or vegan-friendly wine labelling. From 2013 Roy Morgan research, the number of Australians aged 14+ who agree with the statement, "The food I eat is all, or almost all, vegetarian" has grown from 1,608,000 in 2009 to 1,935,000 or 10% of the population. According to media reports, vegetarian-friendly wines now make up more than 50 per cent of wines listed at Tesco, the UK's biggest supermarket chain; fewer vegan-friendly wines are available. Unfortunately the majority of wines do not contain information on their back label to indicate whether or not they are vegetarian or vegan-friendly.

Alcohol consumption is an accepted part of the vegan diet; however when winemaking is carefully considered, not all wine is suitable for vegans. Any wines fined with the animal-derived processing aids casein, potassium caseinate, skim milk, egg albumin/egg white, gelatin and isinglass are not vegan-friendly. Clay-based bentonites are a vegan-friendly alternative fining agent. To aid appropriate buying decisions by vegetarians and vegans, wine producers could consider including information on back labels about the fining agents used.

Other regulatory queries included:

- concentration and potential toxicity of phthalates in wine as well as sources
- concentrations and sources of manganese in Australian wine, as well as other elements
- international legal limits related to the use of ion exchange and electrodialysis, as well as additions of metatartaric acid, mannoproteins and sodium carboxymethylcellulose for stability
- sources of allergens in wine including fining agents as well as lysozyme and new plant proteins
- ingredient and nutritional labelling
- migration of chemicals from various packaging materials
- starter cultures as additives or processing aids
- legality of ethanol addition to wine to enhance alcohol content
- legality of ascorbic acid versus erythorbic acid in international markets
- legality of gold as an additive for wine or wine products
- label declarations for domestic and international markets.

Winemaking problem solving investigations

In 2014/2015 the AWRI helpdesk team conducted 204 winemaking problem solving investigations. The annual number of investigations has been consistent over recent years, although the number of samples analysed as part of these investigations has increased (Table 3). A breakdown of the investigations conducted by state/territory is shown in Table 4. Trends are generally similar to previous years, with SA, Victoria and NSW accounting for the highest numbers of investigations. The sources of the winemaking investigations conducted were generally aligned with the volume of wine-grape production of the different states/territories (Figure 5).

Table 3. Winemaking investigations conducted, and samples analysed, by the AWRI helpdesk team during the past three years

Type of investigation	2012/2013	2013/2014	2014/2015
Identification of hazes and deposits	74	63	53
Microbiological investigations	25	26	23
Sensory assessments	57	36	48
Taint and contamination problems	11	37	47
Other investigative analyses	35	31	29
Closure-related investigations	0	8	4
Total number of investigations	**202**	**201**	**204**
Total number of samples analysed	**914**	**1,059**	**1,152**

Table 4. Winemaking investigations conducted during the past three years broken down by state/territory

State/territory	2012/2013	2013/2014	2014/2015
SA	92	97	102
VIC	43	35	34
NSW	29	39	36
WA	17	19	19
ACT	4	5	1
TAS	16	4	8
QLD	1	2	4
Total	**202**	**201**	**204**

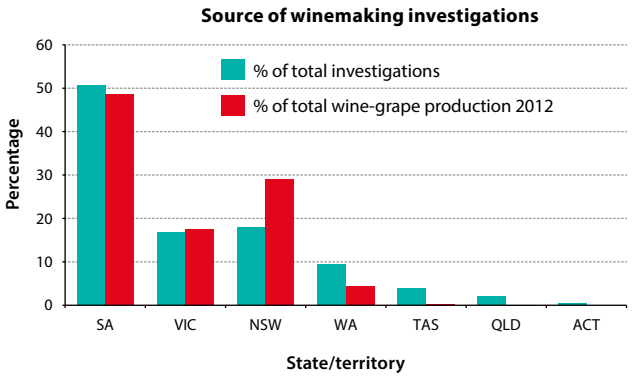


Figure 5. Winemaking investigations undertaken by the AWRI helpdesk team by state/territory, compared to wine-grape production

Michael Downie and Anne Lord

The total number of investigations conducted into wines affected by hazes and deposits continues to be substantial (Figure 6). More than 35% of the deposits identified during 2014/2015 were crystalline, with slightly more potassium hydrogen tartrate deposits than calcium tartrate deposits. A few of the potassium hydrogen tartrate deposits were from wines stabilised with carboxyl methyl cellulose (CMC). In these cases it was found that the wines were grossly cold unstable and not suitable for CMC use. For such wines, it is advisable to partially cold stabilise via traditional chilling before adding CMC.

The number of investigations conducted into microbiological instabilities decreased slightly this year (Figure 7) but was still considered significant. The problems encountered were varied and included high levels of volatile acidity (VA), stuck fermentations, mousiness, 'Brett'-related spoilage, and post-bottling yeast and bacterial growth. 'Brett'-related investigations have increased again this year, making up more than 30% of the microbiological investigations conducted. This suggests that wineries need to maintain a focus on dealing with this issue.

Forty-eight sensory investigations were carried out in 2014/2015 (Figure 8). These included a number of microbial-related issues including wines affected by 'Brett', wines with elevated levels of volatile acidity and aldehyde and wines affected by indole and mousiness. Other investigations examined reductive wines and wines affected by high levels of salt. A further small number of wines were cleared once assessed by the AWRI's trained sensory panel. 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'.

During 2014/2015 there were four investigations relating to closures, compared to eight the previous year. Two investigations involved leakage (one wine under natural closure and one under screwcap). The leakage of the screwcapped wine was attributed to a 'line over finish' fault on the top surface of the glass bottle. This term refers to an elongated line or groove in the glass, which prevents proper sealing by a cap. This type of fault is quite rare and arises during the manufacture of the glass bottles; it would have been very difficult to pick up at the time of packaging. Another investigation involved a sparkling product bottled under both cork closure and crown seal closure. The portion bottled under crown seal had become very reductive and undrinkable over time. The investigation showed that the reductive character has been induced by the presence of metal ions in the wine. The underlying cause was wine seeping between the liner and the metal component of the crown closure, which caused the liners in the crown closures to bubble up and the metal crown to begin to rust, allowing metal ions to leach into the wine.

Twenty-nine investigations classified under the category 'other' were conducted during 2014/2015. Over a third of these investigations were cases where the authenticity of a wine had been brought into question. Some of these cases involved wines that had been assessed prior to purchase but when received by the buyer there were doubts as to whether it was the same wine as had been previously assessed. The AWRI advises producers to keep a holdback sample whenever wine is sent to a contract provider or exported in bulk. This allows an investigation to be conducted if a dispute arises. Other issues investigated included pinking, gas sparging, filtration and method discrepancies between different laboratories.

Forty-seven 'taints and contaminations' investigations were carried out during 2014/2015 (Figure 9), a number that was higher than the previous year (37), and consistent with the long-term average from 1999/2000 to 2014/2015 (45). A large proportion (~85%) of the investigations were carried out using gas chromatography mass spectrometric (GC-MS) techniques. Of these, twelve investigations were related to smoke taint, and others involved vintage-related issues including hydraulic oil (seven investigations), grapeseed oil, cleaning products, musty characters, brine contamination and a wine which was located in close proximity to a coal mine fire. There was also one investigation into a wine with millipede taint, and three investigations into wines containing indole.

Most unusual investigation

The year's most unusual investigation involved a wine that had been bottled from a tank that was found to contain a dead frog. The frog was identified by the South Australian Museum Herpetology Department as a Peron's Tree frog (*Litoria peronii*), a species commonly found around suburban Sydney. Prof. John Bowie, an expert in frog secretions, provided information that this frog species secretes a number of toxic host-defence peptides (Bilusich et al. 2009) and provided the

mass spectrometry fragments that identify these peptides. The SA Metabolomics Facility analysed a control wine and the potentially contaminated sample to look for the marker fragments in the wine, and also compared the control to the potentially contaminated wine to see if any chemical differences could be detected between them. No differences were detected between the wines and none of the frog marker compounds could be detected in the sample. This suggested that the sample was either not contaminated or that any compound present was below the levels of detection or of concern.

Reference

Bilusich, D., Jackway, J., Musgrave, I.F., Tyler, M.J, 2009. The host defence skin peptide profiles of Peron's tree frog *Litoria peronii* in winter and summer. Sequence determination by electrospray mass spectrometry and activities of the peptides. *Mass Spectrom.* 234: 2628-2636.

Library service

Background

The John Fornachon Memorial Library holds the largest knowledge base of grape and wine technical resources in the southern hemisphere. The library continues to support the Australian grape and wine sector through strategic sourcing, management and dissemination of relevant and useful electronic and print resources covering 'vines to wines'. More than 82,940 items (including books, journals, article reprints, conference proceedings, reports, theses, standards and legislation, as well as a reference collection of directories, foreign dictionaries and atlases) are available to levy payers, industry organisations, students and AWRI staff. Members of the Australian grape and wine industry can search the library catalogue online via the AWRI website.

eBook launch

This year, the library launched an eBook platform that enables users to download eBooks to their computers or mobile devices. The collection currently has 46 eBooks covering winemaking, grape and wine biochemistry, wine chemistry, viticulture, wine economics and wine marketing. There are plans to expand the system and the number of eBooks in 2015/2016.

Staff publications database

The AWRI staff publications database contains citations of publications authored by AWRI staff. This useful tool, accessible from the AWRI website, received more than 7,290 hits this year with 740 staff publications requested. This database is updated on a regular basis to ensure the latest publications are available.

Online information packs

Online information packs are collections of relevant references and other resources focused on a single topic. They have been developed by library staff to help users easily locate the information they need on common topics. Three new information packs were added to the AWRI website during the year, bringing the total number to 26 across oenology, viticulture, environment and sustainability and wine and health. During 2014/2015, the library received over 100 requests for information through the online information packs and delivered 362 journal articles in response to these requests.

Library reference and information requests

There has been a 36% increase in the number of requests for information this year (up from 1,330 in 2013/2014 to 1,812 in 2014/2015). The majority of the requests were received by email or via the AWRI website. Although the communication method preferred by library users is still email, a third of all requests are now submitted via the AWRI website. A total of 2,602 articles were supplied with majority of requests completed within one business day. Table 5 outlines the types of articles requested.

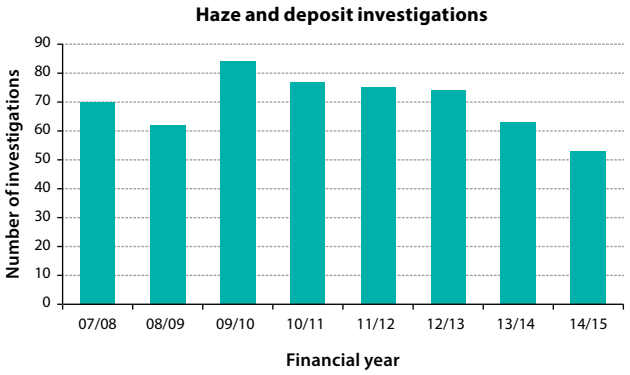


Figure 6. Haze and deposit investigations conducted by the AWRI helpdesk team between 2007/2008 and 2014/2015

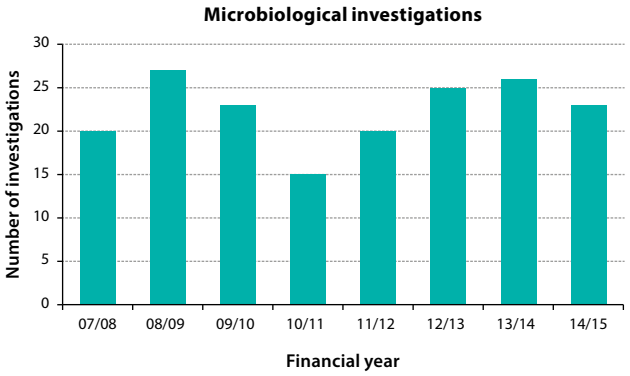


Figure 7. Microbiological investigations conducted by the AWRI helpdesk team between 2007/2008 and 2014/2015

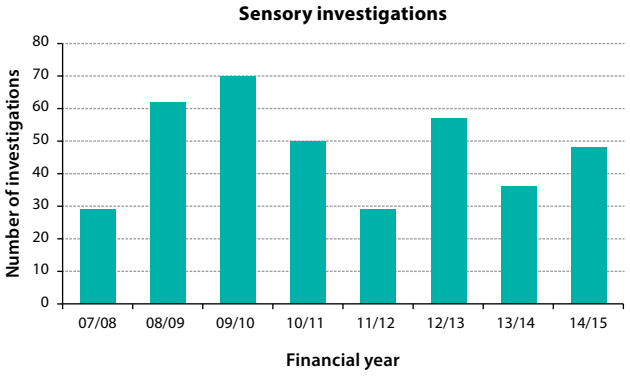


Figure 8. Sensory investigations conducted by the AWRI helpdesk between 2007/2008 and 2014/2015

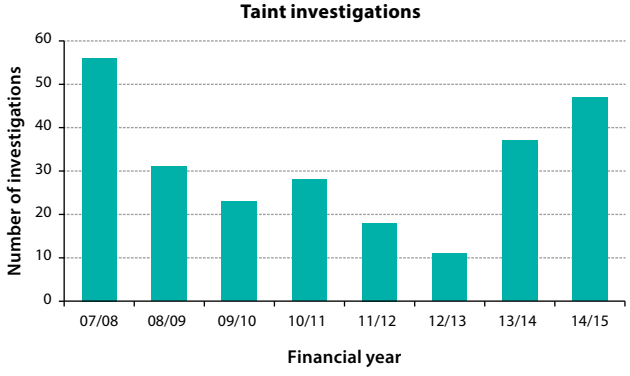


Figure 9. Taint investigations conducted by the AWRI helpdesk between 2007/2008 and 2014/2015

Table 5. Number of articles supplied from library collections

Article type	Number of articles supplied
AWRI staff publications	891
Technical Review Current Literature	740
Library reprint collection	971
Total	**2,602**

Specialised information services

The online library catalogue, information packs and other online databases facilitate self-help from the AWRI website. In addition, the AWRI also offers specialised information services such as literature searches for in-depth retrieval of information across in-house databases and external resources. This year, 40 literature searches were conducted in areas including sustainability, vineyard management, fining and filtration, fermentation and taints and faults.

Communication with stakeholders

Background

This project focuses on written and electronic communication to Australian grape and wine producers, with aims including:

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

Content is derived from across the AWRI's research and extension projects, and delivered through a variety of different channels. The AWRI communicates directly with stakeholders via its *eNews*, *eBulletins*, webinars and social media, publishes the bi-monthly *Technical Review* and contributes regularly to other industry publications. Activities within this project complement the communication objectives of all AWRI staff – the details of presentations delivered and articles published by AWRI staff in 2014/2015 can be found in the Appendices.

AWRI website

The AWRI website is a key mechanism for communicating with stakeholders, students, potential employees and the general public. Approximately 60,000 visitors accessed the AWRI website during the year with more than 278,000 page views. Key updates to the website during the year included improvements to the Grape and Wine Search Portal, a range of new fact sheets, the provision of real-time weather data for NSW growers, new FAQs from the helpdesk team and a blog detailing the making of the AWRI's 60th birthday wine. A refresh of the website's template and navigation was commenced and made good progress. The new version of the website is expected to launch in the first half of 2015/2016.

eBulletins and *eNews*

Electronic delivery of information allows for timely and responsive communications with grape and wine industry personnel across Australia. The *eBulletin* format is used to send out alerts on emerging issues, agrochemical updates and notifications when *Technical Review* is published. Sixteen *eBulletins* were delivered during the year and are shown in Table 6. The *eBulletin* mailing list included more than 2,900 addresses by the end of the year.

Table 6. *eBulletins* issued during 2014/2015

Date	Topic	Author
06/08/2014	*Technical Review* August 2014 issue now available online	Linda Bevin
27/08/2014	AWRI 2014 webinar series	Michael Downie
08/10/2014	AWRI Board election	Shiralee Dodd
15/10/2014	*Technical Review* October 2014 issue now available online	Linda Bevin
01/12/2014	Launch of the Grape and Wine eBook Collection	Linda Bevin
03/12/2014	What topics would you like to see covered at the next Australian Wine Industry Technical Conference?	Kate Beames
08/12/2014	Support available on two recent viticultural issues – hail damage and restricted spring growth	Helpdesk team
15/12/2014	*Technical Review* December 2014 issue now available online	Linda Bevin
22/12/2014	Christmas closure	Helpdesk team
12/01/2015	Dealing with fire damage and smoke taint	Helpdesk team
16/01/2015	Increased risk of bunch rots following heavy rain	Helpdesk team
03/02/2015	*Technical Review* February 2015 issue now available online	Linda Bevin
08/04/2015	*Technical Review* April 2015 issue now available online	Linda Bevin
04/06/2015	Webinar on scale pests	Helpdesk team
24/06/2015	Agrochemical update June 2014	Marcel Essling
25/06/2015	*Technical Review* June 2015 issue now available online	Linda Bevin

The AWRI's electronic newsletter, *eNews*, was distributed bi-monthly to an audience that has grown to 3,000 subscribers. *eNews* provides information on events, updates on research projects and a general snapshot of the AWRI's activities. The distribution of *eNews* in alternate months to *Technical Review* means that information is communicated from the AWRI to stakeholders on at least a monthly basis.

Social media

The AWRI's Twitter following grew by more than 450 during 2014/2015 to 2,819. Twitter has a high uptake within the wine industry and has proven to be an excellent avenue for interacting with stakeholders at an informal level. The AWRI's Facebook presence also grew during the year. While the AWRI's audience on Facebook is significantly smaller than on Twitter, Facebook still works very well for sharing images and visual stories and gained good levels of interaction during the year.

Webinars

The AWRI webinar series continued during 2014/2015 with 22 webinar sessions and 342 participants. Approximately half of the webinars were presented by AWRI staff, with the remainder delivered by guest presenters from other research organisations and industry partners. Webinars provide a convenient and cost-effective way to reach industry practitioners across the country in a single session. Participants have the opportunity to speak with subject experts, ask questions and share experiences.

Annual report

For the past 60 years, the AWRI has produced a printed annual report such as this one, as its formal report to Australian winemakers and grapegrowers. Since 1999, the annual reports have also been made available on the AWRI's website. The AWRI also publishes a four-page summary of the annual report in the *Australian & New Zealand Grapegrower & Winemaker*, and offers to deliver an annual presentation to the board or executive of each major state-based winemaking body. This formal activity complements the vast range of presentations and publications undertaken by AWRI staff members throughout the year (see Appendices).

Technical review

Technical Review publishes abstracts of current technical literature on grape and wine-related topics. It also includes research updates from staff of the AWRI, as well as information about AWRI events. *Technical Review* is published six times a year, and is available to grape and wine producers via the AWRI website or in hard copy. A total of 740 articles featured in the *Technical Review* Current Literature section were requested by and provided to readers during the year.

Editorial support

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

60th birthday commemorative publication

During 2014/2015, the AWRI worked with the *Australian Journal of Grape and Wine Research* to plan a special issue of that journal to mark the AWRI's 60th birthday. It was decided that the special issue would be a collection of review articles authored by AWRI staff on a range of grape and wine science topics. Eighteen review articles have been prepared and are currently at various stages of the peer review process. The special issue is due for publication in December 2015.

Media liaison

The AWRI is regularly approached for comment regarding wine technical matters from national and international media. This provides an excellent opportunity to ensure accurate information is published, and to generate further opportunities to communicate with the AWRI's stakeholders. Many requests from the media were handled during the year, with specific details provided in Appendix 6. Six media releases were prepared and distributed during the year (see Table 7).

Table 7. Media releases prepared and distributed during 2014/2015

Announcement	Date distributed
Wine industry embracing opportunities in a changing climate	01/07/14
Raising a glass to two top tasters	08/09/14
Way now clear for haze-preventing enzymes in Australian winemaking	11/12/14
Unveiling McLaren Vale's VALO	27/03/15
Queensland winemaker tops the tasting class	13/04/15
Cheers to 60 years supporting Australian wine	27/04/15

Enhance national outreach and promote regional engagement

Staff

Dr Mark Krstic.

Student

Pangzhen Zhang (University of Melbourne)

Collaborators

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

Victorian node

Background

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

Node activities

A new Memorandum of Understanding (MOU) was signed between DEDJTR, Wine Australia, WV and the MVW. This MOU has paved the way for a new funding agreement between DEDJTR and the AWRI and maintained delivery support for the Wine Australia regional program in Victoria. The incorporation of the MVW into the MOU means that extension and adoption activities in the grape and wine sector in Victoria are coordinated in a more holistic manner.

In 2014/2015 the key outcomes for the Victorian node included the delivery of an additional 18 unique extension events across Victoria, over and above the AWRI's existing national roadshow seminar and workshop program. These extension activities were delivered in partnership with Wine Victoria and the regional grape and wine industry associations across Victoria. More details can be found in Appendix 2.

The Victorian node also remains actively involved with the AWRI's national research program and has been very active in guiding and supporting the DEDJTR Centre of Expertise in Smoke Taint Research program.

Service capabilities and foundational datasets

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

Staff

Amanda Agius, Alice Barker, Sheridan Barter, Dr Cory Black, Catherine Borneman, Mark Braybrook, Dr Dimitra Capone, Alfons Cuijvers, Dr Chris Curtin, Dr Wies Cynkar, Chris Day, Shiralee Dodd, Dr Leigh Francis, Annette Freeman, Jeremy Hack, Dr Markus Herderich, Adam Holland, Dr Vilma Hysenaj (from 3 November 2014), Dr Dan Johnson, Pauline Jorgensen, Esther Kristianto, Dr Mark Krstic, Dr Natoiya Lloyd, Dr Vince O'Brien, Jennifer O'Mahony, Wes Pearson, Dr Paul Petrie (from 2 February 2015), Tracey Siebert, Con Simos, Dr Mark Smith, Dr Peter Sternes, Fang Tang, Deborah Thornton-Wakeford, Joanna Verwey (from 26 February 2015), Patricia Williamson.

Visiting scientists and students

Dr Federica Blando (Institute of Sciences of Food Production, CNR, Lecce, Italy), Prof. Ulrich Fischer (DLR Rheinpfalz, Neustadt, Germany), Yevgeniya Grebneva (Technical University of Dresden, Germany), Sabrina Reschke (University of Bonn, Germany), Florian Sengler (HS Geisenheim, Germany), Jing Wu (ISVV, Bordeaux, France), Nora Zibi (University of Erlangen-Nurnberg, Germany).

Collaborators

CSIRO (Dr Rob Walker, Peter Clingeleffer); Fondazione Edmund Mach, San Michele all'Adige, Italy (Dr Fulvio Mattivi); HS Geisenheim, Germany (Prof. Manfred Grossmann, Prof. Hans Schulz, Dr Manfred Stoll); ISVV, Bordeaux, France (Prof. Phillippe Darriet, Marta Avramova, Dr Warren Albertin, Prof. Serge Delrot, Prof. Isabelle Masneuf-Pomarède, Dr Takis Stamatopoulos); SARDI (Dr Mike McCarthy, Dr Victor Sadras); University of Adelaide (Prof. Eileen Scott, Stephen Clarke); University of South Australia (Dr Armando Corsi, Prof. Larry Lockshin, Dr Justin Cohen).

Chemistry, sensory, chemometrics and development capacity

Background

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

Sensory analysis

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

The technical quality panel provides detailed tasting notes, as well as fault scores, for wines submitted through AWRI helpdesk investigations, as preliminary screenings for research projects, and for clients of AWRI Commercial Services. During 2014/2015, the panel evaluated 214 wines in formal sessions, as well as numerous training samples, and more than 300 wines in preliminary bench tastings. The 18 judges on this panel have extensive general wine tasting expertise and technical knowledge of wine production and composition, with most having commercial industry experience, formal oenology qualifications and/or having completed the AWRI Advanced Wine Assessment Course. All judges, no matter how experienced, are required to pass a probationary period before being admitted as reportable judges.

In 2014/2015 22 major descriptive analysis studies were completed using the AWRI's highly trained part-time external sensory panel – the highest number of such studies ever completed in a year at the AWRI. After two to four weeks of panel training and assessments the judges rate the intensity of carefully selected, defined appearance, aroma and flavour attributes over multiple replicated occasions. The sensory profiles generated provide invaluable information regarding the effect of viticultural or winemaking treatments; knowledge of key wine components giving rise to flavour characteristics; consumers' drivers of liking; and the influence of closures or storage on wine sensory properties. Assessor performance is continually monitored after completion of each project, with the ability to discriminate, degree of agreement with other panellists, and repeatability carefully assessed and tracked over time. In addition, training exercises including identification, ranking and rating tests with tastes and odours are conducted at regular intervals, with the performance of individuals in these tasks recorded and monitored. The studies included two large projects with SARDI assessing the effect of grapevine clone on wine flavour, with Chardonnay and Shiraz wines made from grapes from vineyards in Victoria, South Australia and Western Australia. As part of helpdesk investigations, the sensory properties of several problem wines were evaluated; while several sets of wines bottled under different closures were assessed, including a Shiraz wine that had been bottled for 48 months. Multiple sets of wines that had been shipped to the UK in bulk transport were evaluated to determine whether shipping routes or conditions had a sensory effect. The techniques of Time-Intensity and Temporal Dominance of Sensations (TDS), two methods providing data on the time course perception of sensory properties, were also applied, with Dr Pascal Schlich from INRA Centre des Sciences du Goût et de l'Alimentation in Dijon, France, running a workshop on TDS with the AWRI for Waite Campus staff and industry personnel.

Difference testing, generally using the method of triangle testing, is also an important sensory technique to find if a treatment has had a perceptible effect on wine aroma or flavour. Approximately 50 AWRI staff are screened and qualified to perform this task, usually assessing two or three sets of wines per session. Fifteen sessions were completed, including tests to find if sooty mould had a sensory effect on wine flavour at different levels. Investigations were also made into the efficiency of the tetrad difference test procedure, where it was confirmed that this method of assessing a set of four wines is not as sensitive as the triangle test.

Consumer testing for degree of liking has been conducted with three major studies, involving more than 350 consumers in total. The studies investigated consumer preferences for commercial Cabernet Sauvignon wines with varied 'green' flavour and mouth-feel characteristics; for commercial Viognier and Chardonnay wines with differing 'apricot' and 'peach' flavour; and for unoaked Chardonnay wines made under pilot-scale conditions from juices sourced from different regions across Australia with different degrees of 'tropical fruit' sensory attributes. An improved registration and recruitment procedure has been developed, so that a greatly increased number of qualified consumers are now on the AWRI database.

Spectral measures of grape and wine composition

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

Synthetic organic chemistry

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

Aroma compound analysis

State-of-the-art analytical instruments, including GC-MS and LC-MS, are carefully looked after to ensure they are in optimal operational order and capable of being used continuously in periods of high demand to give timely results. The suite of analyses that is available continues to expand, with newly published methods available this year for varietal thiol compounds including the compound involved in 'struck flint' aroma, benzyl mercaptan, as well as a range of volatiles implicated in oxidative off-flavour, notably phenyl acetaldehyde and methional. Accurate and precise analytical methods for targeted aroma compounds have been applied in many projects. Important compounds such as norisoprenoids ('fruity', 'violets', 'kerosene'), thiols ('tropical fruit', 'box hedge'), monoterpenes ('citrus', 'floral'), rotundone ('pepper') and C6 compounds ('green', 'grassy') have been quantified in more than 500 samples. These analyses are also available on a fee-paying basis through AWRI Commercial Services.

Wes Pearson and Alice Barker


Mark Braybrook

Metabolomics (South Australian Metabolomics Facility)

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

During 2014/2015, the South Australian Metabolomics facility provided approximately 7,500 analyses on more than 3,500 samples for a diverse range of clients from the environmental, biomedical and agri-food sectors. New HPLC-MS methods allowed the identification and quantification of corynetoxins in grains and detection of sulfur compounds and their precursors in wine. In addition, optimisation and extension of existing methods continued, for example for HPLC-MS analysis of guaiacol glycosides in support of smoke taint diagnostic services; volatile acids in fermentation products by GC-MS; and non-volatile metabolite profiling in diverse biological matrices using an automatised derivatisation reaction in combination with GC-MS. Ongoing collaborations exist with the University of Adelaide and with Fondazione Edmund Mach in Italy.

Wine Innovation Cluster Winemaking Services

Background

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

Vintage 2015

WIC Winemaking Services processed a total of 420 (50-1,000 kg) ferments in what will be remembered as a very early and compressed 2015 vintage. The total number represents 223 more ferments than were conducted in the previous vintage. This is a very strong performance and represents the largest volume crushed and number of ferments processed in the five years of the joint venture arrangement.

WIC Winemaking customers include all of the WIC partners and a number of other clients. Grapes were sourced from many South Australian wine regions as well as from Victoria, Tasmania, Western Australia and New South Wales.

Efficient management and administration

Background

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

Finance

The finance team, led by the Group Manager – Corporate Services, Chris Day, had as its most significant achievement during the year confirmation by the South Australian Government that the AWRI had satisfied the requirements for a charitable exemption from payroll taxes in that state. This achievement (greatly assisted by the AWRI's advisors PricewaterhouseCoopers) is the result of significant efforts which began in 2012, and in addition to a retrospective element will further deliver considerable operational savings on an ongoing basis.

Other finance activities encompassed financial management, budgeting and reporting including to the AWRI Board, funding organisations and government.

Human resources

Alfons Cuijvers, the Human Resources Coordinator, completed his first full year in an expanded role, with his responsibilities encompassing a broad range of recruitment, employment contract management, visa, payroll and compliance activities. A range of employee well-being initiatives were also delivered, including the opportunity for all staff to participate in a 'healthy heart' assessment. A substantial refresh of the AWRI's Employer of Choice program also commenced during the year, based on staff feedback. Professional development opportunities for many AWRI employees were significantly assisted by the AWRI's directors, many of whom elect for the organisation to retain their directorship fees specifically to support such activities.

Operations

The Operations Manager, Mark Braybrook, manages and attends to all AWRI infrastructure, equipment and engineering requirements and represents the AWRI's interests, in partnership with the other occupants of the WIC building, on the WIC Management Committee. Cost-effective custom designed and manufactured engineering solutions are supplied throughout the organisation. Examples this year included scaled tanks, fittings and associated infrastructure for research on wine lees; tank and sampling device modifications for research on wine and oxygen; and infrastructure requirements for the installation of the new inductively coupled plasma mass spectrometer (ICP-MS). Considerable effort continues to be invested in addressing the WHS requirements of the organisation.

Corporate governance

The Company Secretary, Shiralee Dodd, oversaw the successful transition to an electronic ballot process for the 2014 election of directors to the AWRI Board (held in October 2014). This revised process realised significant cost savings and other efficiencies, with the election itself returning three new directors who took office during 2015. Other corporate governance activities included the provision of a comprehensive induction program for these new directors, and the development and implementation of a robust and efficient framework for policy review throughout the organisation.

Information technology

The IT Coordinator, Adam Holland, further progressed the AWRI's strategy to standardise, centralise and virtualise its IT assets and environment. The year's most significant activity was a network access protection project developed in response to the growing workplace trend of employees wishing to use personally owned IT assets in the workplace ('Bring Your Own Device'). Further enhancements were implemented or are being trialled in areas of backup infrastructure and processes, the AWRI virtual and physical server environment, email security and the delivery of Microsoft programs. These efforts will continue to yield further improvements to productivity, and assist in the ongoing cost-effective delivery of IT solutions.

International scientific exchange program

Background

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

The BAG Alliance

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

As part of BAG Alliance activities, the AWRI participates in key PhD research projects with the alliance partners in Bordeaux and Geisenheim:

- PhD research by Marta Avramova into the comparative and functional genomics of *Dekkera (Brettanomyces) bruxellensis* wine isolates from Australia, France and Germany commenced in 2015 in Bordeaux. The AWRI has provided DNA sequencing data, and a PhD student placement at the AWRI has been planned for six months from mid-2016.

- To complement trials into climate change impacts on Riesling wine undertaken at Hochschule Geisenheim, the AWRI established in 2014/2015 a field trial into light and temperature effects in Riesling. The first grape samples were collected during the 2014/2015 growing season for metabolite profiling, and the results so far demonstrate significant impacts of light exposure of the bunch zone on grape composition and wine flavour.

- ISVV in Bordeaux appointed in 2015 a PhD student, Jing Wu, to study climate change effects in Cabernet Sauvignon. Jing Wu has visited the AWRI to facilitate the establishment of a field experiment in the Barossa Valley for the 2015/2016 growing season, and to undertake training in metabolomics.

Collaboration in grape and wine metabolomics with Fondazione Edmund Mach, Italy

This project involves a comparison of the performance of non-targeted metabolomics profiling methods developed at the AWRI with specific HPLC-MS methods for the targeted quantification of common phenolic compounds. Results to date demonstrate that a much broader range of compounds in grape and wine samples can be detected and quantified through non-targeted metabolomics profiling. As part of the project metabolite profiles of Italian and Australian Shiraz and Pinot Noir grape and wine samples have also been established, and the results highlighted metabolites that are common or specific for either variety and related to the country of origin. This work also helped identify grape metabolites which undergo transformations during winemaking.

Knowledge exchange programs with European research networks

To facilitate the exchange of knowledge with European research networks, the AWRI is a member of the Oenodoc/Oenoviti International program, the Innovine – Innovation in the vineyard program, and is affiliated with the MicroWine Training Network.

Commercial services

Staff

Tadro Abbott, Melissa Aitchison, Elyce Batchelor (from 18 February 2015), Karl Forsyth, Andrea Francis, Robyn Gleeson, Kieran Hirlam, Dr Josh Hixson, Leanne Hoxey, Erin Kearsley, Oliver Lovat, Bryan Newell, Candice Newton (from 14 July 2014), Dr Simon Nordestgaard, Dr Kerry Pinchbeck, Tim Reilly, Marco Schoeman (from 1 June 2015), Neil Scrimgeour, Pamela Solomon, Alana Spears, Randell Taylor, Heather Tosen, Dr Tina Tran, Daniel Tynan, Dr Eric Wilkes.

AWRI Commercial Services had another extremely successful year, with strong demand for its services and continued positive relationships with wine industry peak bodies and grape and wine producers. For the first time, the laboratories processed over twenty thousand samples (22,491), an average of more than ninety samples per working day, which represents a 38% increase on the average throughput for the last three years. This increased performance has been achieved without increasing staff numbers in the laboratory and highlights the efficiencies that have been introduced over the past five years. The continued upward trend in sample numbers combined with 120 new customers during the year, in a period of continuing contraction for the industry, demonstrates the increasing importance of AWRI Commercial Services as a source of timely and efficient analytical services and its important role as a reference laboratory for the industry.

Robyn Gleeson and Andrea Francis

During the year the laboratories were audited and successfully regained accreditation against both NATA (ISO 17025) and Good Laboratory Practice (GLP) standards. These internationally recognised standards are important in allowing the AWRI to act as a reference laboratory not only for domestic analysis of wine and agricultural residues, but also as an internationally recognised provider of analysis for wine export and dispute resolution. The Commercial Services team continues to play an important role in the approval process for agricultural sprays, providing world-class analytical support for field trials before products are approved for use in industry as well as providing producers with residue analysis on grapes and wine to ensure they meet national and international standards.

The AWRI's relationship with wine industry peak bodies continues to be strong with the Commercial Services laboratories being commissioned to undertake a number of surveys by Wine Australia. These included a study examining the average content of Australian wines of a range of metals considered to be relevant for human health, as well as a survey to determine the typical levels of phthalates, a common component of plastic manufacture, in Australian wines. These surveys are an important tool in helping to protect the clean and green reputation of the Australian wine industry. Also, in conjunction with members of the wine industry peak bodies, Commercial Services presented information on the sources and occurrence of manganese in wine at international forums in China and the United States as efforts continue to negotiate reasonable limits for this metal that reflect its natural occurrence in wine.

Expanding capabilities

Metals analysis for export of wine continues to be a major activity with more than two thousand samples of wines bound for China submitted for manganese analysis this year. Other metals have also been highlighted in a number of international markets, potentially raising issues for the exports of Australian wine. Metals have also come under increasing scrutiny in terms of their impact on wine flavour and aroma as well as their potential for helping to determine the authenticity of wine from different regions. To meet the demands of both industry and research groups, the AWRI has invested in the purchase of an inductively coupled plasma mass spectrometer (ICP-MS). This new instrument can measure naturally occurring metals at parts per trillion levels in both grapes and wine and will form the basis of a cost-effective metals analysis service that will be available to industry in the second half of 2015.

Another area where new technology is expanding the tools available to industry is in the area of metagenomics. Recent developments and research have for the first time made it practical to determine the microbial species present in a ferment through analysis of DNA markers. Commercial Services has now introduced this capability as a service to the wine industry allowing Australian winemakers to easily determine the species present at various points during a ferment, a process that can be especially important with non-inoculated ferments. Also in the area of microbiological testing, Commercial Services has validated and introduced a new rapid DNA-based test for *Brettanomyces* in wine. This will allow wine producers to evaluate the presence or absence of this spoilage organism in around 24 hours, compared to more traditional plating methods, which require ten days for confirmed results.

Underlying the provision of analytical and microbiological results is the system to manage and store the vast amounts of data generated by the laboratory. Such systems are generically known as laboratory information management systems (LIMS) and are crucial to the efficient running of a commercial laboratory. The AWRI has begun the process of replacing its current (unsupported) system with a new state-of-the-art LIMS. Not only will this system allow increased efficiency in the gathering, storage and reporting of testing data, it will also include a modern web-based interface to allow customers to order analysis, track samples and access results online.

Ensuring the best technology for the Australian industry

The AWRI has an enviable reputation for providing the Australian wine industry with independent and well-informed technical advice on the performance of technological solutions for the production and packaging of wine. The most recent example of this is a consortium-based sparkling wine closure trial which was initiated this year. This two-year trial is evaluating the performance of eight different sparkling closures ranging from traditional cork to alternative screwcap designs and is supported by five wine producers and five closure suppliers. Testing in the red wine closure trial, initiated in 2010, was extended to a fourth year and is providing valuable insights into closure performance for

Bryan Newell

participants. These consortium-based trials run in parallel to the ongoing demand for proof-of-performance trials for a range of novel closure and packaging technologies commissioned by suppliers as they take new products to market. The continued demand for these services highlights the importance of the AWRI's reputation for sound independent assessment of products by both suppliers and producers. Such services are not limited to closures and packaging, with Commercial Services also being commissioned to assess the performance of oak alternatives; large oak vessels in comparison to stainless steel for fermentation; and novel antimicrobial agents, among many others.

As the AWRI's reputation for expertise in the area of applied wine technology continues to grow, Commercial Services is increasingly being approached at the development stage of products rather than solely to test the performance of market-ready products. To this end, the AWRI has been involved as consultants in the development of a range of new closures, alternative packaging solutions and other technological solutions, helping to ensure that products that reach the market meet the needs of the industry and consumers.

Reducing costs and improving outcomes for Australian producers

In the challenging financial climate being experienced by the Australian wine industry it is important that wineries have tools available to reduce costs and increase efficiency; the AWRI is at the forefront of offering such services. Packaging line oxygen and microbiological audits and winery *Brettanomyces* audits continue to be in demand. These services help to develop best practice in winery and packaging facilities and minimise risks of product wastage. Commercial Services also continues to support the development of low cost alternatives to traditional methods for the determination of grape colour by a number of wineries using mid-infrared technology.

Commercial Services continued its active involvement in environmental services through the provision of a number of Life Cycle Analysis (LCA) projects for Australian producers, enabling them to access markets which demand high levels of environmental stewardship.

The long history of excellence and innovation in wine microbiology is reflected in the continued collaborations of Commercial Services with commercial suppliers of yeast and bacteria. This work has focused on the development and characterisation of commercial strains of yeast which have lower tendencies to produce wine faults such as volatile acidity and reductive characters while enhancing the production of favourable volatile compounds. A collaboration has been set up to evaluate the efficiencies of differing strategies of yeast inoculation, with the aim of giving winemakers information on the most cost efficient path while still providing the optimum flexibility and flavour and aroma outcomes.

Financial statements – directors' report

Directors' report

The directors present this report to the members of the Australian Wine Research Institute Limited (the Company) for the year ended 30 June 2015.

Directors

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

	Date of appointment	Cessation date	Board meetings	
			A	B
Ms Louisa E. Rose (Chair)	1 Jan 2011	–	4	4
Mr John C. Angove	1 Jan 2010	31 Dec 2014	2	2
Mr Toby J. Bekkers	1 Jan 2014	–	4	4
Mr James F. Brayne	1 Jan 2009	31 Dec 2014	1	2
Mr Paul D. Conroy	2 May 2006	24 May 2015	3	3
Dr John S. Harvey	1 Jan 2012	31 Dec 2014	2	2
Mr Kim R. Horton	1 Jan 2015	–	2	2
Dr Daniel L. Johnson	1 Dec 2011	–	4	4
Mr Brett M. McKinnon	1 Jan 2008	–	2	4
Dr Stuart C. McNab	1 Jan 2015	–	2	2
Ms Mary J. Retallack	1 Jan 2015	–	2	2
Ms Elizabeth A. Riley	1 Jan 2012	–	3	4
Prof. Brian P. Schmidt	25 Feb 2014	–	4	4
Mr Mark R. Watson	24 Jun 2008	–	4	4

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

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

Overview of result

For the year ended 30 June 2015 the Company recorded a surplus of $2,683,336 (2014: surplus of $506,101). This surplus is primarily due to a reimbursement of $2,335,995 in State taxes received during the year from the South Australian Government, following a determination that the Company satisfies the requirements for a charitable exemption under relevant legislation in that State.

Objectives and strategy

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

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

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

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

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

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

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

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

Principal activities

The Company's principal activities during the year were:

- **Research** activities that strive for scientific excellence and industry relevance
- **Development** activities that seek to bridge the gap between scientific discovery and value adding technology or processes
- **Extension** activities that seek to disseminate research and development outcomes to facilitate rapid uptake by the viticultural and winemaking sectors
- **Commercial** services aimed at providing competitive specific and/or tailored solutions for individual entities across all industry sectors which leverage the other key activities of the AWRI.

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

Performance measures

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

Information on directors

Ms Louisa E. Rose
Chair (non-executive)
Qualifications: BAppSc (Oenology) BSc GAICD
Experience: Head of Winemaking The Yalumba Wine Company and Hill-Smith Family Vineyards, Chair of the Australian Alternative Varieties Wine Show, member of the Alumni Council of the University of Adelaide, member of the Council of Barons of Barossa, former director of the Barossa Grape and Wine Association, member of Wine Barossa and Co-Chair of the South Australian Wine Industry Council. National wine show judge, 24 years' technical, winemaking, viticultural and commercial experience in the Australian wine industry.
Special Responsibilities: Ms Rose is the Chair of the Personnel committee.

Mr John C. Angove
Non-executive director (to 31 December 2014)
Qualifications: BSc
Experience: Chair and Managing Director of Angove Family Winemakers, founding member of the Winemakers' Federation of Australia (WFA) in 1988. Immediate past Chair of WFA/AWBC Wine Industry Technical Advisory Committee and recently retired member of WFA Medium Winemakers' Membership Committee and WFA Executive.

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

Mr James F. Brayne
Non-executive director (to 31 December 2014)
Qualifications: BAppSc (Wine Science)
Experience: Production Director/Chief Winemaker McWilliams Wines Pty Ltd, national wine show judge, 41 years' technical and winemaking experience in the Australian wine industry.

Mr Paul D. Conroy
Non-executive director (to 24 May 2015)
Qualifications: LLB (Hons) BComm
Experience: Chief Legal Officer and Company Secretary Treasury Wine Estates Ltd, admitted as a solicitor in the Supreme Courts of NSW, Victoria and the High Court of Australia, more than 20 years' legal and management experience working in Australia, Asia, United Kingdom and the USA.

Dr John S. Harvey
Non-executive director (to 31 December 2014)
Qualifications: BSc (Hons) PhD MBA GAICD
Experience: Managing Director and owner of Bathe Wines Pty Ltd and Australian Grape and Wine Authority regional mentor for McLaren Vale. Former President of the Adelaide Hills Wine Region, member of the South Australian Wine Industry Association Executive and Executive Director of the Grape and Wine Research and Development Corporation. Fifteen years' wine industry research, R&D management and commercial experience. Current director of Business Development at BioInnovation SA, non-executive director of Studio Nine Architects and Rural Business Support, Deputy Chair of the Can:Do 4 Kids Group of Charities.

Mr Kim R. Horton
Non-executive director (since 1 January 2015)
Qualifications: BAppSc (Wine Science)
Experience: Senior Winemaker Willow Bridge Estate, previously Chief Winemaker Ferngrove Vineyards Estate Pty Ltd. Twenty-one years' technical and winemaking experience in the Australian wine industry.

Dr Daniel L. Johnson
Managing Director
Qualifications: BSc (Hons) PhD MBA GAICD
Experience: Chair of the Australian Wine Industry Technical Conference, director of the National Wine Foundation, member of the International Scientific Council of L'Institut des Sciences de la Vigne et du Vin (ISVV) Bordeaux (France), member of the WFA Innovation Policy Committee, member of the *Australian Journal of Grape and Wine Research* Journal Advisory Committee, member of the *World of Fine Wine* Editorial Board, member of the Wine Innovation Cluster Leadership Group, member of the Waite Strategic Leadership Group, graduate of the Harvard Business School Authentic Leadership Development Program, graduate of the INSEAD Blue Ocean Strategy Program, graduate of the Australian Wine Industry Future Leaders Program, graduate of the IESE Creative Negotiation program, Honorary Adjunct Professor at the Macquarie Graduate School of Management, 18 years' experience in research, development and innovation.

Mr Brett M. McKinnon
Non-executive director
Qualifications: BAgSc (Oenology) (Hons)
Experience: Global Operations Director Pernod Ricard Winemakers, 27 years' technical, winemaking, viticulture and commercial experience, Chair of WFA Innovation Policy Committee, director of 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.

Dr Stuart C. McNab
Non-executive director (since 1 January 2015)
Qualifications: BAgSc (Hons) PhD
Experience: Wine industry and agribusiness consultant, 20 years' experience in the Australian and global wine sectors across technical, winemaking, viticulture, marketing, logistics, operations, commercial and research functions. Previously Chief Supply Officer for Treasury Wine Estates managing global wine production, with past roles including Chair of the Wine Innovation Cluster, member of the Executive Committee and President of the South Australian Wine Industry Association, member of the South Australian Wine Industry Council and member of WFA Board.
Special Responsibilities: Dr McNab is a member of the Audit committee.

Ms Mary J. Retallack
Non-executive director (since 1 January 2015)
Qualifications: BAppSc (CPM) PGradDip (NRM) BEd GradDip (Viti) PCert (Arb) CPAg GAICD ARLF
Experience: Managing Director/Viticulturist Retallack Viticulture Pty Ltd, 20 years' wine sector experience in a wide range of practical, extension and consultancy roles. Member of University of Adelaide Wine Alumni Steering Group, member of the *Australian & New Zealand Grapegrower & Winemaker* editorial panel, founding member of Wine Grape Growers' Australia – Decision Support Network, member of 'Women of the Vine' Global Symposium Advisory Board. Graduate of the Australian Wine Industry Future Leaders Program, fellow of the Australian Rural Leadership Foundation. Past director of Wine Communicators of Australia, past non-executive director of the Grape and Wine Research and Development Corporation, member of South Australian Wine Industry Council. RIRDC Rural Woman of the Year 2012, recognised in 100 Women in Australian Agribusiness 2014 and Len Evans Tutorial Scholar 2014.

Ms Elizabeth A. Riley
Non-executive director
Qualifications: BAppSc (Wine Science)
Experience: Nuffield Farming Scholar, Managing Director and Viticulturist Vitibit Pty Ltd, professional member of the ASVO, associate member of the Hunter Valley Wine and Tourism Association and member of the Viticulture Subcommittee. 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, 23 years' experience in the Australian wine industry.

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

Mr Mark R. Watson
Non-executive director
Qualifications: MBA BEc ACA RITP MAICD
Experience: Managing Director of Blue Sky Alternative Investments (Adelaide office), 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.

Indemnification of officers and auditors

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

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

Members' guarantee

In accordance with the Company's constitution, each member (both during the time he or she is a member and within one year afterwards) is liable to contribute $2 in the event that the Company is wound up. The total amount members would contribute is $28 (2014: $24).

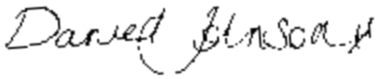
Auditor's independence

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 2015.

Dated at Urrbrae on this the 15th day of September 2015.

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

Louisa E. Rose
Chair



Daniel L. Johnson
Managing Director

Declaration of independence of Paul Gosnold

To the directors of the Australian Wine Research Insitute Limited

As lead auditor of the Australian Wine Research Institute Limited for the year ended 30 June 2015, I declare that, to the best of my knowledge and belief, there have been:

1 No contraventions of the auditor independence requirements of the *Corporations Act 2001* in relation to the audit; and

2 No contraventions of any applicable code of professional conduct in relation to the audit.

Paul Gosnold
Director
BDO Audit (SA) Pty Ltd

Adelaide, 15 September 2015

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 2015

	Note	2015	2014
Revenue from operating activities			
Australian Grape and Wine Authority			
Investment agreement project funding		5,767,856	5,950,000
Investment agreement capital funding		129,148	50,000
Other project funding		2,447,772	2,164,918
Other capital funding		284,712	522,796
Capital specific grant funding		57,847	28,077
Other grant funding		1,191,295	836,686
Commercial services analytical and consulting income		2,881,360	2,822,271
Contract research and other commercial income		1,558,162	1,116,252
Other revenue		183,854	284,125
Total revenue		14,502,006	13,775,125
Other income	*2*	2,336,010	(1,692)
Expenses from operating activities			
Personnel expenses	*3*	8,897,411	8,893,976
Analytical and project operating expenses		2,802,025	1,927,167
Infrastructure and general services expenses		1,352,643	1,349,234
Depreciation and amortisation expense	*8, 9*	1,047,923	1,059,744
Travel expenses		393,174	397,489
Total expenses		14,493,176	13,627,610
Results from operating activities		2,344,840	145,823
Finance income		338,496	360,278
Profit for the period		2,683,336	506,101
Other comprehensive income		–	–
Total comprehensive income for the period		2,683,336	506,101

The notes on pages 62 to 68 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 2015

	Retained earnings	Co-investment reserve	Strategic IT investment reserve	Total equity
Balance at 1 July 2013	13,378,332	–	–	13,378,332
Total comprehensive income for the period				
Profit or loss	506,101	–	–	506,101
Other comprehensive income	–	–	–	–
Total comprehensive income for the period	506,101	–	–	506,101
Transfers between retained earnings and other reserves				
Transfers to (from) reserves	–	–	–	–
Transfers to (from) retained earnings	–	–	–	–
Balance at 30 June 2014	13,884,433	–	–	13,884,433
Balance at 1 July 2014	13,884,433	–	–	13,884,433
Total comprehensive income for the period				
Profit or loss	2,683,336	–	–	2,683,336
Other comprehensive income	–	–	–	–
Total comprehensive income for the period	2,683,336	–	–	2,683,336
Transfers between retained earnings and other reserves				
Transfers to (from) reserves	–	1,000,000	350,000	1,350,000
Transfers to (from) retained earnings	(1,350,000)	–	–	(1,350,000)
Balance at 30 June 2015	15,217,769	1,000,000	350,000	16,567,769

Nature and purpose of reserves

Co-investment reserve

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

(i) That any co-investment be matched on at least an equal basis from externally-sourced funds

(ii) That co-investments create value over the medium to long term for the ultimate benefit of the Australian grape and wine industry

(iii) That co-investments be made only in instances whereby the overall grant funds available to the Australian grape and wine industry are expanded – that is, excluding grant funding programs which already exist for the benefit of that industry.

Strategic IT investment reserve

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

The notes on pages 62 to 68 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 2015

	Note	2015	2014
Assets			
Cash and cash equivalents	4	4,499,417	2,102,532
Other investments	5	8,773,958	8,058,812
Trade and other receivables	6	2,211,938	2,378,947
Inventories	7	81,171	75,980
Prepayments		330,593	242,040
Total current assets		15,897,077	12,858,311
Property, plant and equipment	8	2,252,584	2,288,656
Interest in WIC Building	9	4,759,289	4,962,627
Total non-current assets		7,011,873	7,251,283
Total assets		22,908,950	20,109,594
Liabilities			
Payables and accruals	10	4,397,829	4,146,241
Project funds not expended	11	150,945	357,570
Provisions	12	1,551,460	1,463,390
Total current liabilities		6,100,234	5,967,201
Provisions	12	240,947	257,960
Total non-current liabilities		240,947	257,960
Total liabilities		6,341,181	6,225,161
Net assets		16,567,769	13,884,433
Equity			
Retained earnings		15,217,769	13,884,433
Co-investment reserve		1,000,000	–
Strategic IT investment reserve		350,000	–
Total equity		16,567,769	13,884,433

The notes on pages 62 to 68 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 2015

	Note	2015	2014
Cash flows from operating activities			
Cash receipts from project grants and other income		16,426,246	12,513,956
Cash paid to suppliers and employees		(13,157,706)	(12,249,328)
Net cash from operating activities		3,268,540	264,628
Cash flows from investing activities			
Cash receipts from capital specific funding		144,297	251,262
Interest received		280,889	437,586
Proceeds from sale of property, plant and equipment		273	10,314
Acquisition of property, plant and equipment		(581,968)	(1,145,198)
Acquisition of other investments		(715,146)	(808,812)
Net cash used in investing activities		(871,655)	(1,254,848)
Cash flows from financing activities			
Payment of finance lease liabilities		–	–
Net cash used in financing activities		–	–
Net increase (decrease) in cash and cash equivalents		2,396,885	(990,220)
Cash and cash equivalents at 1 July		2,102,532	3,092,752
Cash and cash equivalents at 30 June	4	4,499,417	2,102,532

The notes on pages 62 to 68 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 15th day of September 2015.

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

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

(a) Basis of preparation

(i) Statement of compliance

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

The financial statements of the Company are Tier 2 general purpose financial statements which have been prepared in accordance with Australian Accounting Standards – Reduced Disclosure Requirements (AASB-RDRs) (including Australian Interpretations) adopted by the 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 Australian Accounting Standards requires management to make judgements, estimates and assumptions that affect the application of accounting policies and the reported amount of assets, liabilities, income and expenses. 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 2015 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 rights 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

	2015	2014
Net gain/(loss) on sale of property, plant and equipment	15	(1,692)
Reimbursement of State taxes	2,335,995	-
	2,336,010	(1,692)

3. Personnel expenses

	2015	2014
Wages and salaries	7,813,518	7,576,826
Other associated personnel expenses	350,416	628,066
Contributions to defined contribution plans	733,477	689,084
	8,897,411	8,893,976

4. Cash and cash equivalents

	2015	2014
Cash on hand	500	500
Bank deposits at-call	4,498,917	2,102,032
Cash and cash equivalents in the statement of cash flows	4,499,417	2,102,532

5. Other investments

	2015	2014
Held-to-maturity investments	8,773,958	8,058,812
	8,773,958	8,058,812

Held-to-maturity investments consist of term deposits with interest rates between 2.92 and 3.61 percent (2014: between 3.56 and 3.97 percent) and mature within 6 months of balance date (2014: within 6 months of balance date).

6. Trade and other receivables

	2015	2014
Trade receivables due from those other than related parties	1,424,498	976,107
Trade receivables due from related parties	11,558	36,412
Other receivables	775,882	1,366,428
	2,211,938	2,378,947

Trade receivables are shown net of impairment losses amounting to $0 (2014: $0) at reporting date. This allowance account is used to record impairment losses until the Company is satisfied that no recovery of the amount owing is possible; at that point the amounts are considered irrecoverable and are written off against the financial asset directly.

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

	2015	2014
Balance at 1 July	–	769
Impairment charge for the year	482	–
Written off during the year	(482)	(769)
Balance at 30 June	–	–

7. Inventories

	2015	2014
Course materials on hand – wine	78,193	75,980
Course materials in transit – wine	2,978	–
	81,171	75,980

8. Property, plant and equipment

	Plant and machinery	Office furniture and IT	Laboratory equipment	Capital WIP	Total
Cost					
Balance at 1 July 2014	359,079	1,043,923	8,741,248	46,657	10,190,907
Additions	10,691	54,446	639,586	104,048	808,771
Transfers	–	2,150	44,507	(46,657)	–
Disposals	(1,498)	(14,363)	(43,335)	–	(59,196)
Balance at 30 June 2015	368,272	1,086,156	9,382,006	104,048	10,940,482
Depreciation and impairment losses					
Balance at 1 July 2014	222,037	740,150	6,940,064	–	7,902,251
Depreciation charge for the year	42,805	125,997	675,783	–	844,585
Disposals	(1,240)	(14,363)	(43,335)	–	(58,938)
Balance at 30 June 2015	263,602	851,784	7,572,512	–	8,687,898
Carrying amounts					
at 1 July 2014	137,042	303,773	1,801,184	46,657	2,288,656
at 30 June 2015	104,670	234,372	1,809,494	104,048	2,252,584

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 Australian Grape and Wine Authority (AGWA).

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

Cost	
Balance at 1 July 2014	6,100,140
Balance at 30 June 2015	6,100,140
Amortisation and impairment losses	
Balance at 1 July 2014	1,137,513
Amortisation charge for the year	203,338
Balance at 30 June 2015	1,340,851
Carrying amounts	
at 1 July 2014	4,962,627
at 30 June 2015	4,759,289

10. Payables and accruals

	2015	2014
Current		
Trade payables due to those other than related parties	636,842	205,670
Trade payables due to related parties	–	–
Income received in advance	1,532,774	1,818,226
PAYG and GST	244,914	349,295
Non-trade payables and accrued expenses	1,983,299	1,773,050
	4,397,829	4,146,241

11. Project funds not expended

Any unexpended AGWA funding is reimbursable to AGWA, except where AGWA agrees that amounts can be retained by the AWRI for purposes approved by AGWA, at which point such amounts are considered to be committed towards that purpose. Project underspends recorded in the year ended 30 June 2015 may be reduced or eliminated by overspends recorded within those projects in prior years – where applicable, the unexpended funds detailed below have been reduced by such amounts.

The unexpended investment agreement funds for the current year totalled $102,996 (2014: none). The unexpended funds from other AGWA contracts for the current year totalled $47,949 (2014: $196,027).

During the year AGWA approved the retention by the Company of unspent prior years' funds totalling $249,511 for the purpose of specific capital purchases (2014: $365,050) and $108,059 for other purposes (2014: $122,755). During the year no unspent prior years' funds relating to AGWA projects were returned to AGWA (2014: $4,480).

	2015	2014
AGWA current year's investment agreement funding unexpended	102,996	–
AGWA current year's other contract funding unexpended	47,949	196,027
AGWA prior years' funding unexpended and uncommitted	–	161,543
	150,945	357,570

12. Provisions

	2015	2014
Current		
Employee entitlements	1,551,460	1,463,390
Non-current		
Employee entitlements	240,947	257,960
Number of employees (FTEs)	92.1	91.7

13. Operating leases

	2015	2014
Leases as lessee		
Non-cancellable operating lease rentals are payable as follows:		
Within one year	20,596	24,913
One year or later and no later than five years	17,419	13,936
Later than five years	–	–
	38,015	38,849

During the year the Company entered into one new lease for a motor vehicle (running for a period of two years) and one new lease for an item of office equipment (running for a period of five years) under operating lease agreements. These leases provide no option to renew or purchase at the completion of their terms.

During the year ended 30 June 2015 an amount of $21,377 was recognised as an expense in respect of operating leases (2014: $21,409).

14. Capital commitments

	2015	2014
Property, plant and equipment		
Contracted but not provided for and payable		
Within one year	264,367	37,605
One year or later and no later than five years	120,000	–
Later than five years	–	–
	384,367	37,605

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:

	2015	2014
Total remuneration	1,539,001	1,583,605

During the year non-executive directors became entitled to compensation totalling $90,331 (2014: $86,333). A number of directors voluntarily elected not to receive $62,333 of this entitlement (2014: $37,000), instead redirecting such amounts to support otherwise unfunded activities of the Company including the participation of all AWRI staff in a wine education event to celebrate the AWRI's 60th anniversary, and a number of professional development opportunities for individual AWRI staff.

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
Retallack Viticulture Pty Ltd
Vitibit Pty Ltd

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

Other related parties:
The Australian Wine Industry Technical Conference Incorporated

Transactions with related parties

	Transactions value for the year ended 30 June		Balance outstanding as at 30 June	
	2015	2014	2015	2014
Services received from related parties	4,204	33,239	–	–
Services provided to related parties	113,300	260,954	11,558	36,412

16. Contingencies

In the opinion of the Directors, there were no material or significant contingent liabilities at 30 June 2015 (2014: none).

17. Subsequent events

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

18. Limited liability

In accordance with the Company's constitution, each member (both during the time he or she is a member and within one year afterwards) is liable to contribute $2 in the event that the Company is wound up. The total amount members would contribute is $28 (2014: $24).

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 62 to 68 are in accordance with the *Corporations Act 2001*, including:

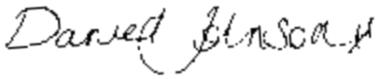
(i) giving a true and fair view of the Company's financial position as at 30 June 2015 and of its performance for the financial year ended on that date; and

(ii) complying with Australian Accounting Standards – Reduced Disclosure Requirements and the *Corporations Regulations 2001*; and

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

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

Louisa E. Rose
Chair



Daniel L. Johnson
Managing Director

Dated at Urrbrae on this the 15th day of September 2015.

Independent auditor's report to the directors 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 2015, the statement of profit or loss and other comprehensive income, statement of changes in equity and statement of cash flows for the year then ended, notes comprising a summary of significant accounting policies and other explanatory information, and the directors' declaration.

Directors' responsibility for the financial report

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

Auditor's responsibility

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

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

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

Independence

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

Opinion

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

(a) giving a true and fair view of the company's financial position as at 30 June 2015 and of its performance for the year ended on that date; and

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

BDO Audit (SA) Pty Ltd

Paul Gosnold
Director

Adelaide, 22 September 2015

Memorial funds

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

Statement by directors of the trustee company

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

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

(a) (i) the Statements of profit or loss and other comprehensive income give a true and fair view of each Trust's profit or loss for the year ended 30 June 2015; and

(ii) the Statements of financial position give a true and fair view of each Trust's state of affairs as at 30 June 2015.

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

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

Louisa E. Rose
Chair

Dated at Urrbrae on this the 15th day of September 2015.

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 2015	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**
Income								
Interest	2,686	3,114	2,005	2,543	1,746	2,023	2,233	2,742
Donations and other income	–	–	–	–	–	–	–	–
Total income	2,686	3,114	2,005	2,543	1,746	2,023	2,233	2,742
Expenses								
Advertising	–	–	–	–	–	–	–	–
Audit fees	–	–	–	–	–	–	–	–
Bank charges	–	–	–	–	–	–	–	–
Technical Review contributions	–	–	–	–	–	–	–	–
Sponsorship	–	–	–	10,000	–	–	–	7,000
Total expenses	–	–	–	10,000	–	–	–	7,000
Profit/(loss) from ordinary activities	2,686	3,114	2,005	(7,457)	1,746	2,023	2,233	(4,258)
Other comprehensive income	–	–	–	–	–	–	–	–
Total comprehensive income for the period	2,686	3,114	2,005	(7,457)	1,746	2,023	2,233	(4,258)

STATEMENTS OF FINANCIAL POSITION								
As at 30 June 2015	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**
Assets								
Cash at bank	–	–	–	–	–	–	–	–
Investments	130,063	127,286	97,076	95,003	84,533	82,728	108,126	105,818
Receivables	161	252	120	188	104	163	133	208
Total current assets	130,224	127,538	97,196	95,191	84,637	82,891	108,259	106,026
Investments	–	–	–	–	–	–	–	–
Total non-current assets	–	–	–	–	–	–	–	–
Total assets	130,224	127,538	97,196	95,191	84,637	82,891	108,259	106,026
Liabilities								
Sundry creditors	–	–	–	–	–	–	–	–
Total current liabilities	–	–	–	–	–	–	–	–
Net assets	130,224	127,538	97,196	95,191	84,637	82,891	108,259	106,026
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	114,753	111,639	70,141	77,598	62,891	60,868	105,976	110,234
Profit/(loss) for the year	2,686	3,114	2,005	(7,457)	1,746	2,023	2,233	(4,258)
Closing balance	117,439	114,753	72,146	70,141	64,637	62,891	108,209	105,976
Total trust funds	130,224	127,538	97,196	95,191	84,637	82,891	108,259	106,026

Appendix 1

External presentations

Staff	Title of presentation	Presented to and where	Date
D.L. Johnson	Overview and launch 'Opportunities in a new climate'	Opportunities in a new climate launch, Adelaide, SA	1 Jul 14
M.L. Longbottom	Mitigation, adaptation or innovation?		
E.J. Bartowsky	Unravelling the mysteries of malolactic fermentation: from microbiology to frontier technology	Australian Society for Microbiology, Melbourne, Vic	7 Jul 14
N. Scrimgeour	Unravelling the relationship between grape and wine composition	US webinar, hosted by Enartis	10 Jul 14
E.J. Bartowsky	Chasing wine aroma: impact of different LAB and MLF scenarios	Malolactic Symposium, Toulouse, France	10-11 Jul 14
P.W. Godden	Perspectives on Nebbiolo in Australia	Negociants Australia, Working With Wine seminar, Adelaide, SA	14 Jul 14
M. Parker	Flavours in wine	Melbourne Writers Festival 'Flavours in Wine' event, Mount Langi Ghiran, Vic	10 Aug 14
M.J. Herderich	Terroir effects on grape and wine aroma compounds	Advances in Wine Research Symposium at the American Chemical Society National Meeting, San Francisco, USA	11 Aug 14
P.W. Godden	What style of PinotG are you? Helping consumers understand the styles of wine made from Pinot Grigio and Pinot Gris	New Zealand Society for Viticulture and Oenology 'To Gris or not to Gris' workshop, Blenheim, New Zealand	26 Aug 14
M.P. Krstic	Winegrowing with technology – an Australian perspective	Romeo Bragato conference, Blenheim, New Zealand	28 Aug 14
E.J. Bartowsky	Genomic analysis of 80 *Oenococcus oeni* strains and connecting the genome with winemaking properties	11th International Symposium on Lactic Acid Bacteria, Egmond aan Zee, The Netherlands	3 Sep 14
	Chasing wine aroma: impact of different LAB and MLF scenarios	Malolactic Symposium, Stellenbosch, South Africa	5 Sep 14
M.J. Herderich	Latest developments in analysing macromolecules and metabolites in grapes and wine: practical applications and potential pitfalls	MacroWine 2014 – Macromolecules and secondary metabolites of grape and wine, Stellenbosch, South Africa	8 Sep 14
M.Z. Viviers	Formation of 'reduced' odours in wine post-bottling: natural occurring precursors or additive effect?		9 Sep 14
I.L. Francis	Describing wine aromas and flavours	Advanced Wine Assessment Course, Adelaide, SA	
P.W. Godden	Looking towards the wine science horizon	Nederburg 40th anniversary wine auction, Paarl, South Africa	13 Sep 14
W.P. Pearson	Describing wine aromas and flavours	Advanced Wine Assessment Course, Adelaide, SA	15 Sep 14
N. Scrimgeour	Unravelling the relationship between grape and wine composition	Pernod Ricard Winemakers, Barossa Valley, SA	18 Sep 14
M.Z. Viviers	Copper, it never does any harm	Distell, Stellenbosch, South Africa	
C.A. Simos	Welcome and introduction	AWRI roadshow seminar, Geelong, Vic	24 Sep 14
	What options do you have in cold stabilising your wine?		
	Features of the AWRI website		
M.P. Krstic	How can irrigation management strategies be used to manipulate wine quality?		
	It's getting hotter – what does this mean for vineyard management strategies?		
M. Essling	Salt management in vineyards		

Staff	Title of presentation	Presented to and where	Date
K.A. Bindon	Managing phenolic quality in the vineyard	AWRI roadshow seminar, Geelong, Vic	24 Sep 14
C.D. Curtin	Winemaking with non-conventional and hybrid yeast		
	Did you know that DAP can strongly affect the flavour profile and style of wine?		
C.A. Simos	Welcome and introduction	AWRI roadshow seminar, Macedon Ranges, Vic	25 Sep 14
	What options do you have in cold stabilising your wine?		
	Features of the AWRI website		
M.P. Krstic	How can cultural practices be used to improve fruit set?		
	Does soil and vine nutrient status affect wine quality?		
K.A. Bindon	Managing phenolic quality in the vineyard		
M. Essling	Why do we need new varieties for the future?		
C.D. Curtin	Winemaking with non-conventional and hybrid yeast		
	Did you know that DAP can strongly affect the flavour profile and style of wine?		
E.J. Bartowsky	Genomic analysis of 80 *Oenococcus oeni* strains and connecting the genome with winemaking properties	Crush 2014 – the grape and wine science symposium, Adelaide, SA	
M.Z. Viviers	The evolution of 'reduced' odours in wine post-bottling: additive effect?		
S.A. Schmidt	Genomic differences powering variation in primary fermentation		
M. Parker	Lingering flavours: sensory and analytical studies demonstrating retronasal aroma perception from in-mouth release of flavour glycoconjugates		26 Sep 14
M.Z. Viviers	The revolving door of stinky sulfurs	AWRI webinar	7 Oct 14
G.D. Cowey	Adapting to difficult vintages welcome and introduction	AWRI roadshow workshop, Glen Innes, NSW	15 Oct 14
	Salinity, sodicity and salty wine		
	Hotter and drier – processing ripe fruit		
	Sustainability and efficiencies in the winery		
	New varieties for a changing climate tasting		
C.A. Simos	Bushfires and smoke taint tasting		
	Winemaking in wet seasons		
M. Essling	Hotter and drier in the vineyard		
	Growing grapes in wet seasons		
	Q&A session and case studies		
C.A. Simos	Welcome and introduction	AWRI roadshow seminar, Great Southern, WA	21 Oct 14
	What options do you have in cold stabilising your wines?		
	Features of the AWRI website		
M. Essling	It's getting hotter – what does this mean for our vineyard management strategies?		
	Why do we need new varieties for the future?		
I.L. Francis	Pepper and spice in Shiraz: what influences rotundone levels in wines?		
	Thinking outside the bottle: insights on how Chinese consumers choose wine		
P.A. Henschke	Managing H_2S during fermentation		
	Winemaking at low pH: avoiding stuck fermentations in whites and sparkling wines		
M.G. Holdstock	Adapting to difficult vintages welcome and introduction	AWRI roadshow workshop, Griffith, NSW	22 Oct 14
	Hotter and drier – processing ripe fruit		
	Winemaking in wet seasons		
	New varieties for a changing climate tasting		

Staff	Title of presentation	Presented to and where	Date
M.L. Longbottom	Hotter and drier in the vineyard	AWRI roadshow workshop, Griffith, NSW	22 Oct 14
	Salinity, sodicity and salty wine		
	Growing grapes in wet seasons		
	Q&A session and case studies		
A.D. Coulter	Sustainability and efficiencies in the winery		
	Bushfires and smoke taint tasting		
C.A. Simos	Welcome and introduction	AWRI roadshow seminar, Pemberton, WA	
	Features of the AWRI website		
M. Essling	Does soil and vine nutrient status affect wine quality?		
	Is it possible to control bunch rot without fungicides?		
K.A. Bindon	Crafting diverse wine styles through an understanding of how grape composition affects wine composition		
	The changing wine style of the ripening grape		
P.A. Henschke	Increasing red and white wine complexity with the AWRI's *bayanus* yeast		
	Putting the texture back into white wine – the role of white wine phenolics		
J.R. Bellon	Introducing a new breed of wine yeast	Institute of Research on Cancer and Aging, Nice, France	
P.W. Godden	Summary of the wines entered and the judging process	Royal Adelaide Wine Show, national schools competition awards ceremony, Wayville, SA	
C.A. Simos	Welcome and introduction	AWRI roadshow seminar, Margaret River, WA	23 Oct 14
	Features of the AWRI website		
M. Essling	It's getting hotter – what does this mean for our vineyard management strategies?		
	Why do bunches get hot – and what does this mean for wine quality?		
P.A. Henschke	Winemaking with non-conventional and hybrid yeast		
K.A. Bindon	Predicting wine tannin and colour in the vineyard		
	The changing wine style of the ripening grape		
I.L. Francis	The origins of eucalyptol and minty flavours in red wine		
	Thinking outside the bottle: insights on how Chinese consumers choose wine		
C.A. Simos	Welcome and introduction	AWRI roadshow seminar, Swan Valley, WA	24 Oct 14
	Why is managing dissolved oxygen at bottling so important?		
	Features of the AWRI website		
M. Essling	Does soil and vine nutrient status affect wine quality?		
I.L. Francis	Key wine flavour compounds		
	Pepper and spice in Shiraz: what influences rotundone levels in wines?		
P.A. Henschke	Winemaking with non-conventional and hybrid yeast		
E. Wilkes	SO_2 – the misunderstood component	AWRI webinar	30 Oct 14
J.R. Bellon	Introducing a new breed of wine yeast	Biochemistry Department, Cambridge University, UK	7 Nov 14
C.S. Stockley	Wine and health – anything new?	Treasury Wine Estates' annual technical seminar, Magill, SA	
G.D. Cowey	The carbon farming initiative and emissions reduction fund: climate change policy and the impact on the grape and wine sector	AWRI webinar	11 Nov 14
P.R. Dry	Extreme and increasing temperatures – effects on grapes and wine	Opportunities in a new climate workshop, Penola, SA	
	Cultural practices to improve fruit set	AWRI webinar	13 Nov 14

Staff	Title of presentation	Presented to and where	Date
M.P. Krstic	Adapting to difficult vintages welcome and introduction	AWRI roadshow workshop, Bendigo, Vic	17 Nov 14
	Hotter and drier in the vineyard		
	Salinity, sodicity and salty wine		
	Growing grapes in wet seasons		
	Q&A session and case studies		
M.G. Holdstock	Winemaking in wet seasons		
	New varieties for a changing climate tasting		
	Hotter and drier – processing ripe fruit		
A.D. Coulter	Sustainability and efficiencies in the winery		
	Bushfires and smoke taint tasting		
J.M. McRae	Alternatives to bentonite – what's on the horizon?	ASVO seminar, Adelaide, SA	18 Nov 14
S. Nordestgaard	Grape destemming and sorting technology – developments in-winery and on-harvester		
M.P. Krstic	Adapting to difficult vintages welcome and introduction	AWRI roadshow workshop, Avoca, Vic	
	Hotter and drier in the vineyard		
	Salinity, sodicity and salty wine		
	Growing grapes in wet seasons		
	Q&A session and case studies		
M.G. Holdstock	Hotter and drier – processing ripe fruit		
	Winemaking in wet seasons		
	New varieties for a changing climate tasting		
A.D. Coulter	Bushfires and smoke taint tasting		
	Sustainability and efficiencies in the winery		
C.A. Simos	Additives and processing aids: when things go wrong	ASVO seminar, Adelaide, SA	19 Nov 14
M.G. Holdstock	Welcome and introduction	AWRI roadshow seminar, Mornington Peninsula, Vic	20 Nov 14
	What options do you have in cold stabilising your wines?		
	Features of the AWRI website		
J.M. McRae	Predicting wine tannin and colour in the vineyard		
	Managing phenolic quality in the vineyard		
P.A. Henschke	Managing H_2S during fermentation – latest research		
	Managing stuck fermentations		
R. Gawel	Managing the risk of protein haze formation in white wines		
	Putting the texture back into white wine – the role of white wine phenolics		
D.L. Johnson	2014 AWRI annual report	New South Wales Wine Industry Association, Sydney, NSW	
M.P. Krstic	Welcome and introduction	AWRI roadshow seminar, Gippsland, Vic	24 Nov 14
	Features of the AWRI website		
	Vine balance – how does it affect yield and quality?		
K.A. Bindon	Managing phenolic quality in the vineyard		
E.J. Bartowsky	Using MLF to accentuate wine aroma and flavour		
	Using the timing of MLF inoculation to optimise your winemaking		
P.A. Henschke	Managing H_2S during fermentation – latest research		
	Winemaking with non-conventional and hybrid yeast		
I.L. Francis	Thinking outside the bottle: insights on how Chinese consumers choose wine		
M.P. Krstic	Welcome and introduction	AWRI roadshow seminar, Yarra Valley, Vic	25 Nov 14
	How can cultural practices be used to improve fruit set?		

Staff	Title of presentation	Presented to and where	Date
M.P. Krstic	How can irrigation management strategies be used to manipulate wine quality?	AWRI roadshow seminar, Yarra Valley, Vic	25 Nov 14
	Features of the AWRI website		
K.A. Bindon	Managing phenolic quality in the vineyard		
I.L. Francis	Pepper and spice in Shiraz: what influences rotundone levels in wines?		
P.A. Henschke	Winemaking with non-conventional and hybrid yeast		
E.J. Bartowsky	Technologies to manage microbial spoilage or delay MLF		
J.R. Bellon	New yeast for the New World	Plumpton College, UK	26 Nov 14
M.P. Day	The effect of oxygen in pressing and juice handling	AWRI webinar	27 Nov 14
C.A. Simos	Welcome and introduction	AWRI roadshow seminar, Griffith, NSW	1 Dec 14
	Features of the AWRI website		
P.A. Henschke	Managing H_2S during fermentation – latest research		
E.J. Bartowsky	Using the timing of MLF inoculation to optimise your winemaking		
R. Gawel	Putting the texture back into white wine – the role of white wine phenolics		
N. Scrimgeour	Winery cost reduction strategies/doing more with less: sustainable process solutions for profitability		
	Measuring phenolics to add value to your business		
M.L. Downie	eBooks – introducing the AWRI's brand new Grape and Wine eBook collection	AWRI webinar	2 Dec 14
M. Essling	Impacts on soil health from organic, biodynamic and conventional viticultural practices	Burnett Mary Regional Group workshop, South Burnett, Qld	
	Emissions reductions opportunities in the viticulture industry		
J.R. Bellon	Introducing a new breed of wine yeast	Department of Genetics, University of Leicester, UK	4 Dec 14
D.L. Johnson	2014 AWRI annual report	Queensland Wine Industry Association AGM, Stanthorpe, Qld	
C.D. Curtin	Biosciences research at the AWRI	Department of Biology, Catholic University of Leuven, Belgium	5 Dec 14
E. Wilkes	Impact of temperature on pH, it's not automatic	Interwinery Analysis Group, Berri, SA	
	Preparing your lab for vintage		
	SO_2 – the misunderstood component		
C.D. Curtin	Biosciences research at the AWRI	Wolfe Laboratory, Conway Institute, University College Dublin, Ireland	8 Dec 14
S.A. Schmidt	What do you need to know about rehydration nutrients and nutrient additives?	AWRI webinar	9 Dec 14
I.L. Francis	Wine flavours	AWRI wine flavours workshop, Coonawarra, SA	
T.E. Siebert	Stone fruit flavours		
	Pepper flavour (rotundone) in red wine		
D.L. Capone	Thiols and tropical flavours in Chardonnay		
	Green flavours in Shiraz and Cabernet Sauvignon		
	Eucalyptus flavour (1,8–cineole) in red wine		
D.L. Johnson	2014 AWRI annual report	Wine Tasmania Board meeting, Relbia, Tas	
J.M. McRae	Recent advances in the development of alternatives to bentonite	AWRI webinar	16 Dec 14
M.L. Longbottom	Climate and the wine industry	Opportunities in a new climate workshop, Melbourne, Vic	18 Dec 14
G.D. Cowey	Where does the wine industry sit in terms of Australian climate policy and the global carbon market?		
M. Essling	What are the opportunities for the grape and wine sector?		
C.A. Simos	Wine flavours, faults and taints	IMW international seminar, Odney, UK	8 Jan 15
	Trouble free winemaking		

Staff	Title of presentation	Presented to and where	Date
M.L. Longbottom, E.A. Riley[1]	*Botrytis* – risk and control options	AWRI webinar	16 Jan 15
M.P. Krstic, M.J. Herderich, M.G. Holdstock	Smoke taint Q&A	AWRI smoke taint seminar, Adelaide Hills, SA	20 Jan 15
M.L. Longbottom, L.M. Bevin	NSW DPI weather station network	AWRI/NSW DPI webinar	22 Jan 15
C.A. Simos	Welcome and introduction	AWRI roadshow seminar, Launceston, Tas	3 Feb 15
M.P. Krstic	I have *Botrytis* bunch rot – what can I do about it?		
	Vine balance – how does it affect yield and quality?		
K.A. Bindon	Managing phenolic quality in the vineyard		
C.A. Simos	Winemaking strategies for *Botrytis* and powdery mildew		
	Features of the AWRI website		
	Welcome and introduction	AWRI roadshow seminar, Hobart, Tas	4 Feb 15
	Winemaking strategies for *Botrytis* and powdery mildew		
	Features of the AWRI website		
M.P. Krstic	I have *Botrytis* bunch rot – what can I do about it?		
	Vine balance – how does it affect yield and quality?		
K.A. Bindon	Managing phenolic quality in the vineyard		
M.G. Holdstock	Adapting to difficult vintages, welcome and introduction	AWRI roadshow workshop, Geelong, Vic	10 Feb 15
	Salinity, sodicity and salty wine		
	Winemaking in wet seasons		
	Q&A session and case studies		
	New varieties for a changing climate tasting		
A.D. Coulter	Hotter and drier – processing ripe fruit		
	Bushfires and smoke taint tasting		
	Sustainability and efficiencies in the winery		
M. Essling	Hotter and drier in the vineyard		
	Growing grapes in wet seasons		
G.D. Cowey	Simulated flavours, faults, taints and mouth-feel tasting	Taints and faults workshop, Tanunda, SA	
N. Scrimgeour	Use of the AWRI WineCloud for rapid determination of grape polyphenols	Webinar, ISVEA polyphenols and wine congress, 2nd edition, Florence, Italy	13 Feb 15
A.M. Barker	The use of time-intensity to measure the in-mouth flavour release of precursors present in Gewurztraminer wine: training protocols and application of data analysis techniques.	9th Annual Australia and New Zealand Sensory and Consumer Science Symposium, Waiheke Island, New Zealand	17 Feb 15
C.A. Simos, M.P. Krstic	Smoke taint Q&A	AWRI smoke taint seminar, Manjimup, WA	
P.W Godden	Overview of the AWRI	OIV MSc in wine management, Adelaide, SA	5 Mar 15
M.J. Herderich	Overview of research at the AWRI		
E. Wilkes	Commercial Services		
P.J. Chambers	Biosciences research at the AWRI		
C.A. Simos	Industry development and support		
J.C. Hack	AWRI metabolomics node update	Metabolomics Australia analytical meeting, Parkville, Vic	17 Mar 15
	Analysis of stinky sulfur compounds in wine		
	R-based molecular feature extraction workflow for GC-MS and LC-MS data		18 Mar 15
P.O. Williamson, I.L. Francis	Influence of sensory perceptions in wine tasting	VALO launch event, Adelaide, SA	1 Apr 15
P.R. Petrie	Impacts of climate change on agriculture (wine)	Governor's leadership foundation program, climate, water and energy, Urrbrae, SA	9 Apr 15
M.J. Herderich	Treatment of wine with agar as a fining agent	OIV Technology Expert Group, Paris, France	15 Apr 15
R.L. Taylor	Magic in the laboratory – turning samples into numbers	Peracto company conference, Adelaide, SA	21 Apr 15

Staff	Title of presentation	Presented to and where	Date
M.J. Herderich	Potassium carbonate for de-acidification of wine	OIV specifications for oenological products expert group, Paris, France	23 Apr 15
D.L. Johnson	The AWRI's history	The AWRI's 60th birthday dinner, Adelaide, SA	30 Apr 15
E. Wilkes	The AWRI and the WineCloud, phenolic measurements in grape and wine production	Enartis customer education centre, Sonoma, USA	1 May 15
M.L. Longbottom	Introduction to mulch and compost	NSW DPI skills development program mulch workshop, Griffith, NSW	6 May 15
	Results of mulch trials in other regions		
G.D. Cowey	Hotter and drier – processing ripe fruit and high sugar juices	AWRI roadshow workshop, Mildura, Vic	12 May 15
	Salinity, sodicity and salty wine		
	Winemaking in wet seasons		
	New varieties for a changing climate tasting		
M. Essling	Hotter and drier in the vineyard		
	Building resilience and sustainability in the grape and wine sector		
	Growing grapes in wet seasons		
A.D. Coulter	Bushfires and smoke taint tasting		
	Sustainability and efficiencies in the winery		
P.R. Petrie	Greenhouse gas emissions abatement in viticulture		
G.D. Cowey	Hotter and drier – processing ripe fruit and high sugar juices	AWRI roadshow workshop, Renmark, SA	13 May 15
	Salinity, sodicity and salty wine		
	Winemaking in wet seasons		
	New varieties for a changing climate		
M. Essling	Hotter and drier in the vineyard		
	Building resilience and sustainability in the grape and wine sector		
	Growing grapes in wet seasons		
A.D. Coulter	Bushfires and smoke taint tasting		
	Sustainability and efficiencies in the winery		
P.R. Petrie	Greenhouse gas emissions abatement in viticulture		
C.A. Simos	Welcome and introduction	AWRI roadshow seminar, Pokolbin, NSW	19 May 15
	Features of the AWRI website		
P.R. Petrie	Terroir – separating fact from fiction		
	I have *Botrytis* bunch rot – what can I do about it?		
C.D. Curtin	Did you know that DAP can strongly affect the flavour profile and style of wine?		
	Complex yeast nutrients – how do they fit into your fermentation management strategy?		
E.J. Bartowsky	Using the timing of MLF inoculation to optimise your winemaking		
E. Wilkes	Get the best out of your winery using 'lean production'		
	Energy for the future: moving towards on-site renewable biomass and solar technology		
T.E. Siebert	Common and interesting wine aromas	Blackwood winemakers and brewers club, Blackwood, SA	20 May 15
G.D. Cowey	Wine aromas, flavours, faults and taints and Australian wine show judging	Pernod Ricard Winemakers, Tanunda, SA	21 May 15
C.A. Simos	Welcome and introduction	AWRI roadshow seminar, Langhorne Creek, SA	26 May 15
	Winemaking management strategies for *Botrytis* and powdery mildew		
	Features of the AWRI website		
P.R. Petrie	Terroir – separating fact from fiction		

Staff	Title of presentation	Presented to and where	Date
P.R. Petrie	Why do varieties respond differently to drought and heat stress – and what does this mean for your irrigation?	AWRI roadshow seminar, Langhorne Creek, SA	26 May 15
M. Essling	Why do bunches get hot – and what does this mean for wine quality?		
	Greenhouse gas emissions abatement in viticulture		
K.A. Bindon	The changing wine style of the ripening grape		
T.J. Abbott	Making your production more environmentally sustainable		
M.L. Longbottom	Greenhouse gas abatement in viticulture	Action on the Ground workshop, Margaret River, WA	
		Action on the Ground workshop, Swan Valley, WA	28 May 15
P.A. Smith	Factors influencing extractability, retention and modification of tannins during winemaking	9th World Congress on Polyphenols Applications, St. Julian's, Malta	3 Jun 15
C.S. Stockley	Celebrating the resveratrol clinical trial	Royal Melbourne Hospital, Melbourne, Vic	6 Jun 15
M.G. Holdstock	Adapting to difficult vintages	AWRI roadshow workshop, Coonawarra, SA	10 Jun 15
M.L. Longbottom	Hotter and drier in the vineyard		
A.D. Coulter	Hotter and drier – processing ripe fruit		
	Bushfires and smoke taint tasting		
M.G. Holdstock	Salinity, sodicity and salty wine		
	Q&A session and case studies		
	New varieties for a changing climate tasting		
M.L. Longbottom	Growing grapes in wet seasons		
A.D. Coulter	Winemaking in wet seasons		
	Sustainability and efficiencies in the winery		
M.L. Longbottom	Building resilience and sustainability in the grape and wine sector		
C.A. Simos	Welcome and introduction	AWRI roadshow seminar, Mildura, Vic	11 Jun 15
	Features of the AWRI website		
P.A. Henschke	Choose the right yeast to achieve the red style you want		
I.L. Francis	Pepper and spice in Shiraz: what influences rotundone levels in wines?		
	Thinking outside the bottle: insights on how Chinese consumers choose wine		
R. Gawel	Solids ferments: effect of juice clarity and clarification method on drivers of wine texture		
M.P. Krstic	Vine balance – how does it affect yield and quality?		
	Does soil and vine nutrient status affect wine quality?		
P.R. Petrie	Why do varieties respond differently to drought and heat stress – and what does this mean for your irrigation?		
	It's getting hotter – what does this mean for our vineyard management strategies?		
P.O. Williamson	Insights on how Chinese consumers choose wine and the influence of tasting on consumer preferences	Wine consumer and market insights symposium, Melbourne, Vic	18 Jun 15
I.L. Francis	Understanding wine consumers: the role of analytical sensory testing, consumer product acceptance and marketing research		
G.D. Cowey	Hotter and drier – processing ripe fruit	AWRI roadshow workshop, Launceston, Tas	23 Jun 15
	Salinity, sodicity and salty wine		
	Building resilience and sustainability in the grape and wine sector		
	New varieties for a changing climate tasting		
M.P. Krstic	Hotter and drier in the vineyard		
	Growing grapes in wet seasons		

Staff	Title of presentation	Presented to and where	Date
A.D. Coulter	Bushfires and smoke taint tasting	AWRI roadshow workshop, Launceston, Tas	23 Jun 15
	Winemaking in wet seasons		
	Sustainability and efficiencies in the winery		
G.D. Cowey	Hotter and drier – processing ripe fruit	AWRI roadshow workshop, Hobart, Tas	25 Jun 15
	Salinity, sodicity and salty wine		
	Q&A session and case studies		
	Building resilience and sustainability in the grape and wine sector		
	New varieties for a changing climate tasting		
M.P. Krstic	Hotter and drier in the vineyard		
	Growing grapes in wet seasons		
A.D. Coulter	Bushfires and smoke taint tasting		
	Winemaking in wet seasons		
	Sustainability and efficiencies in the winery		
M.L. Longbottom	Building resilience and sustainability in the grape and wine sector	Opportunities in a new climate workshop, Willunga, SA	26 Jun 15
	Greenhouse gas abatement in viticulture		
	Climate and the wine industry		
M.G. Holdstock	Opportunities for the grape and wine sector		
	The emissions reduction fund – how does it work?		
J. Hixson, K. Hirlam	Maximising the potential of grape marc		
A. Mierczynska-Vasilev	Understanding the role of colloids in wines	French National Institute for Agricultural Research (INRA), Avignon, France	
M.J. Herderich	Terroir effects on grape and wine aroma compounds	Oeno 2015 Symposium, Bordeaux, France	29 Jun 15

Affiliations: [1]Vitibit Pty Ltd

Appendix 2

Events organised by AWRI staff

Staff	Title of event	Held	Date
M.L. Longbottom	Opportunities in a new climate launch	Adelaide, SA	1 Jul 14
M.P. Krstic	Grampians soils and Shiraz benchmarking session	Great Western, Vic	2 Jul 14
	Pyrenees soils and Shiraz benchmarking session	Pyrenees, Vic	3 Jul 14
M.L Longbottom	Research to practice workshop – Grapevine nutrition in a changing environment	Macedon Ranges, Vic	18 Jul 14
C.A. Simos, U. Fischer[1]	Unveiling the secrets of German Riesling and terroir	Clare Valley, SA	21 Jul 14
		Barossa Valley, SA	22 Jul 14
M.P. Krstic, U. Fischer[1]	Unveiling the secrets of German Pinot Noir and terroir	Mornington Peninsula, Vic	30 Jul 14
		Yarra Valley, Vic	31 Jul 14
M.L. Longbottom	Climate change and the SA wine industry	Adelaide, SA	
M.P. Krstic	Bud dissection workshop	Mornington Peninsula, Vic	4 Aug 14
M.L. Longbottom, K. DeGaris	Spring vine health field day	Mudgee, NSW	2 Sep 14
		Canberra, ACT	3 Sep 14
		Griffith, NSW	4 Sep 14
		Irymple, Vic	5 Sep 14

Staff	Title of event	Held	Date
C.A. Simos, M.G. Holdstock, G.D. Cowey, F. Blefari, V.F. Phillips	Advanced Wine Assessment Course (AWAC 35)	Adelaide, SA	9-12 Sep 14
	Advanced Wine Assessment Course (AWAC 36)		15-18 Sep 14
M.L. Longbottom	Research to practice workshop – Grapevine nutrition in a changing environment	Orange, NSW	16 Sep 14
		Hunter Valley, NSW	19 Sep 14
C.A. Simos, M.P. Krstic, M. Essling, K.A. Bindon, C.D. Curtin	AWRI roadshow seminar	Geelong, Vic	24 Sep 14
		Macedon Ranges, Vic	25 Sep 14
I.L. Francis, P. Schlich[2], A.M. Barker, W.U. Cynkar	Temporal dominance of sensations (TDS): a sensory science workshop	Adelaide, SA	29 Sep 14
M. Essling	Research to practice workshop – Integrated pest management for changing viticultural environments	Macedon Ranges, Vic	10 Oct 14
G.D. Cowey, C.A. Simos, M. Essling	AWRI roadshow workshop – Adapting to difficult vintages	Glen Innes, NSW	15 Oct 14
M.L. Longbottom	Research to practice workshop – Grapevine nutrition in a changing environment	Canberra, ACT	21 Oct 14
C.A. Simos, M. Essling, I.L. Francis, P.A. Henschke	AWRI roadshow seminar	Great Southern, WA	
		Pemberton, WA	22 Oct 14
A.D. Coulter, M.L. Longbottom, M.G. Holdstock	AWRI roadshow workshop – Adapting to difficult vintages	Griffith, NSW	
C.A. Simos, M. Essling, I.L. Francis, P.A. Henschke	AWRI roadshow seminar	Margaret River, WA	23 Oct 14
		Swan Valley, WA	24 Oct 14
M.L. Longbottom	Opportunities in a new climate workshop	Penola, SA	11 Nov 14
M.P. Krstic, M.G. Holdstock, A.D. Coulter	AWRI roadshow workshop – Adapting to difficult vintages	Bendigo, Vic	17 Nov 14
		Avoca, Vic	18 Nov 14
M.G. Holdstock, J.M. McRae, P.A. Henschke, R. Gawel	AWRI roadshow seminar	Mornington Peninsula, Vic	20 Nov 14
M.P. Krstic, K.A. Bindon, E.J. Bartowsky, P.A. Henschke, I.L. Francis		Gippsland, Vic	24 Nov 14
		Yarra Valley, Vic	25 Nov 14
C.A. Simos, P.A. Henschke, E.J. Bartowsky, R. Gawel, N. Scrimgeour		Griffith, Vic	1 Dec 14
M. Essling	Research to practice workshop – Sustainable viticulture: a comparison of organic, biodynamic and conventional practices	Stanthorpe, Qld	4 Dec 14
M.P. Krstic	Grapevine trunk disease workshop	Yarra Glen, Vic	8 Dec 14
I.L. Francis, D.L. Capone, T.E. Siebert, C.A. Simos, F. Blefari.	Wine flavours workshop	Coonawarra, SA	9 Dec 14
M.P. Krstic	Grapevine trunk disease workshop	Mornington Peninsula, Vic	
		Geelong, Vic	10 Dec 14
		Wagga Wagga, Vic	15 Dec 14
		Bendigo, Vic	16 Dec 14
		Grampians, Vic	17 Dec 14
M.L. Longbottom	Opportunities in a new climate workshop	Melbourne, Vic	18 Dec 14
M.P. Krstic	Smoke taint round table		
M.P. Krstic, M.J. Herderich, M.G. Holdstock	AWRI smoke taint seminar	Adelaide Hills, SA	20 Jan 15
C.A. Simos, M.P. Krstic, K.A. Bindon	AWRI roadshow seminar	Launceston, Tas	3 Feb 15
		Hobart, Tas	4 Feb 15
M.P. Krstic	Flavour development in the vineyard workshop	Yarra Glen, Vic	5 Feb 15
	International Pinot Noir celebration	Mornington Peninsula, Vic	6-7 Feb 15
M.G. Holdstock, M. Essling	Opportunities in a new climate workshop	Geelong, Vic	9 Feb 15
G.D. Cowey	Taints and faults workshop	Tanunda, SA	10 Feb 15
M.G. Holdstock, A.D. Coulter, M. Essling	AWRI roadshow workshop – Adapting to difficult vintages	Geelong, Vic	
C.A. Simos, M.P. Krstic	AWRI smoke taint seminar	Manjimup, WA	17 Feb 15
V.T. O'Brien, P.O.Williamson, I.L. Francis	VALO launch event	Adelaide, SA	1 Apr 15
M.P. Krstic	Smoke taint round table	Melbourne, Vic	30 Apr 15

Staff	Title of event	Held	Date
M.L. Longbottom	NSW DPI skills development program mulch workshop	Griffith, NSW	6 May 15
F. Blefari, P.O. Williamson	AWRI Aroma Bar, Wine Australia – Aussie wine month	Sydney, NSW	7 May 15
M.P. Krstic	Clonal tasting and Shiraz benchmarking workshop	Great Western, Vic	12 May 15
A.D. Coulter, G.D. Cowey, M. Essling, P.R. Petrie	AWRI roadshow workshop – Adapting to difficult vintages	Mildura, Vic	
		Renmark, SA	13 May 15
M.P. Krstic	Next generation planting material workshop	Plumpton, Vic	14 May 15
P.R. Petrie, C.D. Curtin, E.J. Bartowsky, E. Wilkes, C.A. Simos	AWRI roadshow seminar	Pokolbin, NSW	19 May 15
M.P. Krstic	Smoke taint forum	Melbourne, Vic	20 May 15
P.R. Petrie, M. Essling, K.A. Bindon, T.J. Abbott, C.A. Simos	AWRI roadshow seminar	Langhorne Creek, SA	26 May 15
A.D. Coulter, M.G. Holdstock, M.L. Longbottom	AWRI roadshow workshop – Adapting to difficult vintages	Coonawarra, SA	10 Jun 15
P.A. Henschke, I.L. Francis, R. Gawel, C.A. Simos, M.P. Krstic, P.R. Petrie	AWRI roadshow seminar	Mildura, Vic	11 Jun 15
G.D. Cowey, F. Blefari	Barossa wine assessment tasting	Richmond Grove, SA	16-17 Jun 15
M.P. Krstic	Perfecting Pinot Noir workshop	Red Hill South, Vic	17 Jun 15
	Wine consumer and market insights symposium	Melbourne, Vic	18 Jun 15
A.D. Coulter, G.D. Cowey, M.P. Krstic	AWRI roadshow workshop – Adapting to difficult vintages	Launceston, Tas	23 Jun 15
		Hobart, Tas	25 Jun 15
M.L. Longbottom, M.G. Holdstock, J. Hixson, K. Hirlam	Opportunities in a new climate workshop	Willunga, SA	26 Jun 15

Affiliations: [1]Department of Viticulture and Oenology, DLR-Rheinpfalz, Breitenweg Neustadt, Germany, [2]INRA, Dijon, France

Appendix 3

Posters

Staff	Title of poster	Presented at	Date
T.E. Siebert, M.A. de Barros Lopes[1], P. Darriet[2], M.J. Herderich, I.L. Francis	Are γ-lactones responsible for 'stone fruit' aroma in white wine?	14th Weurman Flavour Research Symposium, Cambridge, UK	15-19 Sep 14
J.R. Bellon, F. Yang[3], D.L. Inglis[3], B.L. Dunn[4], G. Sherlock[4], C.D. Curtin, P.J. Chambers	*Saccharomyces* interspecific hybrids display genome evolution and phenotypic diversity	European Molecular Biology Organization Conference Series, Experimental Approaches to Evolution and Ecology using Yeast and Other Model Systems, Heidelberg, Germany	12-15 Oct 14
Y. Grebneva[5], C.A. Black, M.P. Krstic, M.R. Solomon, M. Stoll[6], D. Rauhut[6], C. Patz[6], M.J. Herderich, S. Delrot[2], P. Darriet[2], H.R. Schultz[6]	Heat effects on Riesling: a case study of managing fruit and aroma composition in a changing climate	Bordeaux Adelaide Germany (BAG) alliance meeting, Bordeaux, France	26 Jun 15
T.E. Siebert, W.P. Pearson, A.M. Barker, M.A. De Barros Lopes[1], P. Darriet[2] , M.J. Herderich, I.L. Francis	Volatile aroma compounds related to 'stone fruit' aroma in Viognier and Chardonnay wines	Oeno 2015 Symposium, Bordeaux, France	29 Jun-1 Jul 15
A.C. Monteau[7], V. Renouf[7], N. Scrimgeour, N. Tiquet-Lavandier[8]	Alcoholic fermentation in new oak tanks: effects on the color, chemical composition and sensory profile of Shiraz wine, before and after ageing in barrels		

Affiliations: [1]University of South Australia, [2]Institut des Sciences de la Vigne et du Vin, France, [3]Cool Climate Oenology and Viticulture Institute, Brock University, Canada, [4]Department of Genetics, Stanford University, USA, [5]Dresden University of Technology, [6]Hochschule Geisenheim University, Germany, [7]Chêne & Cie Research and Development, France, [8]Tonnellerie Taransaud, France

Appendix 4

Teaching responsibilities (lectures) of AWRI staff

Institution	Subject number	Subject name	Number of lectures	Staff member
University of Adelaide	3007WT/7010WT	Stabilisation and clarification	2	R. Gawel
			3	A.D. Coulter
			1	J.M. McRae
	3420/3046WT	Fermentation technology III	1	I.L. Francis
	3005WT	Grape industry practice, policy and communication	2	
			2	C.S. Stockley
			1	P.R. Petrie
	3500WT	Biotechnology in the food and wine industries III	2	P.J. Chambers
	7046WT	Fermentation technology	5	P.A. Henschke
	7520 WT	Advances in wine science	3	E.J. Bartowsky
			1	C.A. Simos
			2	P.A. Henschke
	7047WT	Winemaking at vintage	2	
			1	M.P. Day
	GENETICS 3210	Advanced molecular biology IIIB	1	A.R. Borneman
Flinders University		Brain and behaviour – perspectives on alcohol and drug use	1	C.S. Stockley
University of Melbourne		Food for a healthy planet – bioactive compounds	1	

Appendix 5

Student supervision responsibilities of AWRI staff

Student	Supervisors	Source of funds
PhD		
Jenny Bellon	P.J. Chambers, A.R. Borneman, C. Ford[1]	University of Adelaide
Mango Parker	M. de Barros Lopes[2], C.A. Black, I.L. Francis, M.J. Herderich	Wine Australia
Tracey Siebert	I.L. Francis, M.J. Herderich, M. de Barros Lopes[2]	Wine Australia
Federico Tondini	V. Jiranek[1], M.J. Herderich	Australian Research Council Industrial Transformation Training Centre, University of Adelaide
Patricia Williamson	I.L. Francis, L. Lockshin[2], S. Mueller-Loose[3]	Wine Australia
Ryan Zeppel	A.R. Borneman, C.D. Curtin, J. Kelly[1]	Wine Australia and University of Adelaide
Pangzhen Zhang	M.P. Krstic, M.J. Herderich, K.S. Howell[4], S. Barlow[4], S. Fuentes[4],	University of Melbourne
Masters		
Yevgeniya Grebneva	M.J. Herderich, M.P. Krstic, C.A. Black, T. Henle[5]	BAG Alliance
Yu Hou	D.L. Capone, D.W. Jeffery[1]	University of Adelaide
Hons		
Lisa Hartmann	A.R. Borneman, C.D. Curtin, J. Kelly[1]	

Affiliations: [1]University of Adelaide, [2]University of South Australia, [3]University of Aarhus, Denmark, [4]University of Melbourne, [5]Dresden University of Technology, Germany

Appendix 6

Media interviews

Date	Staff member	Discussed	Media
1 Jul 14	M.L. Longbottom	Opportunities in a new climate launch	Nikolai Beilharz, *ABC SA Country Hour*
14 Jul 14	K.K. Forsyth	Research on grape marc	Elise Fantin, *ABC South East,* Mount Gambier
17 Jul 14	M.P. Day	Effects of early oxygen exposure in winemaking	Eloise Fuss, *ABC News*
21 July 14	C.D. Curtin	New developments in wine yeast research	Alessandra Biondi Bartolini, *Vigne & Vini*, Italy
23 Jul 14	M.P. Krstic	Effects of warm winter on next year's harvest in Tasmania	Grace McCallum, *ABC News,* Hobart
21 Aug 14	P.A. Smith	Relationships between grape chemical composition and grape allocation grade	Jen Barwick, *AGWA RD&E @work*
22 Aug 14	M.J. Herderich	Authenticity	Max Allen, *The Australian*
1 Sep 14	M. Parker	Wine flavour precursors	Jen Barwick, *AGWA RD&E news*
	M. Essling	'Dog book' updates	
3 Sep 14	M.G.M. Coode	Winery trials: winemaking trials in smaller wineries can be valuable if done properly	Cathy Howard, *Wine & Viticulture Journal*
12 Sep 14	P.W. Godden	The AWRI's wine science program	Jaco Wolmarans, *Distell media*, Paarl, South Africa
			Idelle Esterhuizen, *SABC2,* South Africa
13 Sep 14			Chris Mabuya, *SABC TV,* South Africa
			Marius van de Wall, *Kyknet TV,* South Africa
16 Sep 14	M. Parker	Wine flavour precursors	Matthew Doran, *ABC News SA,* Pt Pirie
24 Sep 14	P.W. Godden	The AWRI refrigeration demand calculator	Jen Barwick, *AGWA RD&E news*
7 Nov 14	C.A. Simos	Wine authenticity	Bridget Fitzgerald, *ABC News South West Region,* WA
11 Nov 14	M.L. Longbottom	Opportunities in a new climate workshop	*ABC Radio*
18 Nov 14	N. Scrimgeour	Preview of process sensors project	Jen Barwick, *AGWA RD&E news*
21 Nov 14	M.J. Herderich	Metabolomics in grape and wine research	Jeffrey Perkel, Freelance Writer, *Biotechniques*
24 Nov 14		The science behind terroir	Elizabeth Finkel, *Cosmos Magazine*
25 Nov 14	M.G. Holdstock	VA issues from the helpdesk	Jen Barwick, *AGWA RD&E news*
18 Dec 14	P.W. Godden	Enzymes for heat stabilisation	Don Neel, *Practical Winery and Vineyard,* USA
5 Jan 15	C.A. Simos	Smoke taint	Tony Love, *The Advertiser*
6 Jan 15	M.P. Krstic		Jane Wardell, *Thomson Reuters*
		Disease management in grapevines	*3AW radio*
7 Jan 15	N. Scrimgeour	New research aiming to help winemakers more quickly identify problems during fermentation	*ABC Eyre Peninsula and West Coast,* SA
			ABC Riverland, SA
			ABC South East, Mount Gambier
	C.A. Black	Flavour synthesis, in-mouth flavour release	Abbey Flanagan, *AGWA RD&E@Work*
9 Jan 15	M.P. Krstic	Smoke taint	Warren Moore, *2GB radio*
14 Jan 15			Fergus Sweeney, *the John Murray Show, RTE Radio 1,* Ireland.
20 Jan 15			Simon Royal, *ABC TV news*
21 Jan 15			Jenna Crowther, *2UE Fairfax Radio Network*
29 Jan 15			Anthony Madigan, *WBM*
3 Feb 15	M.P. Day	Update on oxygen research	Nick Carne, *AGWA RD&E news*

Date	Staff member	Discussed	Media
5 Feb 15	E. Wilkes	Wine analysis	Tim Wildman, *WineTutor.TV*
	M.G. Holdstock	Taints and faults in wine	
6 Feb 15	C.A. Simos	Smoke taint	Olivia Garnett, *ABC WA Country Hour*
9 Feb 15	J. Hixson	Grape marc to reduce methane in livestock	*ABC 639 North West SA*
12 Feb 15	V.T. O'Brien	VALO project	Anthony Madigan, *WBM*
23 Feb 15	C.D. Curtin	Update on the *Brettanomyces* research project	Nick Carne, *AGWA RD&E news*
24 Feb 15	P.A. Smith	Measuring tannin in grapes	Nick Carne, *AGWA RD&E@work*
28 Feb 15	C.A. Simos, I.L. Francis	AWRI activities at the Vancouver International Wine Festival, Canada	Tony Gismondi and Casey Wilson, *Best of Food and Wine, Radio CISL 650AM,* Vancouver, Canada
2 Mar 15	M.L. Downie, L.M. Bevin	New eBooks collection	Nick Carne, *AGWA RD&E news*
3 Mar 15	T.E. Siebert	Rotundone, Mt Langi Ghiran and the 'pepper map'	Sarah Hadson, *Weekly Times,* Melbourne
	M.P. Day	Using oxygen during winemaking can have positive impacts	Sallese Gibson, *ABC News Riverland and Mallee*
4 Mar 15	C.A. Varela	Research on lower alcohol wine	Nick Carne, *AGWA RD&E news*
17 Mar 15	M.L. Longbottom	Adapting to earlier vintages	Lauren Waldhuter, *ABC Rural*
24 Mar 15	P.J. Chambers	Soil bacteria and wine quality	*Australian Science Media Centre*
26 Mar 15	C.A. Varela	Exploring how different strains of yeast can be used to make lower alcohol wine	Sallese Gibson, *ABC News Riverland and Mallee*
1 Apr 15	C.A. Simos	Smoke taint	Bension Siebert, *InDaily Adelaide*
			Claire Peddie, *The Advertiser*
2 Apr 15			Jenna Crowther, *2UE Fairfax Radio Network*
12 Apr 15	P.W. Godden	The AWRI's 60th anniversary, particularly the commemorative Barossa Shiraz	Caroline Winter, *ABC Country Hour*
20 Apr 15	C.A. Varela	Researcher profile	Nick Carne, *AGWA RD&E@work*
23 April 15	N. Scrimgeour	Closure trials	Jane Faulkner
27 Apr 15	D.L. Johnson	The AWRI's 60th anniversary	Sonya Feldhoff, *ABC 891 afternoon program*
29 Apr 15			Will Goodings, *5AA radio*
7 May 15	G.D. Cowey	Riverland adapting to difficult vintages workshop	Elise Fantin, *ABC Rural Radio Riverland*
13 May 15	A.D. Coulter	Smoke taint	Emma Brown, *ABC Rural Radio Riverland*
	P.R. Petrie	Adapting to warmer vintages and heatwaves	
20 May 15	M.G. Holdstock	Pinking	Nick Carne, *AGWA RD&E news*
21 May 15	V.T. O'Brien	VALO	Michael Milnes, *News Corp Australia*
28 May 15	P.A. Smith	Extension to the grape objective measures project	Nick Carne, *AGWA RD&E@work*
29 May 15	I.L. Francis, V.T. O'Brien	Research at the AWRI, Chinese wine consumer preferences and VALO	Chinese TV documentary
3 June 15	P.R. Petrie	Researcher profile	Nick Carne, *AGWA RD&E@work*
20 Jun 15	I.L. Francis	The effect of pine and cypress trees on wine flavour	Jen Barwick, *AGWA RD&E news*
25 Jun 15	P.J. Chambers	Microorganisms and terroir	Max Allen, *The Australian*

Appendix 7

Papers published by AWRI staff recorded during 2014/2015

1636 McRae, J.M., Kirby, N., Mertens, H.D.T., Kassara, S., Smith, P.A. Measuring the molecular dimensions of wine tannins: comparison of small-angle x-ray scattering, gel-permeation chromatography and mean degree of polymerization. *J. Agric. Food Chem.* 62(29): 7216-7224; 2014.

1637 Cowey, G. Ask the AWRI: the ABCs of filtration and what works for you. *Aust. N.Z. Grapegrower Winemaker* (606): 60; 2014.

1638 McRae, J., Smith, P. Closure selection and pH influence on red wine color and tannin during bottle aging. *Wines Vines* 95(6): 64-66; 2014.

1639 Coulter, A., Cowey, G., Dry, P., Essling, M., Holdstock, M., Stockley, C., Simos, C., Johnson, D. Vintage 2014 – trends from the AWRI helpdesk. *Wine Vitic. J.* 29(4): 34-36; 2014.

1640 Dry, P. Albariño. *Wine Vitic. J.* 29(4): 60; 2014.

1641 Johnson, D. Opportunities in a new climate. *Aust. N.Z. Grapegrower Winemaker* (607): 7; 2014.

1642 Longbottom, M. Adaptation, mitigation and innovation in a changing climate. *Aust. N.Z. Grapegrower Winemaker* (607): 16; 2014.

1643 Longbottom, M. Ask the AWRI: Viticulture and greenhouse gas emissions. *Aust. N.Z. Grapegrower Winemaker* (607): 54; 2014.

1644 Ruiz-Garcia, Y., Smith, P.A., Bindon, K.A. Selective extraction of polysaccharide affects the adsorption of proanthocyanidin by grape cell walls. *Carbohyd. Polym.* 114: 102-11; 2014.

1645 Stockley, C.S. Chair of WineHealth 2013 scientific advisory committee. *Nutr. Aging* 2(2-3): 77-79; 2014.

1646 Scholey, A., Benson, S., Stough, C., Stockley, C. Effects of resveratrol and alcohol on mood and cognitive function in older individuals. *Nutr. Aging* 2(2-3): 133-138; 2014.

1647 Jolly, N.P., Varela, C., Pretorius, I.S. Role of non-*Saccharomyces* yeasts in wine production. *Wines Vines* 95(7): 52, 54, 56; 2014.

1648 Albertin, W., Panfili, A., Miot-Sertier, C., Goulielmakis, A., Delcamp, A., Salin, F., Lonvaud-Funel, A., Curtin, C., Masneuf-Pomarede, I. Development of microsatellite markers for the rapid and reliable genotyping of *Brettanomyces bruxellensis* at strain level. *Food Microbiol.* 42: 188-195; 2014.

1649 Bizaj, E., Curtin, C., Čadež, N., Raspor, P. Interactions between industrial yeasts and chemical contaminants in grape juice affect wine composition profile. *Food Technol. Biotechnol.* 52(2): 222-231; 2014.

1650 Dry, P., Dry, N. Carignan – the unmasking of an imposter. *Wine Vitic. J.* 29(4): 49-52; 2014.

1651 Marty, P., Dry, P. Sparkling wine production in the southeast of England. *Wine Vitic. J.* 29(4): 60; 2014.

1652 Kidman, C.M., Dry, P.R., McCarthy, M.G., Collins, C. Effect of root-stock on nutrition, pollination and fertilisation in 'Shiraz' (*Vitis vinifera* L.). *Vitis* 53(3): 139-145; 2014.

1653 Herderich, M., Mayr, C., Parker, M., Baldock, G., Black, C.A., Hayasaka, Y., Francis, L. Glycoconjugates of volatile phenols and smoke related off-flavours in wine. Gougeon, R. (ed.) *Wine Active Compounds 2014: Proceedings of the 3rd edition of the International Conference Series on Wine Active Compounds,* Beaune, France, 26-28 March 2014. Chaintré, France: Oenopurimedia: 227-230; 2014.

1654 Marangon, M., Smith, P.A. Clarifying the mechanism of protein haze formation in white wines. Gougeon, R. (ed.) *Wine Active Compounds 2014: Proceedings of the 3rd edition of the International Conference Series on Wine Active Compounds*, Beaune, France, 26-28 March 2014. Chaintré, France: Oenopurimedia: 121-123; 2014.

1655 Francis, L. The ageing of aromas: how complexity develops in wine. *TONG* (18): 2-7; 2014.

1656 Scrimgeour, N., Godden, P. O_2: how closures beat terroir. *TONG* (18): 20-27; 2014.

1657 McRae, J. Don't get all hazed over bentonite – help is coming. *Aust. N.Z. Grapegrower Winemaker* (608): 86-87; 2014.

1658 Coulter, A. Ask the AWRI: Acidity in all its various aspects. *Aust. N.Z. Grapegrower Winemaker* (608): 88; 2014.

1659 McRae, J.M., Day, M.P., Bindon, K.A., Kassara, S., Schmidt, S.A., Schulkin, A., Kolouchova, R., Smith, P.A. Effect of early exposure oxygen on red wine colour and tannins. *Tetrahedron* 71: 3131-3137; 2015.

1660 Gawel, R., Day, M., Van Sluyter, S.C., Holt, H., Waters, E.J., Smith, P.A. White wine taste and mouthfeel as affected by juice extraction and processing. *J. Agric. Food Chem.* 62(41): 10008-10014; 2014.

1661 Forsyth, K. It's time to check your refrigeration plant. *Aust. N.Z. Grapegrower Winemaker* (609): 85-86; 2014.

1662 Stockley, C. Ask the AWRI: Export focus on residual metals. *Aust. N.Z. Grapegrower Winemaker* (609): 80; 2014.

1663 Dry, P. Saperavi. *Wine Vitic. J.* 29(5): 54; 2014.

1664 Curtin, C., Borneman, A., Zeppel, R., Cordente, T., Kievit, R., Chambers, P., Herderich, M., Johnson, D. Staying a step ahead of 'Brett'. *Wine Vitic. J.* 29(5): 34, 36-37; 2014.

1665 Bindon, K.A., McCarthy, M.G., Smith, P.A. Development of wine colour and non-bleachable pigments during the fermentation and ageing of (*Vitis vinifera* L. cv.) Cabernet Sauvignon wines differing in anthocyanin and tannin concentration. *LWT – Food Sci. Technol.* 59(2) (part 1): 923-932; 2014.

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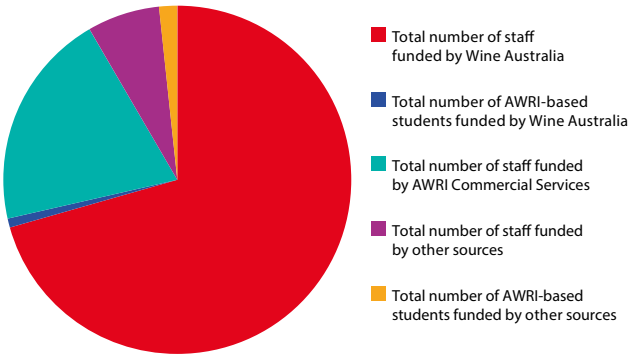

Figure 10. Funding of AWRI staff and students, excluding visiting researchers

Staff of The Australian Wine Research Institute

Top row (L to R): Pauline Jorgensen, Peter Sternes, Marcel Essling, Wies Cynkar, Kathrin Vollmer, Nadine Jaeckels, Federica Blando, Yevgeniya Grebneva, Ryan Zeppel, Alice Barker, Sheridan Barter, Jacqui McRae, Simon Nordestgaard, Mango Parker, Chris Day, Mark Braybrook, Chris Curtin, Eveline Bartowsky, Simon Dillon, Tracey Siebert, Kylee Watson, Deborah Thornton-Wakeford, Simon Schmidt, Annette Freeman.

Middle row (L to R): Natoiya Lloyd, Francesca Blefari, John Gledhill, Maria Calabrese, Agnieszka Mierczynska-Vasilev, Radka Kolouchova, Michael Downie, Danna Lee, Alfons Cuijvers, Creina Stockley, Peter Godden, Paul Petrie, Caroline Bartel, Toni Garcia Cordente, Wes Pearson, Leanne Hoxey, Patricia Williamson, Geoff Cowey, Leigh Francis, Tadro Abbott, Mark Smith, Yoji Hayasaka, Peter Costello.

Front row (L to R): Robyn Gleeson, Con Simos, Tina Tran, Vilma Hysenaj, Jeremy Hack, Richard Gawel, Virginia Phillips, Oliver Lovat, Adrian Coulter, Ella Robinson, Marco Schoeman, Bryan Newell, Eric Wilkes, Angus Forgan, Dan Johnson, Josh Hixson.

Absent: Adam Holland, Alana Spears, Alex Schulkin, Andrea Francis, Anne Lord, Anthony Borneman, Catherine Borneman, Cory Black, Cristian Varela, Darek Kutyna, Dimitra Capone, Elyce Batchelor, Erin Kearsley, Esther Kristianto, Fang Tang, Gayle Baldock, Heather Tosen, Jane McCarthy, Jelena Jovanovic, Jenny Bellon, Jillian Lee, Joanna Verwey, Kate Beames, Keren Bindon, Kerry DeGaris, Kerry Pinchbeck, Kieran Hirlam, Linda Bevin, Lisa Hartmann, Mardi Longbottom, Mark Solomon, Markus Herderich, Marlize Bekker, Martin Day, Matt Holdstock, Melissa Aitchison, Michael Roach, Neil Scrimgeour, Pam Solomon, Paul Chambers, Paul Smith, Peter Dry, Randell Taylor, Shiralee Dodd, Stella Kassara, Tim Reilly, Vince O'Brien.

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