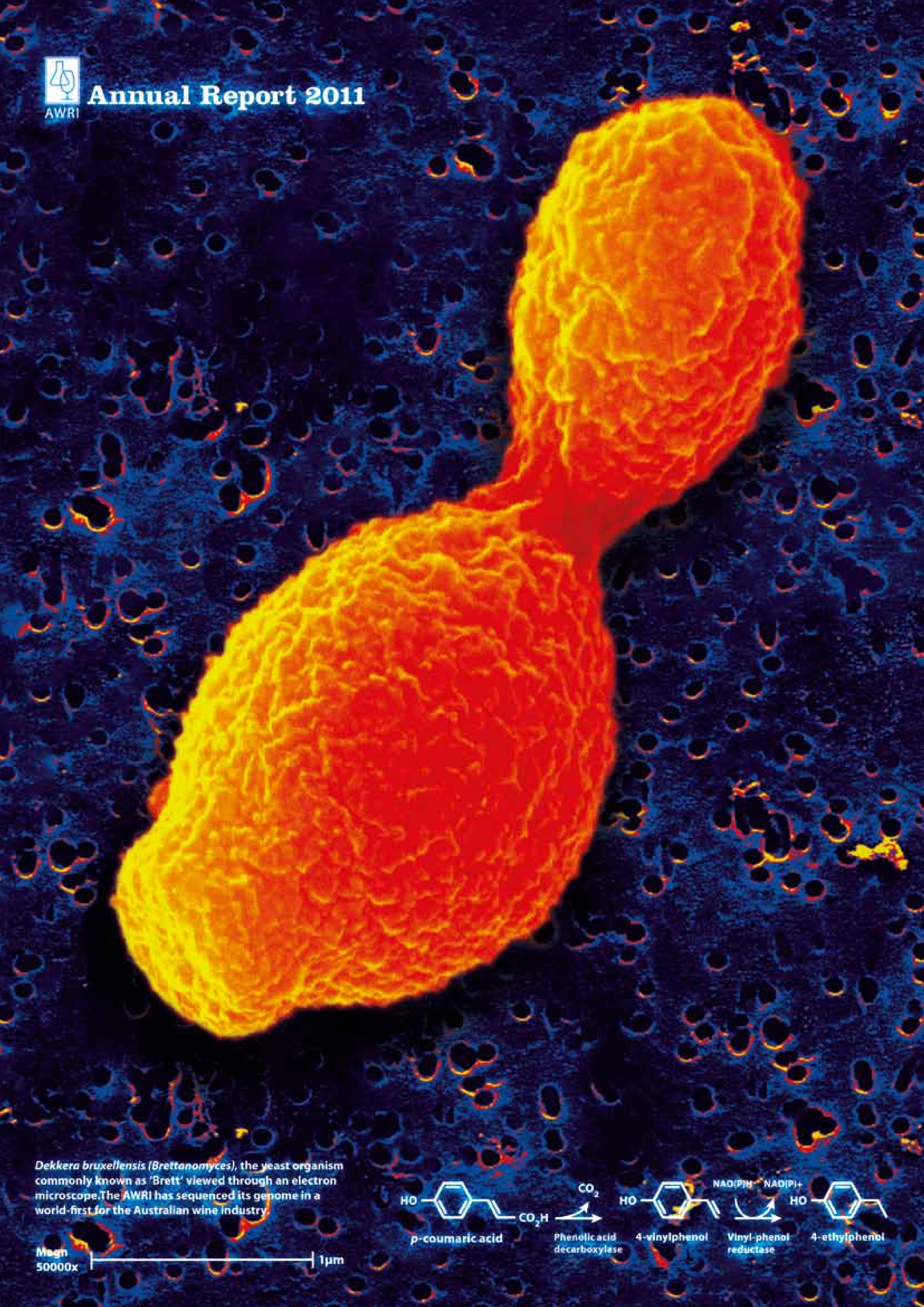
Annual Report 2011



Dekkera bruxellensis (Brettanomyces), the yeast organism commonly known as 'Brett' viewed through an electron microscope.The AWRI has sequenced its genome in a world-first for the Australian wine industry.

BOARD MEMBERS

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

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

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

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

Mr G.R. Linton, BAppSc(AppChem), GradDip(SysAnal)
Elected a member under Clause 25.2(c) of the Constitution (up to 31 December 2010)

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

Ms J.S. O'Connor, BEd (PE)
Elected a member under Clause 25.2(b) of the Constitution

Ms L.E. Rose B AppSc, BSc
Elected as a member under Clause 25.2(c) of the Constitution (from 1 January 2011)

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

Mr J.A. Lumbers BSc(Microbiol); Lit B(Public Policy)
Elected a member under Clause 25.2(c) of the Constitution

Professor I.S. Pretorius, BSc(Hons), MSc, PhD
Ex officio under Clause 25.2(a) of the Constitution as Managing Director of the AWRI

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. In 2006, the AWRI implemented its ten-year business plan *Towards 2015*, and stated its purpose, vision, mission and values:

Purpose
To contribute substantially in a measurable way to the ongoing success of the Australian grape and wine sector

Vision
To deliver high value to the Australian grape and wine sector through world-class research and integrated solutions and to provide thought leadership to the research activities of the Australian wine sector

Mission
To underpin our world-class research and integrated solutions with:

» a tenacious pursuit of understanding;
» the development of a unique, extensive and usable knowledge base; and
» a focus on contributing substantially to stakeholders achieving their needs

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

» scientific integrity and excellence;
» a culture of delivering results;
» internally and externally collaborative;
» accountability and transparency; and
» focused on the Australian wine sector and industry driven

The AWRI's laboratories and offices are housed in the Wine Innovation Central Building of the Wine Innovation Cluster (WIC). The WIC is located within an internationally renowned research cluster on the Waite Precinct at Urrbrae in the Adelaide foothills, on land leased from The University of Adelaide. Collocated in the Wine Innovation Central Building with the AWRI are grape and wine scientists from The University of Adelaide and the South Australian Research and Development Institute. The WIC includes three buildings: WIC East, WIC Central and WIC West. WIC West accommodates the other member of the WIC concept: CSIRO Plant Industry.

Along with the WIC parties mentioned, the AWRI is clustered on the Waite Precinct with the following research and teaching organisations: Australian Centre for Plant Functional Genomics (ACPFG), Australian Genome Research Facility (AGRF), Australian Grain Technologies (AGT), Australian Wheat Management, BiometricsSA, three divisions of CSIRO, Department of Water, Land and Biodiversity Conservation, Primary Industries and Resources South Australia (PIRSA), Membrane Transporter Expression Facility, VivoPharm and The University of Adelaide's *School of Science* (which includes the Schools of Agriculture and Wine, and Earth and Environmental Sciences).

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Chairman's report

Peter Dawson

Industry investment in Research, Development and Extension (RD&E) is crucial to the future of the Australian wine proposition. Investment in RD&E is managed by the Grape and Wine Research Development Corporation (GWRDC) and the development of the GWRDC's five year plan for the period of 2012 – 2017 called for input regarding future priorities and strategy for RD&E investment.

The GWRDC is the largest funder of The Australian Wine Research Institute (AWRI). Under its current seven year investment agreement, which expires in 2013, the AWRI receives approximately 60% of its funding requirements from GWRDC, equating to around 40% of the GWRDC's available funds on an annual basis. This funding is based on a set of agreed RD&E programs designed to meet industry needs and priorities. Under the agreement, progress and outputs are reviewed on a quarterly basis and, where necessary, focus is shifted to accommodate changing needs.

Over the past five years, the AWRI has been encouraged to pursue actively additional sources of funding for its operations to supplement industry levy funds. Sources of additional funding have included specific Australian and State government grants, and commercial contracts from the global grape and wine sector. For every dollar of industry levy funds, the AWRI has leveraged a further 50 cents which is often invested in longer-term non-core activity that has resulted in substantial developments in knowledge and capability for the benefit of our industry. The advances in metabolomics and genomics are notable examples.

The AWRI's input to the GWRDC's planning process resulted from direct engagement with key grape and wine levy payers and the monitoring of trends measured through our trouble shooting and analytical services and extension and education activities.

Nine priorities for RD&E were identified along with researchable themes for each.

The priorities are:

» Understanding and communicating with our customers

» Wine, alcohol content, taxation and health

» Environmental and economic sustainability, including climate change (heat and smoke) and efficient winery and vineyard operations

» Understanding the links between the grapes, the place and the wine by objectively understanding regional differences to support the re-positioning of Australian wines

» The bulk shipping and offshore packaging paradigm

» Fingerprinting to aid authenticity, traceability, grape purchasing decisions and the objective setting of grape and wine quality specifications

» Relevant, responsive information and troubleshooting

» Codifying and understanding the genetic, proteomic and metabolomic information in grapes and wine

» Oxygen management

In its submission to the GWRDC's 5 year plan, the Winemakers Federation of Australia (WFA) identifies all but one of the above priorities, however it advocates radical change to RD&E investment policy in Australia.

Some of the notable features in the proposed 'new paradigm' are:

» A greatly increased emphasis on short-term, highly applied projects and problem solving.

» A significantly reduced commitment to funding core capability.

» A move toward new RD&E expertise at the expense of existing capability including the positioning of AWRI as 'one of many' RD&E providers.

» Fewer 'in-house' researchers and a greater use of global networks and outsourcing.

» User-pays model for industry problem solving.

» A significantly increased emphasis on market intelligence data generation.

The WFA submission talks, on the one hand, of the need for transformational, 'game-changing' innovation and, on the other hand, of having an emphasis on short-term, highly applied research with a problem solving objective. Conventional thinking on innovation would recognise a conflict in these objectives.

As Chairman of the industry's own RD&E organisation, I believe that it is important that all grape and wine levy payers are fully informed of the changes being advocated by WFA and understand the potential consequences with respect to the AWRI and the service that it has provided to industry over the past 56 years.

The Australian model for wine industry RD&E is envied the world over. No other wine producing country has an industry-owned centre of excellence for wine research that is responsive and dedicated to its competitive advantage. Underpinning the success of the AWRI in driving competitive advantage has been the integrated model of world class science coupled with industry leadership and engagement. A secure funding agreement with the GWRDC has been critical to attracting and retaining some of the world's leading researchers and providing unique capability.

In my nine years as a director of the AWRI, I have seen this capability applied to the vexing problems of oxidation and closure performance, *Brettanomyces* and wine taints including, most recently, smoke taint. From my years in industry, I have a very clear insight to the hundreds of millions of dollars of lost opportunity stemming from these problems and the opportunity now presented through winemakers being better informed and equipped to manage these ongoing issues now and into the future. The recent 'world first' breakthrough in determining the genetic blueprint of the most prevalent strains of *Brettanomyces* in Australia will greatly assist in future-proofing control strategies. Similarly, world class science will open up new horizons in managing alcohol levels, managing 'reduced' characters, producing wines which are a true expression of place that enhance the Australian wine proposition.

The AWRI remains responsive to industry needs and has a track record of quickly adapting to change, but it is of the view that the industry's future RD&E requirements can be addressed without wholesale change to investment policy and existing capability. Inevitably there is a need for shifts in focus but the industry is well positioned to leverage existing capability through effective collaboration in RD&E throughout the value chain. Innovation and the place where we grow our grapes and make our wine remain as strengths of the Australian wine proposition.

In recent months, the AWRI board reluctantly accepted the resignation of Professor Sakkie Pretorius as Managing Director. Sakkie has led the AWRI over the last seven years and has made an outstanding contribution to the AWRI and the Australian wine sector as a whole. He has been a true thought leader and has driven the quality of research carried out at the AWRI to levels that have gained international recognition and respect. Sakkie's legacy is an outstanding team and a greatly enhanced global network of research collaborations that will continue to deliver value to the Australian grape and wine sector for many years to come.

Following an international search I was pleased to announce the appointment of Dr Dan Johnson as Managing Director of the AWRI effective 1 December 2011. As General Manager of Business Development with the AWRI over the past five years, Dan has been instrumental in securing diverse funding and forging important collaborative relationships locally and internationally. Dan offers a strong understanding and passion for science together with highly developed commercial skills. In his previous position, he gained a very clear insight to the current and future challenges facing our industry and he is in an ideal position to lead the AWRI through a new era focussing on closer integration of science and application.

I wish to acknowledge and thank the staff and board of the GWRDC for their ongoing support and cooperation. Without clear direction and a productive working relationship we would not have maintained the high quality of output and the level of service to industry that has been achieved.

Finally, I would like to thank my fellow Board members and, in particular, Sakkie Pretorius, for their tireless commitment to the AWRI and its industry focus. I also extend my thanks to our dedicated staff for their high professional standards and world class outputs. In an age of rapidly unfolding discovery they are to be commended for keeping our industry at the forefront of understanding.

The year ahead offers the opportunity for meaningful change that will leverage our industry's leadership in innovation to drive sustainable and profitable outcomes into the foreseeable future.

Peter Dawson
Chairman

Derek Morikawa – Vision Robotics Corporation (USA)

Mario Pezzotti – University of Verona (Italy)

Managing Director's report

Sakkie Pretorius

Putting industry first

This year has been defined by significant developments. Some could be defined as 'firsts' – with long-term consequences for the Australian wine sector. In a world first, for example, AWRI researchers have announced that they have sequenced the genome of a strain of *Brettanomyces*, offering new hope to winemakers determined to remove this troublesome yeast from their wineries.

There were also 'firsts' in weather patterns. Last year's unusually wet vintage left grape and wine producers facing an outbreak of downy mildew, unprecedented in scale in recent years, with far-reaching consequences. The AWRI became an agency of first response: multi-tasked to provide information, technical advice and support and by collaborating with other industry bodies for action at a national level.

There were also significant steps forward in our low-alcohol research programmes; our consumer sensory studies; and environmental sustainability work. It was a year when the AWRI proved itself to be truly multi-disciplinary, collaborative and responsive consistently to the needs of grape and wine producers.

It was a year that I will remember with pride: a year when the AWRI set a new standard in demonstrating capability, adaptability and flexibility.

Rising to the challenge

At the AWRI, our telephones often run 'hot' with calls from grape and wine producers, seeking advice and technical support. Our teams of industry specialists field some six thousand calls a year from people working across the industry.

Sometimes we are asked for help regarding wine composition: using detective work to sort out an unusual smell or assisting troublesome fermentations. Sometimes we are asked to give advice on the use of agrochemicals: the AWRI's well-known 'Dog Book' is regarded as the sector's most reliable resource for the management of Maximum Residue Limits (MRLs).

Occasionally, we receive a call that marks a significant event with far-reaching consequences for grape and wine producers nationally. This year, I received such a call from Jan O'Connor, who is a member of our Board and a well-known figure in our industry, particularly in the Riverland. Concerned about this year's unusually wet vintage and the outbreak of downy mildew alongside the 'usual suspects', powdery mildew and botrytis, she echoed the concerns of the Hunter Valley Wine Industry Association who had also contacted the AWRI, seeking support. The outbreak had highlighted a significant problem: how to manage downy mildew when the use of phosphorous acid (commonly referred to as 'phos acid') is restricted.

The lack of consistency concerning phos acid, internationally, remains a source of confusion and frustration for Australian grape and wine producers. Some countries permit its usage; others do not. In China, for example, no MRL has been set – the relevant regulatory frameworks are still emerging. With limited alternatives, Australian grapegrowers found this year's wet vintage to be particularly challenging.

Our response at the AWRI was to take immediate and decisive action. Without delay, we sent key staff members out into the field to gather information from those directly affected: grape and wine producers themselves. We discovered that the problem was not limited to the Hunter Valley, which often experiences disease pressure due to humidity and high summer rainfall. This year's outbreak of downy mildew, powdery mildew and botrytis was widespread, affecting many wine producing areas throughout New South Wales, Victoria and South Australia. It required coordinated, national action.

The AWRI put its business model to work – with its unique combination of research, development, extension and commercialisation activities – by providing much-needed information and support. In particular, we drew on our research, development and extension capabilities to provide grape and wine producers with the most up-to-date information and technical advice, based on more than half a century of experience.

We also played our part in lobbying for restrictions on phos acid to be eased. We understood the need for exemptions and regulatory changes to support the Australian wine sector through a time of crisis. As part of our contribution, we also contacted Wine Australia, Wine Grape Growers Australia, Winemakers' Federation of Australia, and the Grape and Wine Research and Development Corporation to support a co-ordinated, multi-agency response. In parallel, AWRI staff mounted an information and technical support campaign, which lasted through to the end of the season. We continued to field calls, send out alerts and support the industry as it wrestled with the 'knock-on' effects of downy mildew, including powdery mildew, botrytis and laccase problems.

From our first contact with the grape and wine producers directly affected, through to our ongoing efforts to push for regulatory change, the AWRI drew on its multi-disciplinary capability.

'Swiss Army Knife' capability

The AWRI is more than one building or a group of researchers. Our expert staff are recognised, internationally, as world leaders in their respective fields of specialisation. Our 'Swiss Army Knife' capability include chemists, biochemists, microbiologists, molecular biologists, sensory scientists, engineers, bioinformaticians, spectroscopists, chemometricians, winemakers, oenologists, viticulturists, experts in the field of wine and health and regulations, extension officers, knowledge and event management ensuring effective dissemination of information and knowledge to Australian producers. Our staff are drawn to Australia and to the AWRI to contribute to a culture of innovation and world-class expertise.

But innovation is just one outcome of the AWRI's capability. Our ability to respond to national problems is growing – supported by our collaborative networks embracing wine researchers in partner institutions throughout Australia. From the Hunter Valley to Margaret River, from the Granite Belt to the Tamar Valley, our staff members are working closely with grapegrowers and winemakers, drawing on a comprehensive network of infrastructure and multi-disciplinary expertise to generate the answers grape and wine producers need.

This year's work on low-alcohol wines at the AWRI is a case in point. For some time, the AWRI has been investigating new ways to reduce alcohol levels, while meeting consumer demand for particular sensory properties. While governments have been advocating lower alcohol levels, consumers have seemed to prefer fruity wines, and even closer to the 'jammy' end of the scale. These wines often contain higher levels of alcohol.

This year, however, we made a discovery that has the potential to transform the way that alcohol levels are managed. The discovery was made possible by putting the AWRI's cross-disciplinary capability into action.

We maximised resources by using wines from one consumer study in another, examining alcohol content more closely. The wines came from Cabernet Sauvignon grapes grown at Langhorne Creek that had been harvested at five different times – some were taken on or close to winemakers' preferred harvest date, others were taken earlier.

The results were revelatory. Grapes harvested earlier than current common practice can produce wine with reduced alcohol levels that consumers like. Wine from 'early' harvest grapes had 2% less alcohol compared to wine made from more mature grapes but, contrary to expectation, consumers showed equal preference for the two wines that contained 13.5% and 15.5% alcohol, respectively. Harvesting earlier might therefore give winemakers more control of alcohol yields. And – when consumers are more accepting of GM products – if we were to use an AWRI state-of-the-art GM low-alcohol yeast to ferment juice from early harvest grapes we could make quality wines with 11% or less alcohol.

The Langhorne Creek study has demonstrated the capability of the AWRI researchers at their best: working collaboratively, across disciplines, to deliver industry-orientated results. The study brought together researchers across a number of AWRI divisions – health, tannin, biosciences, sensory and consumer research – to work towards a common goal.

This year, the AWRI proved itself to be a 'Swiss Army Knife' for the Australian wine sector. Whatever the problem or issue, our team has proven their capability.

L to R: Dan Johnson, Kate Beames, Sakkie Pretorius, Markus Herderich

World-class responsive research

This year, we also put our capability to work in tackling other challenges, faced by the wine sector nationally. Indeed, it is the AWRI's technological capability, combined with its industry-orientated focus that has led to another discovery that has put Australia on the map globally, following another scientific breakthrough.

Over the past two decades, the AWRI has been active in disseminating a comprehensive 'Brett' control strategy, which enabled Australia's winemakers to gain an 'upper hand' on spoilage by the yeast *Dekkera (Brettanomyces) bruxellensis.*

In order to future-proof this control strategy, the AWRI researchers set out to decode the 'software' of this troublesome yeast. For the first time, the genetic blueprint of the predominant *Brettanomyces* strain found in Australian wineries has been determined. This brings 'Brett' research and the winemakers' battle against barnyard-like taints in their wine into a new era. It will enable the search for genes that confer tolerance to sulfite and the ability to grow in (and spoil) wine. We can now learn what makes this yeast so resilient and identify 'chinks in its armour' to future-proof winemakers' control strategies against strains with increased sulfite tolerance.

Again, the breakthrough draws on cross-disciplinary capability: the control strategies were developed by our 'on-the-ground' staff from our Development, Extension and Commercial teams, while the genome sequencing was completed by our Research team. Above all, the breakthrough responds directly to the needs of grape and wine producers. As a result, the specific and rapid detection of problem strains of 'Brett' with increasing levels of sulfite tolerance will soon be available, with novel surveillance and control strategies to follow.

National engagement

Throughout the year, our teams worked nationally with stakeholders to deliver a range of other notable outcomes:

» We started the year with the **14th Australian Wine Industry Technical Conference.** Given the current challenges facing our industry, we set out to inspire change. The event attracted more delegates than expected, with representation from more than a dozen countries overseas, as well as Australia. The high quality program featured 43 Australian and 15 international speakers and there was continued support for the extensive workshop program. The AWRI staff worked long and hard to support the event that has built a reputation for excellence. They delivered a quality learning environment inspiring confidence in workshop presenters and attendees. The AWRI staff also contributed to the Planning, Program and Social Committees; they managed registration; coordinated poster displays and managed publicity. Many of the AWRI staff presented in the formal program, ran workshops and presented posters (see Appendix 1 for details).

» We expanded our national network of **regional nodes** by establishing a new node in the Riverina, led by the AWRI process and environmental engineer Dr Richard Muhlack. We thank local industry members for their help in establishing the node so quickly, and for their support of the regional-node concept. Its purpose is to offer regional Australia more direct and widespread access to the AWRI's knowledge and capabilities, and to tailor our research, development, and extension activities to address industry's regional priorities more closely. Importantly, it is a two-way exchange: the AWRI benefits greatly from close, daily interaction with industry partners. Optimisation of process efficiency is a major focus of the Riverina nodes' activities. This includes investigation of the efficacy of alternative energy sources, work on automated collection of fermentation data and the building of a fermentation simulation model for great process control, and the facilitation of the uptake of rapid analytical methods, including the development of a spectral calibration for the measurement of yeast assimilable nitrogen (YAN).

» Our **consumer preference** work not only investigated the relationship between grape maturity, alcohol levels and consumer liking, it also examined the effect of exposure and education on consumer preferences for red wines. Individuals can change their liking and consumption patterns for different wine types over time and there has been little information as to when changes occur. To find out more, two separate investigations were conducted. Together, they showed that preferences can change in the short term, and that providing opportunities for people to consume 'new' wines – varieties or labels they have not tried before – is a beneficial strategy for industry, especially where younger consumers are concerned. This research is of particular value for winemakers exploring emerging markets that are less familiar with Australian wine styles.

» The AWRI has observed increased interest from wineries to improve their **environmental performance** and to communicate this with consumers. Genuine environmental credentials are best earned through taking real action and the AWRI has endeavoured to assist the industry in this regard. Process efficiency and the adoption of new technology have been the focus of our work. Initiatives have included the production of a practical guide for wineries on how to reduce their refrigeration-related electricity consumption (refrigeration typically accounts for 50-70% of winery electricity usage) and work with producers to reduce winery water use and wastewater loads. Environmental and economic performance are not mutually exclusive with initiatives related to improving environmental performance often also yielding real processing cost reductions.

» **Fermentation performance** was also a focus. Due to seasonal variation, rootstock variation and differences in grape processing, grape juice composition can vary – with repercussions for fermentation. Partnering grape juice with a wine yeast can produce a match made in heaven or a disaster waiting to happen. For a perfect marriage, the juice will be a generous and nurturing partner, catering for all of a yeast cell's needs, with the yeast reciprocating by helping the grape juice reach its full potential. In such relationships, fermentations go without a hitch and produce top quality wines. At the other end of the spectrum, when a juice is harsh and unforgiving, providing a hostile home, the yeast is required to be more robust and adaptable; many wine yeast strains fit this bill. However, some strains may not be able to cope with difficulties in the relationship, becoming stuck and requiring the intervention of a therapist (the winemaker). Most vinification relationships probably fall between these extremes, requiring at least some attention from their 'therapist', without being excessively needy or becoming stuck. Until recently, the degree to which grape juice nutrient composition varies and how variation affects fermentation performance was not well understood. But a recent AWRI survey of 100 different Chardonnay juices and subsequent analysis of yeast strain performance in these juices revealed that a major limiting factor for yeast performance was low juice pH and associated low potassium concentrations, with some yeast affected more than others. Winemakers working with low pH juices can minimise the risk of sub-optimal fermentation (prolonged fermentation times and elevated volatile acidity) through careful choice of yeast strain.

Leaving with pride

This year was also to be my last as Managing Director, following my appointment as Deputy Vice Chancellor – Research and Innovation, at the University of South Australia. I value the support that the Board and the AWRI staff have provided to me during my tenure and I am proud of what has been achieved at the AWRI over the past seven years (selected key achievements listed on the next page).

Today, the AWRI remains a driving force in the Australian wine sector, with industry-specific research programmes that are national in scope but internationally recognised for their dynamism, innovation and excellence. The future of our industry lies in our ability to face challenges with adaptability, determination and dedication. A new generation of leaders is emerging in our industry: under their leadership, the AWRI will strive for continued success.


Dan Johnson and Sakkie Pretorius

In my position of Managing Director of the AWRI, I have appreciated the support given to me and the AWRI. Whilst I leave the AWRI with much sadness, I'm very proud of what has been achieved for the Australian grape and wine industry. In particular, the collaborations that Team AWRI has built within the Wine Innovation Cluster and other national and international research centres, universities and commercial companies are most noteworthy. I am inspired by the value of working with likeminded partners in industry and in academia, and the AWRI's contribution to the creation of new knowledge that underpins new products and innovation has been rewarding. The AWRI is in a good position to continue to support all aspects of the value chain of the wine industry in the years ahead. I am grateful for the financial support provided also by the Grape and Wine Research Corporation, for without their vision and trust in us, so much of what has been achieved for this industry would never happen.

Finally, in the words of H.E. Luccock, 'No one can whistle a symphony. It takes a whole orchestra to play it.' This is also true in our endeavours to deliver value to the Australian wine industry. I give sincere thanks to the staff at the AWRI who have worked tirelessly on behalf of Australian winemakers and grapegrowers this year. Also, I am deeply appreciative of the support provided by grape and wine producers and our other important stakeholders and collaborators, who inspire us to do our best work.

Sakkie Pretorius,
Managing Director

Foundational changes to enhance AWRI's value proposition to the Australian wine sector 2005 – 2011

Achievement	Significance	Value
2005: Production and distribution of the AWRI's 50th anniversary commemorative book, *Advances in wine science – commemorating 50 years of The Australian Wine Research Institute*	Critical analysis and interpretation of key findings in various areas of research conducted since the inception of the AWRI in 1955 Outline of new instructive directions of various fields of research related to the AWRI's expertise	A handy, easy-to-read single source of information and knowledge available to practitioners, researchers and students
Early 2006: Conclusion of a 12-month stakeholder consultative process to develop the AWRI's first long-term strategic plan, Towards 2015. That Plan redefined AWRI's purpose, vision, mission and values, and set out the 'where' and 'how' AWRI wanted to be by 2015, and the 'why'. The opportunities and roadblocks were discussed and developed into an action plan identifying ten new business initiatives and goals. Mid 2006: The finalisation and implementation of the AWRI's first fully costed 7-year Research, Development and Extension (RD&E) Plan, which was instrumental in securing a 7 year investment agreement with the GWRDC. Second half of 2006: Completion of fully-costed architectural plans, and tri-lateral agreements, to build a new 'home' for the AWRI. Construction of the 'Wine Innovation Central' (WIC) building commenced in mid 2007 and was completed by late 2008. From 2009 to 2011: Development and refinement of the AWRI's 'Swiss Army Knife' RDE&C business model and cementing AWRI's position as the Australian wine industry's own innovation engine room	*Financial sustainability:* A 150% increase in the AWRI's revenue. Initially, by securing a 7-year investment agreement with the GWRDC; and then new, non-levy based funding to allow an expanded research footprint which facilitated developing new commercialisation opportunities and expanding contract research and other consulting services *Human resources:* Developing new strategic human resources strategies and initiatives with a strong focus on attracting, retaining, and training of high-quality staff with expanded capabilities *Physical infrastructure:* A new purpose-built world-class offices and laboratories occupied in October 2008 *Collaboration*: Expanded collaborative network by establishing: » the Wine Innovation Cluster in Adelaide; » satellite nodes in in Tasmania and NSW; » Bordeaux-AWRI-Geisenheim alliance; and » meaningful collaborations with > 140 nation-wide and international research and commercial partners. *Governance*: Enhanced corporate governance by modernising AWRI's constitution, appointing an industry led, skills-based Board and more risk conscious management practices.	An agreed industry-focussed roadmap for the AWRI to continue to provide integrated solutions and deliver high value in a measurable way to the Australian wine industry through world-class research, development, extension and commercial services. With enhanced capability and capacity of a 'new-look' Team AWRI of 100 FTEs, operating from a world-class facility and embedded in a tightly-knit collaborative network of first-class partnerships, the AWRI has leveraged 50c for each levy dollar invested by the GWRDC, i.e. ~$6 million of its ~$16 million annual budget is generated from non-GWRDC sources.

Incoming Managing Director's report

Dan Johnson

The way forward

If there is one issue that unites the Australian wine sector, that issue is economic reality. The need has never been greater for Australia's wine industry and its value chain to generate competitive advantage through technical innovation.

The AWRI is a key industry asset for driving that technical innovation. It has proven to be more than a research company, wholly owned by the Australian wine industry and its stakeholders. It has become one of Australia's globally competitive research institutes, internationally renowned for its world-class expertise and capability. The past year, in particular, has demonstrated the AWRI's capability to provide emergency response services and technical support in a crisis, while continuing to make significant progress in the pursuit of new knowledge.

Since joining the AWRI five years ago, I have been closely involved in the decisions and processes that have seen the AWRI continue to create value for industry and excel in its pursuit of scientific breakthroughs. I have also been closely involved in the AWRI's renewed focus on applied, practical outcomes through a business model grounded in an integration of research, development, extension and commercialisation capabilities.

It's now my privilege to lead the AWRI to build on this success in a new era, an era defined by the economic realities we now face. We all want to see a thriving, dynamic industry with the capability and adaptability to respond to changing market conditions and consumer preferences. We all recognise the need to use new technology and scientific know-how to secure a competitive edge in a challenging global market.

As a scientist, I am passionate about world-class science and its publication in high impact, peer-reviewed journals. I am, however, equally passionate about its application in industry, without which it is impossible to make a meaningful difference to Australia's wine community. Scientific breakthroughs are most useful when they respond directly to the needs of grape and wine producers.

The AWRI recently identified nine priorities for future investment that are noted in the Chairman's report. Subject to ongoing dialogue with the industry and the AWRI's key stakeholders, notably including the Grape and Wine Research and Development Corporation, these priorities will feature in the next phase of the AWRI's role in supporting innovation in the Australian wine industry.

The world-class team at the AWRI owe a great deal of thanks to the outgoing Managing Director, Sakkie Pretorius. His leadership and management over the past seven years have had a significant, lasting impact, and he has been directly responsible for the professional development of so many in Australia's wine research sector. On behalf of the AWRI team, I wish him well in his new role.

The future of the AWRI lies in a common purpose, shared with its partners and stakeholders; a purpose grounded in economic reality and sustainability, supported by world-leading scientific and technical capability. I, and the entire AWRI team, look forward to working with you all to deliver outcomes that underpin that future.

Daniel Johnson

Dan Johnson

Selected key achievements, their significance & value to the Australian wine sector 2005 – 2011

Yeast genomics and strain development

Achievement: In a world first, the genomes of five commercial *Saccharomyces cerevisiae* wine yeast strains were sequenced and compared, and a wine yeast gene deletion library was constructed. These data are being screened, amongst other things, for genes encoding flavour-active enzymes, and are being used to support the AWRI's yeast strain development program.

Significance:

- We are learning what makes a wine yeast 'tick' and why wine yeast strains differ so much; the AWRI has the intelligence and resources to become a world leader in wine yeast strain development.
- Several genes associated with flavour generation were identified.
- Novel yeast strains and yeast blends were developed:
  - Three commercialised inter-specific hybrid strains for increased wine complexity.
  - Two commercialised blends of wine strains for increased fruitiness.
  - Three commercialised mutant strains with significantly reduced levels of hydrogen sulfide (H_2S) driven 'reductive' characters.
  - Two commercialised *S. bayanus* strains with enhanced savoury flavour attributes.
  - A mutant strain with significantly reduced levels of volatile acidity and vinegar-like characters.
  - A thiol-releasing prototype strain with significantly-enhanced tropical fruit flavours.
  - A low-alcohol prototype strain capable of producing wine with 3% less alcohol.

Value: Choice of yeast strain during fermentation is a very low cost but highly influential component of winemaking. New yeast strains provide greater opportunities for winemakers to shape the composition of their wines to create styles that achieve their business objectives. The new yeast strains can enhance fruitiness, lower alcohol levels and/or eliminate off-flavours.

Understanding of critical aroma and flavour compounds important to wine quality

Achievement: Notable successes have included the world first identification of the pepper compound that produces the spicy, 'black pepper' smell so popular with many Shiraz drinkers, and greater understanding of the origin of the minty/eucalyptus flavour in some wines.

Significance: Having identified the 'black pepper' aroma compound, rotundone, and its sensory significance, the effect of berry ripening, clone, season and other viticultural and winemaking influences on levels of this potent compound have been revealed.

The aroma compound giving rise to minty/eucalyptus flavour has been shown to be derived almost entirely from eucalyptus trees grown in proximity to vineyards, with leaves included in harvested grapes being the single largest source.

Value: Shiraz wines are identified strongly with Brand Australia in international markets. Producers have an improved ability to produce quality wines which are diverse and distinctive and can align with consumer preferences.

Wine companies can adjust the influence of the eucalypt character using straightforward management techniques, and the knowledge generated has been used in commercial decisions for high sales products, as well as in insurance and legal cases.

Breakthrough in 'Brett' research

Achievement: Following the success of winemakers using the AWRI's 'Brett' management strategies to bring that yeast under control, the genetic blueprint of the predominant *Dekkera (Brettanomyces) bruxellensis* strain was determined.

Significance: This brings 'Brett' research into a new era, enabling the search for genes that make 'Brett' tolerant to sulfite and help it to grow, with the potential to spoil wine. We can now learn what makes this yeast resilient and identify 'chinks in its armour'.

Value: By working with winemakers to get 'Brett' under control, the AWRI saved the Australian wine industry an estimated $0.5 billion over 10 years. If/when more resilient strains of 'Brett' emerge, ongoing genomics research at the AWRI will provide the intelligence necessary to develop new tools to keep this spoilage yeast at bay.

Grape juice analysis and improved yeast fermentation performance

Achievement: A juice bank was established and surveyed for composition and efficiency of fermentation using different wine yeasts.

Significance: The number of trouble-shooting investigations performed by the AWRI over the years relating to sub-optimal fermentation is testament to the huge amount of quality and value lost in Australian wine during this crucial production phase. It was discovered that a major limiting factor for yeast performance was low juice pH and associated low potassium concentration, with some yeasts affected more than others. This observation is a major advance in our understanding of why fermentations become sluggish or stuck, and why this problem is so unpredictable: efficient, reliable fermentations require judicious choice of yeast strain, particularly for low pH juices.

Value: At a very conservative estimate, the Australian wine industry loses over $15m per annum as a result of unpredictable and problem fermentations. In some vintages this figure increases dramatically.

Understanding the underlying causes of problem fermentations will enable the development of risk minimisation strategies to reduce losses and costs, and make the winemaker's job less stressful.

Nitrogen management

Achievement: The complex and potentially beneficial effects that DAP supplementation has on the non-volatile, volatile and sensory attributes of wine was revealed.

Significance: Yeast strain, as well as nitrogen, was shown to be a major factor in the accumulation of residual H_2S in wine, which contributes to wine 'reduction'. This work has led to improved guidelines on the use of DAP for modulating wine flavour and style. Choice of yeast strain in combination with nitrogen supplementation provides a tool for managing residual H_2S and 'reduction' in wine.

Value: Winemakers can now optimise wine profile and style – and produce wines that consumers want to drink – by monitoring nitrogen in juice and during fermentation.

Bacterial genomics and improvement of malolactic fermentation

Achievement: The genomes of 12 commercial *Oenococcus oeni* malolactic bacterial strains were sequenced and compared.

Genes and enzymes capable of releasing flavour-active active molecules identified.

Significance: The biochemistry underpinning MLF-derived red berry aromas is being unravelled and the genome information will underpin future understanding of the role of MLF bacteria in winemaking.

An improved understanding of the role of MLF bacteria in liberating aroma and flavour compounds helps to explain why wines continue to evolve during maturation and in bottle.

Value: Better informed selection of malolactic bacterial strains will enable winemakers to modulate the fruitiness and quality of their wines according to consumer preferences.

'Measuring' wine style by spectral analysis

Achievement: The style of Pinot Grigio and Pinot Gris (PinotG) wines can now be assigned by a cheap and rapid spectral scan, without the need for sensory evaluation.

Significance: The establishment of a spectral calibration for wine style using experienced taster's ratings as reference data is a world first development. It is the first fully-developed application of 'spectral fingerprinting' technology, which has the capacity to revolutionise grape and wine analysis at all stages of the value chain from vineyard to point of sale of the finished wine, and beyond.

Value: A labelling device, the PinotG Style Spectrum, has been developed and launched, which informs consumers and wine trade of the style of the PinotG wine in the bottle before purchase and helps to limit confusion as to the wide range of styles produced under Pinot Gris/Pinot Grigio labels. PinotG is among the most rapidly growing categories of wine in Australia, and has the potential to challenge the domination of Sauvignon Blanc in the Australian white wine market. The 'Spectrum' is being used by several large producers who see great value in being able to objectively differentiate their wines in the marketplace.

Rapid measurement of phenolics (tannins and pigments) in grapes and wines

Achievement: Wine producers are able to measure key drivers of wine quality and style rapidly and cheaply, at any point during production.

Significance: Phenolic compounds (tannins and pigments) are abundant in wine, and are known to be key drivers of wine quality. Until recently it was very difficult to measure phenolic compounds. The AWRI developed the first simple and quick wet-chemistry method for the measurement of tannins in wine, the MCP assay. The MCP assay was later calibrated against a simple spectral scan using the type of spectrophotometer found in many wineries, and the AWRI Tannin Web Portal was developed to allow automated calculation of the concentration of tannin and other phenolic compounds. It has now been demonstrated that the same principles can be used to measure grape tannin and colour, as well as other phenolic constituents of wine which are known to be indicators of wine quality and stability, and the Portal is being expanded accordingly. The web portal system, with in-built data quality control, benchmarking and industry-wide comparison features, is a technology which will make a profound contribution to future grape and wine production systems though virtually unlimited additional applications.

Value: Producers can now measure tannin quickly, reliably and cheaply through the AWRI Tannin Web Portal, potentially saving substantial sums in analysis cost alone. However, even greater value is obtained when data related to colour and tannin are linked. This had particular value during the 2011 harvest when there was very low wine colour in most regions. Colour intensity is known as a key driver for consumer perception of wine quality and, therefore, wine value. Targeted tannin addition during fermentation would have led to wines with higher colour and higher value. It would also have optimised the use of an expensive wine additive. Data generated by the Portal, and by enhancements now underway, allowed wine producers to understand, predict and tackle this problem.

Rapid and simple measurement of yeast assailable nitrogen (YAN)

Achievement: Now possible in must and during fermentation with very low sample volume and minimal or zero sample pre-processing.

Significance: YAN is a key measurement related to fermentation performance. However, until recently the measurement of YAN was costly, cumbersome and time consuming, and rarely performed by wine producers on a routine basis as a result. A rapid and simple assay for YAN using mid infrared reflectance spectroscopy was developed, which requires little or no sample preparation. Homogenised grapes or fermenting wine can be analysed on very small sample volumes.

Value: Sub-optimal fermentation delivers wines with 'faulty' aromas, and a key variable related to fermentation performance is YAN. The new AWRI method reduces the cost of analysis by more than half, even after accounting for the cost of depreciation of a winery spectrometer. Winemakers can now measure and respond to YAN measurements in real time during fermentation and add substantial value to wines, or at least prevent the loss of value.

In-bottle spectroscopy

Achievement: Non-destructive analysis of wine in its original bottle can now be performed**.**

Significance: In a world first breakthrough, an instrument was developed that allows wines to be analysed non-destructively – in the bottle, though the glass, without having to open the bottle. This allows samples to be tested on multiple occasions. It is an invaluable production, wine distribution and research tool.

Value: Non-destructive testing allows wine producers, distributors, researchers or retailers to follow the development of wines 'in bottle', to optimise stock rotation, and to collect data from research trials. It is also a powerful trouble-shooting tool, allowing the sorting of good, bad or simply different bottles for whatever reason.

Potential elimination of bentonite

Achievement: Now available using a protease enzyme to prevent protein-haze formation in bottled wines.

Significance: Bentonite fining of white, sparkling and rosé wines is widespread world-wide, but it is a cumbersome and time-consuming process. It results in the substantial loss of wine and the removal of flavour and aroma compounds – afterwards the lees also have to be discarded. However, winemaking without bentonite might soon become a reality. A successful trial with a protease enzyme was completed: when combined with rapid heating and cooling of the juice, the enzyme resulted in the removal of practically all potentially haze-forming proteins. During sensory analysis of the finished wines - conducted six weeks after bottling - experienced tasters were unable to distinguish between wines made from the heated and enzyme-treated portion of juice, and the un-heated control.

Value: A viable alternative to bentonite fining has been sought for many years. The cost of the bentonite itself is not insubstantial, but is small compared to the large amount of labour involved in mixing it and adding it to tanks of juice and wine. Bentonite use results in a substantial amount of wine loss, averaging around 3%, and disposing of bentonite lees is expensive. The cost is increasing as environmental regulations become more stringent. Finally, in addition to removing unwanted protein, bentonite also removes desirable things from wine, such as flavour and aroma compounds. With further trials, an inexpensive additive alternative might soon be available for Australian producers.

Improved oxygen management at bottling and during storage

Achievement: Development of a commercially accessible method to quantify the total package oxygen (TPO) at bottling (TPO accounts for oxygen dissolved in the wine matrix and present in the bottle headspace).

- Development of a proficiency testing program for TPO and dissolved oxygen (DO) measurements through the Inter Winery Analysis Group
- Incorporation of TPO measurement specifications into the Winemakers' Federation of Australia's Packaging Guidelines for the Australian Wine Industry

Winemaking doesn't finish once the product is in the bottle:

- research has improved our technical understanding of oxygen on the 'in-bottle maturation' of wine
- The oxygen transmission rate of wine packaging can now be quantified post-bottling non-destructively for any packaging technology.

Significance: Many wines prematurely reach their shelf-life due to poor oxygen management at bottling. The existing industry practice of quantifying dissolved oxygen at bottling did not account for oxygen present in the package headspace: bottling the same wine with a TPO of 1 and 5 mg/L leads to significant loss of shelf-life.

- Benchmarking studies showed while dissolved oxygen levels were being managed, TPO values were up to 10 times higher than the targeted range. Development of a proficiency testing tool for DO and TPO measurement enables wineries to have effective quality assurance regimes for oxygen management which were previously unavailable.

The understanding of the impact of oxygen on the 'in-bottle maturation' of wine has improved significantly.

- A long-term bottling trial demonstrated that wine development is influenced strongly by the choice of closure used to package the wine.
- The oxygen transmission rate of packaging materials drives evolution of wine style post-bottling. This property, which previously could only be estimated for natural corks and multi-component packaging using destructive testing, can now be quantified non-destructively for any packaging technology.

Value: New tools enabling total packaging oxygen management empowers wineries to:

- minimise premature oxidation of wines;
- increase control of shelf-life; and
- increased control over wine style development.

Knowledge of wine style evolution post-bottling and the closure performance parameters that underpin it provides winemakers with greater control over the style of their wine purchased by consumers.

Bottling of a red wine closure trial

Achievement: A new red wine closure trial comprising 16 different closure technologies was bottled under controlled TPO management specifications.

Significance: The trial provided any winery access to a complete robust evaluation of 10 popular closure technologies in the Australian market at a cost significantly less than would be required to run the trials internally. Participants will benefit from objective consumer research results providing an understanding of the impact closure technologies have on consumer enjoyment of the product.

Value: The trial enables wineries to make informed choices about a range of closure technologies and the impact they have on red wine style.

Establishment of a suite of analytical methods for accurate measurement of most key wine aroma compounds and their precursors

Achievement: Commercialised methods are now available for compounds including undesirable 'reductive' sulfur flavour components, tropical thiols important to white wine flavour, 'green' aroma compounds from less ripe grapes, fruity fermentation-derived esters, floral and citrus grape-derived compounds, and compounds important to bottle age.

Significance: We now have unprecedented knowledge regarding which specific compounds create particular flavours, with great insight into ways to decrease undesirable flavours and to increase desirable flavours. Examples include the choice of closure on the level of hydrogen sulfide or methane thiol in bottled wine, or the large increase observed in tropical thiol compounds in Sauvignon Blanc must held for a period post-harvest.

Value: Wine producers can now quantitatively measure and monitor a range of important aroma compounds, and the results of studies have had practical value in knowledge of pre-harvest, post-harvest, fermentation, and post-bottling flavour changes.

Sensory science

Achievement: The capacity to conduct sensory studies to routinely quantify and characterise sensory attributes of wines has been greatly expanded through a dedicated sensory descriptive panel and other specialised assessors. This panel now operates in addition to a professional sensory group.

Significance: Linking objective sensory data with instrumental data, usually with imposed treatments, has resulted in major advances in understanding in areas such as 'Brett' taint and other off-flavours, yeast strains, malolactic fermentation, and impact of individual aroma compounds such as tropical thiols. Data are provided directly to wine producers as well as through taint and fault sensory directed studies, such as chlorophenol and smoke taint investigations. The combination of chemical and sensory data gives guidance regarding levels of compounds that have sensory significance, so companies can make informed commercial decisions.

Value: Wine is valued for its aroma and flavour properties, and improving aspects of product quality requires reliable sensory analysis techniques. All research trials are ultimately assessed against their impact on wine quality.

Consumer insight

Achievement: The measurement and interpretation of consumer preferences has resulted in a wealth of insights into wine quality from a consumer perspective, notably including: a highly informative understanding of Chinese taste preferences for red wines; the reaction of consumers to off-flavours such as 'Brett', reductive flavour and cork taint; sensory attributes of red and white wines driving consumer sub-groups liking scores; and the relative influence of sensory and non-sensory attributes of wines.

Significance: An awareness of the differences between wine consumers in China and Australia provided a strong foundation for Australian wine companies entering the difficult Chinese market at a crucial time.

The rapid feedback to wine companies on the sensitivity of many consumers to even low levels of off-flavours provided impetus to avoid 'Brett' and other defects.

The key sensory attributes motivating positive responses for different wine styles, together with demographic differences among consumer groups and the link with non-sensory data, is progressively becoming clear.

Value: China is the fourth largest export market for Australia, and bottled wine exports have increased to a current value of A$141 million, with value per litre continuing to increase over time, in contrast to many other markets.

The Australian wine sector is targeting sales growth, especially in export markets; consumer insights are a critical component of any market development/market access activity, especially when linked to AWRI's more traditional strengths of sensory and technical knowledge.

Improving refrigeration efficiency

Achievement: Production of the 'Improving winery refrigeration efficiency' handbook.

Significance: Refrigeration is typically responsible for approximately 65% of a winery's electricity bill. Many wineries are keen to reduce their power bill and carbon footprint but lack the technical know-how to improve refrigeration efficiencies. The 'Improving winery refrigeration efficiency' handbook provides a simple overview of how refrigeration systems work and simple low cost opportunities to significantly reduce power use and carbon footprints.

Value: Most small- and medium-sized wineries can improve their refrigeration efficiency by 30% with minimal effort amounting to a 15-20% reduction in power bills and carbon footprint.

Trouble shooting

Achievement: The AWRI's Technical Problem Solving and Consultancy team assisted Australia's winemakers with confidential, expert advice. They answered 8,212 winemaking queries and investigated 3,332 technical problems involving 8,536 samples.

Significance: Quality loss during wine processing and packaging represents a major cost to the Australian wine industry. The AWRI addresses this issue in a targeted manner, by providing preventative and remedial advice based on the extensive, cumulative problem solving and practical winemaking experience of the staff. Subsequently, the information and knowledge gained is disseminated in a variety of ways to foster industry-wide understanding of the causes of many common winemaking problems, and to prevent their frequent recurrence. The problem-solving staff also act as a liaison between the AWRI research department and the wine industry, so that problems arising can be identified early and research programs can be implemented in response.

The technical problem-solving team has played a pro-active role in protecting the integrity of Australian wine. Taints and off-flavours in wines can have a variety of origins and can result in substantial losses and erosion of consumers' confidence. Wine affected by a taint or off-flavour is usually rendered unsaleable and has to be destroyed as there is usually no cure for the problem: prevention of further incidents is often the only remedy.

In one specific example, in the case of the discovery of the cause of plastic-like taints, a number of wineries were impacted, ranging from one or two tanks of wine in some wineries through to a whole vintage worth of wine for one winery. At least $15 million worth of wine was affected. The compounds responsible were not detectable by methods of analysis at the time and were therefore unknown, yet wineries required conclusive evidence that wines were tainted. The various plastic-like taints were successfully identified, and routine research methods were developed for the three compounds and these methods were used to trace the source of the contaminant.

Value: Industry provided with a level of protection against issues that have potential to cause widespread loss of wine quality and integrity.

- Enhancement of the knowledge and skills base of industry personnel.
- Industry able to avoid quality loss by being provided with solutions to wine composition and processing problems.
- Industry able to identify wines most susceptible to spoilage by being able to benchmark against composition of 'problem' and 'non-problem' wines.
- The AWRI has access to knowledge identifying key areas of industry need, which can be applied to the prioritisation of research activities.
- Continual enhancement of the image of the Australian wine industry, Australian wine, and of the AWRI through the dissemination of technical knowledge to journalists, wine trade, and wine industry personnel, leading to the regular use of information in articles published in leading trade journals.
- Industry provided with a competitive advantage through access to technical support that rapidly identifies problems:
  - avoiding sub-standard or tainted wines entering the market place.
  - assisting wine producers in insurance claims and disputes resulting from the supply of inferior processing aids, additives or packaging products.
- The availability of routine testing for compounds such as plastic-like taint compounds should reduce the likelihood of contaminated wine reaching consumers in national or international markets with consequent damage to the industry's reputation.

Increased focus on information dissemination

Achievement: Approximately 25 requests for information are responded to each working day; monthly formal communication with levy payers and other stakeholders; regional workshops and seminars increased; presentations around Australia and the world; industry training with AWACs and Research to Practice workshops; Australian Wine Industry Technical Conference events.

Significance: Grape and wine producers can call the AWRI for specialist information. Information requests are serviced by our winemakers, viticulturists, wine/health/regulatory expert and by our Information Services staff.

- >36,000 information requests were responded to including technical problem solving, copies of journal articles and professional opinions.
- The outcomes of the AWRI's research would be meaningless without an effective communication strategy. Many AWRI staff members give presentations around Australia and the world. Roadshow seminars and workshops are also held in regions around Australia. >110 roadshow workshops/seminars were delivered to >2,200 industry attendees. >1,650 presentations delivered to industry, scientific and student audiences.
- The AWRI website is regularly updated and it now contains many invaluable winemaking tools and information such as web portals and wine calculators. >1.5 million hits on the AWRI website.
- We introduced *eBulletins* (issued *ad hoc*) and *eNews* (issued 6 times a year), which are distributed to more than 2,700 email addresses each time.
- Through feedback received, the format of *Technical Review* (issued 6 times a year) changed to improve its value to readers.
- To supplement our annual printed report, the Managing Director gives an annual presentation to all major state-based associations and we publish a supplement in the November issue of the *Aust. N.Z. Grapegrower & Winemaker.*
- The Agrochemicals ('Dog book') booklet updated regularly on website and > 11,000 copies distributed each year.
- Staging of the 13th and 14th AWITC (Australian Wine Industry Technical Conference) event and associated workshop and exhibition events were noted for their professionalism and potential to act as a turning point in an industry downturn.
- Re-establishment of the Research to Practice series of workshops provided applied content to practitioners. Four workshops were developed with more to follow, covering viticulture and winemaking topics with the underlying themes of sustainability and adaptation.
- 9 AWACs (Advanced Wine Assessment Courses) were run in Australia, for 270 people. 10 AWACs were run in export markets in support of Wine Australia, for 246 of the world's wine opinion leaders.

Value:
Improved decision-making is facilitated, through producers receiving relevant and credible information. The value created includes:

- economic loss is reduced;
- potential for increased market penetration is improved;
- an innovative culture is supported, which leads to product and market development; and
- environmental sustainability is supported.

Our activities in support of Wine Australia help to underpin the building and maintenance of positive brand awareness of Australian wine.

Wineries can reduce the risk of tainting by implementing AWRI screening tests as part of quality control procedures. The AWRI includes newly discovered taint compounds in tasting seminars as part of Roadshow Workshops so that winemakers can become familiar with and determine their own sensitivity to them.

Board notes

Chairman
Mr P.J. Dawson

Alternate Directors of the Board
Mr N.A. McGuigan
Mr C.B. Ryan
Mr A.N. Sas

Audit Sub-Committee
Mr M.R. Watson (Chair)
Mr P.D. Conroy
Mr J.A. Lumbers

Remuneration and Nomination Sub-Committee
Mr P.J. Dawson (Chair)
Mr J.C. Angove
Ms L.E. Rose

Meetings

Ordinary General Meeting

The 56th Ordinary (Annual) General Meeting was held on 7 December 2010.

Special General Meeting

n/a

Board

The Board of the AWRI met on the following dates: 21 September 2010, 7 December 2010, 1 March 2011, 5 April 2011, 7 June 2011.

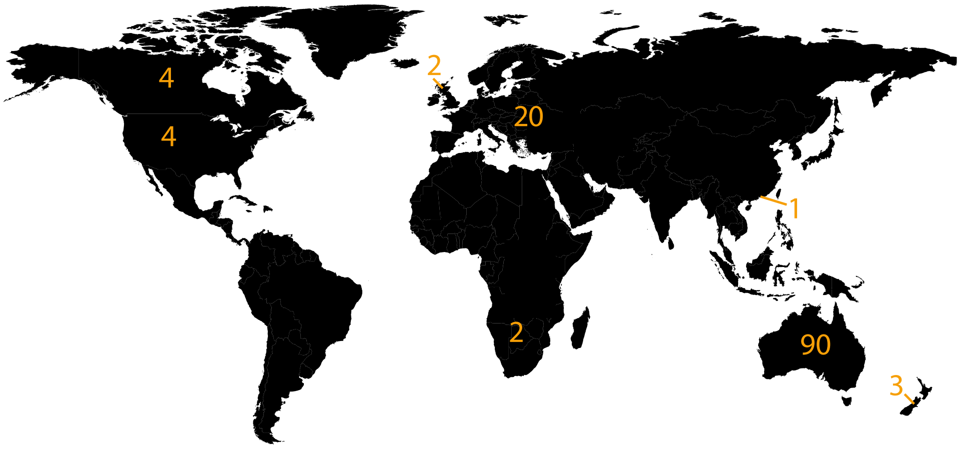
Funding

The Board of the AWRI acknowledges the continuing financial support of the Grape and Wine Research and Development Corporation.

Appreciation

The activities at the AWRI benefit from collaborations from individuals and organisations from 13 different countries: Australia (Australian Capital Territory, New South Wales, Queensland, South Australia, Tasmania, Victoria, Western Australia), Belgium, Canada, France, Germany, Hong Kong, Italy, New Zealand, Portugal, South Africa, Spain, United Kingdom and the USA. We gratefully acknowledge the assistance, cooperation and/or collaboration from our partners across the globe.

L to R (front row) Peter Dawson, John Angove, Louisa Rose, Paul Conroy, (second row) Jim Lumbers, Sakkie Pretorius, Jim Brayne, (back row) Brett McKinnon, Mark Watson. (Absent: Jan O'Connor)



Number of collaborators in areas around the world

Highlights of the year 2010-2011

1 **Breakthrough in Brett:** In a 'world first', the genetic blueprint of the predominant *Dekkera (Brettanomyces) bruxellensis* strain found in Australian wineries has been determined. This brings 'Brett' research and the winemakers' battle against barnyard-like taints in their wine into a new era. It will enable the search for genes that confer tolerance to sulfite and the ability to grow in (and spoil) wine. We can now learn what makes this yeast so resilient and identify 'chinks in its armour' to future-proof winemakers' control strategies against strains with increased SO_2 tolerance.

2 **Fight against downy mildew.** The seasonal conditions and shortages of chemicals put a lot of pressure on the grape sector. The AWRI played an important role in alleviating the stress on growers through the dissemination of information on control strategies. Ten eBulletins or agrochemical updates were issued. Visits were made to regions in NSW and SA to appreciate better the difficulties being faced. Emergency use permits for agrochemicals were obtained from the APVMA. Special efforts were made to inform and engage stakeholders about the potential use of phosphorous acid for the control of downy mildew. Strategies for botrytis control in the vineyard and laccase in the winery were delivered in presentations held in Mudgee, Orange and Canberra.

3 **Lower alcohol through earlier harvest gains consumers' approval**: Grapes harvested earlier than current common practice can produce wine with reduced alcohol levels that consumers like. Wine from 'early' harvest grapes had 13.5% (v/v) alcohol compared to 15.5% (v/v) for wine made from more mature grapes. Consumers showed equal preference for the two wines. Harvesting earlier might therefore give winemakers more control of alcohol yields. And - when consumers are more accepting of GM products - if we were to use an AWRI state-of-the-art GM low-alcohol yeast to ferment juice from early harvest grapes we could make quality wines with 11% or less alcohol.

4 **Stop getting stuck**: A survey of 100 different Chardonnay juices and subsequent analysis of yeast strain performance in these juices revealed that a major limiting factor for yeast performance was low juice pH and associated low potassium concentrations, with some yeast affected more than others. Winemakers working with low pH juices can minimise the risk of sub-optimal fermentation (prolonged fermentation times and elevated volatile acidity) through careful choice of yeast strain.

5 **Nitrogen plays a role in aroma intensity and 'fruity' attributes:** Comparison of inorganic (diammonium phosphate) and organic (amino acid) nitrogen supplementation of (Chardonnay) grape juice showed that moderate additions increased both the aroma intensity and 'fruity' attributes in wine whilst reducing 'complex' attributes. In contrast, high addition of inorganic, but not organic nitrogen, produced a 'solvent' or 'estery' taint. Hence nitrogen management provides an important additional tool for modulating wine flavour and 'next-gen' Chardonnay styles.

6 **Modulating minty aromas in red wine:** Eucalyptus flavour in red wine was found to be linked strongly to the presence of Eucalyptus leaves in the crush, and therefore can be managed where required. Chemical formation of the minty compound, eucalyptol, from grape precursors, or uptake of volatiles from Eucalyptus trees, appears to play only a minor role.

7 **A striking enhancement of tropical fruit precursor compounds** was found after post-harvest storage of machine-harvested Sauvignon Blanc grapes. This means that in white winemaking the choice of processing options may significantly influence the flavour potential of grapes and wine style.

8 **Consumers can change their taste preferences over the short-term** as a result of increased experience with different wine styles, showing that avenues for education or exposure of consumers to different wines are a fruitful avenue for the industry to pursue.

9 **From research to new analyses; the battle on smoke taint.** (i) Additional markers for smoke exposure of grapes were identified as phenolic glycosides, and although they don't directly contribute to smoky aromas, they are precursors from which a smoky aroma can be released during winemaking and ageing. (ii) Improved analysis for smoke taint is now available through the AWRI's Commercial Services and the method performance was very consistent across a range of grape and wine varieties and significantly improved compared to other analytical methods. (iii) A comprehensive survey of the baseline levels of volatile phenols and their glycosides in samples of grapes and laboratory-scale wines has been finalised, allowing 'normal' clean grapes to be identified and aid the interpretation of analytical data from samples suspected of smoke exposure.

10 **Traction in tannin gained.** (i) Skin cell wall tannin binding affinity increases as ripening progresses, meaning that this material selectively removes tannins after they have been solubilised during vinification. (ii) A rapid method for grape tannin analysis has been validated successfully and will allow monitoring of tannin during the growing season. (iii) The AWRI Tannin Web Portal can predict tannin concentrations in European, New Zealand and US wines and international use of the portal is increasing. (iv) Fermentation trials with Pinot Noir have indicated wine tannin levels can be doubled by manipulating maceration methods.

11 **Influences on white wine mouth-feel perception.** (i) The addition of purified white wine polysaccharides resulted in improved palate texture and reduced perceived alcohol hotness, factors that could be achieved by using winemaking practices that favour polysaccharide extraction and retention. (ii) The addition of prominent phenols from white grapes, caftaric acid and 'Grape Reaction Product', enhanced bitterness and palate oiliness of low alcohol (10% v/v) model wine, but reduced astringency, which suggests that other phenolic compounds may be responsible for astringency in white wine.

12 **Gaining the upper hand on haze formation:** (i) Mechanisms for aggregation and precipitation of haze-forming proteins have been shown to be different, and influenced by the ion profile and ionic strength of the model wine. (ii) Using this knowledge we have evaluated on a small production scale an alternative to bentonite fining using a protease. Trials on the addition of the protease enzyme to two clarified white juices demonstrated that when combined with heating practically all of the heat-unstable protein was removed, paving the way for a commercially viable application of a protease to reduce haze proteins in white wine.

13 **Managing oxygen:** (i) The impact of oxygen post-bottling through ingress through the closure can be similar to the effect of oxygen pre-bottling through micro oxygenation during winemaking, giving winemakers two different tools to achieve similar outcomes. (ii) We have developed and communicated the tools required to manage total package oxygen (TPO) at bottling, which is essential for effective bottling operations, although very few Australian bottling facilities were doing it. (iii) Oxygen transmission through wine storage and packaging materials has a significant impact on wine sensory properties and shelf life. We have developed and commercialised a tool enabling industry to quantify this property in still and sparkling wine bottles, bag in box bladders, tanks and wine storage containers.

14 **The AWRI's national outreach strengthened** with the establishment of our second regional node, located in the Riverina in NSW. Following on from the AWRI's collaborative work in this area with Tarac Technologies and the University of Adelaide, Tarac Technologies and Murrumbidgee Irrigation issued an invitation to tender for design and construction of a $10MW_{th}$ grape marc bio-energy facility to be located in Griffith NSW.

15 **Wine producers embrace the PinotG Style Spectrum.** Several wine producers have committed to use the Spectrum for 2011 vintage wines on a total of over 1.2 million units (bottles and casks).

Manfred Stoll
Geisenheim Research Centre (Germany)

16 **Commercial Services analyses quality recognised but cheaper and faster.** Our laboratories passed successfully the NATA Surveillance audit, and analysis of natamycin and multi-residue analyses on grapes, wine and juice now cheaper and faster through extending capability to measure it on the LC/MS/MS.

17 **Source of musty tetrachloroanisole taint found.** The mechanism of tainting of musty tirage wine during storage was aerial contamination followed by migration of tetrachloroanisole through the crown seals. This is the first time musty taint has been shown to occur via this mechanism in the wine industry.

18 **Newly registered agrochemicals assessed.** A review of wine and field study data specific to the newly registered agrochemicals metrafenone, mandipropamid, chlorantraniliprole and etoxazole was undertaken. Details were submitted by the registrant to support the establishment of a recommended withholding period.

19 **Red wine closure trial bottling and six month testing reports.** A consortium of wineries is participating in our red wine closure trial comprising 16 different closure technologies. This is the first consortium trial of its type in which participating wineries can access all trial data for 10 closure technologies of their choice. We expect the number of participating wineries to increase as the trial results emerge.

20 **'Improving Winery Refrigeration Efficiency' reference guide launched**. This document has been widely circulated (and is available on the AWRI website) and was extremely well received.

21 **Record number of requests for information and assistance serviced.** We responded to 6,411 recorded requests for information during the 2010/2011 year. To put the statistics into perspective, 26 people contacted the AWRI seeking information on every working day of the year. This is an increase of 4 more requests *per day* over last year. This figure does not include the amount of problem solving samples investigated (1,197) or the number of Commercial Service analyses undertaken during the year. Of the total number, **1,062 requests were for technical information and winemaking related enquiries**. Our viticulture staff were kept busy with **335 requests for viticulture assistance.** The majority (245) were 'agrochemical-related'. The remaining 90 calls related to various general viticulture enquiries. **210 troubleshooting investigations were conducted** with reportable outcomes and recommendations to Australian wineries. **67 information health and nutrition requests and 121 independent regulatory, science and technical-related information requests** were managed by the Health and Regulatory Information Manager. The Information Services team managed **4,826 requests for information**. **The AWRI website proved to be an excellent source of information** with 356,088 pages being viewed during the year.

22 **14th Australian Wine Industry Technical Conference an inspiring event for sharing ideas.** The AWRI team was involved in all aspects of running the 14AWITC from planning the event, registration, presenting and poster coordination through to the conduct of the Workshop Program. There were 52 workshops held with the total number of places available being 2,212. The AWRI had a stand at WineTech 2010, where we were able to discuss the AWRI's products, services and technologies face-to-face with conference delegates.

23 **Wine and health information series developed.** Fact sheets on 13 different wine and health issues, such as *How a glass of wine affects the body*, was developed for the wine and health section of the AWRI website to complement *The A-Z of information on wine and health issues* booklet.

24 **Resveratrol's effects to be studied.** Funding was secured from the Australian Wine Foundation for the project entitled *Effect of resveratrol in red wine on cognitive function in older adults - a pilot study.* This project with the Brain Sciences Institute, Swinburne University will assess the impact of resveratrol-enhanced red wine on cognitive function in an aged Australian population.

25 **Easy access to approved wine composition for export markets**. The AWRI databases *Analytical specifications for the export of Australian wine* and *Approved additives and processing aids for winemaking in Australia and internationally* were updated and are available on the AWRI website. The former database contains specifications for 38 markets and the latter for 15 markets.

26 **All about allergens:** (i) Chaired by the AWRI's Health and Regulatory Information Manager, the Organisation de la Vigne et du Vin's Taskforce on allergens was successful in submitting documentation which secured an extended temporary derogation on egg and milk allergen labelling for wine in the EU; further documentation was also subsequently submitted to hopefully secure a permanent derogation. (ii) We now have the capacity to screen wine for the presence of dairy products such as the milk protein casein, and egg residue.

27 **Alternative varieties under the spotlight.** The idea for a new *Research to Practice* module was conceived (Alternative Varieties: emerging options for a changing environment), the materials were developed and these were accredited by FarmReady. Training was conducted in Griffith and four additional events were organised for the following financial year.

28 **60 more wine professionals train their palates.** Two Advanced Wine Assessment courses were held bringing the total number of wine professionals trained to ~900 since 1992. With each course a dux is chosen: Peter Kelly, Winemaker from Peter Lehmann Wines was Dux for AWAC29 and Han Tao Lau from Long Gully Estate was Dux for AWAC30. Both winners have been offered assistant judging positions at the Royal Adelaide Wine Show. During the first event, the **AWRI Twitter account was launched** which enabled the AWRI, judges and participants to share the experience in benchmarking 320+ wines with our Twitter followers. We now have over 700 followers.

29 **Our award-winning staff:** (i) Dimitra Capone, Senior Scientist in the aroma chemistry research team, won the Max Tate Prize for the best presentation at the University of Adelaide Agriculture, Food and Wine post graduate symposium. (ii) Matteo Marangon, Research Scientist in the protein chemistry research team, was awarded the Viticulture and Oenology 2011 Science and Innovation Award for Young People in Agriculture, Fisheries and Forestry.

30 **Additional infrastructure funding from Bioplatforms Australia (BPA) and The South Australian Government** enabled the expansion of the Metabolomics and Bioinformatics service delivery**.**

31 **Throughout the year, the AWRI staff gave 326 presentations**, presented 92 posters, conducted 34 workshops, presented 34 lectures (plus coordinated a 50 hour subject) and supervised/co-supervised 22 students.

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

Staff

The actual number of AWRI staff employed in a full-time, part-time and casual capacity as at 30 June 2011 was 118 (99.8 full-time equivalents). When the number of AWRI-based students (both from Australia and overseas) and visiting researchers are added to our complement, the number increases to 135. Of this number of people working on outcomes for Australian grape and wine producers, less than two-thirds (65%) are funded by the GWRDC.

Chris Savage – E&J Gallo Winery (USA)

Office of the Managing Director

Isak Stephanus Pretorius, BSc (Ag) (Hons), MSc (Ag), PhD *Orange Free State Uni*, Managing Director

Daniel Luke Johnson, BSc (Hons), PhD *Flinders*, GAICD, MBA *UAdel*, General Manager – Business Development

Raelene Joan Blair, CertAppMgt (Mkting) *AIM*, GAICD, Communication Manager

Shiralee Joy Dodd, BA, BLaw (Hons), LLB (Hons) *UAdel*, Executive Officer

Roxanne Portolesi, BSc (Hons) *UniWA*, PhD *Flinders*, Project Manager – Business Development (concluded 22 December 2010)

Amy Rose Hill, Personal Assistant to the Managing Director

Kathryn Sarah Beames, AWITC Conference Manager

Susanne Judy Milnes, AWITC Conference Secretariat (concluded 23 July 2010)

Corporate Services

Hans Engelbert Muhlack, BEc *UAdel*, CPA, Group Manager – Corporate Services

Christopher John Day, BAgSc (Oenology) *UAdel*, MBA *UAdel*, Grad Chartered Accounting Foundations *Deakin Uni*, Finance Manager (commenced 5 January 2011)

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

Mark Raymond Braybrook, Operations Manager

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

Adam Leigh Holland, Cert IV IT *NTUni*, IT Coordinator (commenced 7 February 2011)

Jeffrey Mark Eglinton, BSc (Hons) *UAdel*, IT Manager (concluded 14 January 2011)

Alfons Cuijvers, M (Law) *UniAntwerp*, Project Officer HR, OHS, Business Development (commenced 20 September 2010)

Michelle Tania Carter, BCom (Acc) *UAdel*, HR Administrator (concluded 16 September 2010)

Anne Hazel Haworth, Finance Officer

Susan Louise Rock, Help Desk Officer (concluded 3 September 2010)

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

Janice Margaret O'Donnell, Receptionist

Deborah Joy Thornton-Wakeford, Receptionist

Jeanette Fay Tooley, Administration Support

Research

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

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

Ian Leigh Francis, BSc (Hons) *Monash*, PhD *UAdel*, Research Manager – Sensory

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

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

James Austin Kennedy, BSc, PhD *UniCalDavis*, Research Manager – Chemistry (concluded 22 July 2010)

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

Elizabeth Joy Waters, BSc (Hons), PhD *UAdel*, Research Manager – Biochemistry (concluded 27 April 2011)

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

Anthony Richard Borneman, BSc (Hons), PhD *UMelb*, Senior Research Scientist – Biosciences

Christopher Daniel Curtin, BSc (Hons), PhD *Flinders*, Senior Research Scientist – Biosciences

Robert George Dambergs, BSc (Hons) *UAdel*, PhD *UniQLD*, Senior Research Scientist

David William Jeffery, BTech (Forens & AnalytChem), BSc (Hons), PhD *Flinders*, Senior Research Scientist – Chemistry (concluded 29 September 2010)

Cristian Andres Varela, BSc (Biochem), MSc (Biochem), PhD *CatholicUniChile*, Senior Research Scientist

Keren Bindon, BSc (Hons) (Biology) *UniNatal*, MSc (Plant Biotechnology) *UniStellenbosch*, PhD (Viticulture) *UAdel*, Research Scientist

Cory Alan Black, BSc (Hons), PhD *UOtago*, Research Scientist

Antonio Felipe Garcia Cordente, BSc (Chem), BSc (Biochem), PhD *UniBarcelona*, Research Scientist

Peter James Costello, BSc (Hons)/MSc *UniNSW*, PhD *UAdel*, Research Scientist

Martin Peter Day, BSc (Hons) *USussex*, PhD *UNantes*, M (Oenology) *UAdel*, Research Scientist

Richard Gawel, DipEd, BSc, GradDip (Oen) *UAdel*, Research Scientist

Jason Geue, BSc (Hons),PhD *UAdel*, Research Scientist (concluded 4 March 2011)

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

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

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

Mark Edward Smith, BSC (Hons)/ PhD *UAdel*, Research Scientist (commenced 5 January 2011)

Maurizio Ugliano, BSc (Hons) *UniNaples*, PhD *UniFoggia*, Research Scientist (concluded 16 August 2010)

Dariusz Roman Kutyna, MSc *AgUniPoland*, PhD *VicUni*, Post Doctoral Research Fellow

Christine Marianne Mayr, State Examination (Pharmacy) *LMUMunich*, PhD, Post Doctoral Research Fellow (commenced 1 March 2011)

Jacqui Marie McRae, BSc (EnvMgmt) *VictUni*, BSc (Hons) (Biotechnol), PhD *SwinburneUni*, PhD *SwinburneUni*, Post Doctoral Research Fellow

Steven van Sluyter, BA, BSc *UniNthCarolina-Wilmington*, PhD *Charles Sturt Uni*, Post Doctoral Research Fellow (concluded 29 September 2010)

Marlize Zaretha Viviers, BSc (IndustChem), BSc (Hons), M (Chem) *Stellenbosch Uni*, Post Doctoral Research Fellow (commenced 4 April 2011)

Dimitra Liacopoulos Capone, AssDip (Chem), BAppSc (Chem) *UniSA*, Senior Scientist

Patricia Chaves Osidacz, BSc (FoodEng) *StateUniCampinas*, MSc (FoodSc) *UniIllinois*, Senior Sensory Scientist

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

Jennifer Rose Bellon, BSc (Biochem&Genetics) *UAdel*, Scientist

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

Maria Jolanta Kwiatowski, MSc *SilesianUniTech*, Scientist (concluded 16 September 2010)

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

Alexander Schulkin, BSc, Bar-Ilan, GradDip(Oen) *UAdel*, Scientist

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

Caroline Elisabeth Abrahamse, BSc (Biotech) (Hons) *UAdel*, Technical Officer

Belinda Ruth Bramley, ScTechCert (Biol) *SAIT*, BSc (Viticult) *UAdel*, Technical Officer

Sylvester Holt, BSc, MSc *Copenhagen*, Technical Officer (concluded 9 December 2010)

Robyn Louise Kievit, BSc *UniSA*, BSc (Hons) *UAdel*, Technical Officer

Radka Kolouchova, AssDip *TechCollFoodTech*, Technical Officer

Jane Melissa McCarthy, Cert (AnimHand), Cert (VetNurs) *TAFE SA*, AdvCert (MedLabSc) *UniSA*, Technical Officer

Kevin Herbert Pardon, AssDip (AppChem) *SAIT*, Technical Officer

Mark Roger Solomon, BSc (Chem) (Hons), BSc (Med Chem) *Flinders*, Technical Officer

Katryna Agatha Van Leeuwen, BSc (Hons) *Flinders*, Technical Officer (concluded 30 March 2011)

Natoiya Dee Rayette Lloyd, BSc (MedChem) (Hons) *Flinders*, Laboratory Technician (concluded 13 May 2011)

Russell Bond Gardiner, Winery Assistant

Heather Margaret Donnell, Administrator

Jelena Jovanovic, Administration Officer

June Robinson, Research Laboratory Support

Microbial Metabolomics Facility

Meagan Diane Mercurio, BSc (Hons), BTech (Foren&AnalChem) *Flinders*, Manager – Metabolomics Facility

Philip Mercurio, BSc *UniNthArizona*, BSc (Hons), MSc *JamesCookUni*, Scientist

Jeremy Crispin Hack, Technical Officer (until 24 December 2010)

Bioinformatics

Wade Michael Hines, BA *UC Santa Barbara* (BioChem/MolecBiol), PhD *UC San Francisco* (PharmChem), Manager AWRI/BPA Bioinformatics Node (commenced 23 March 2011)

Nathan Spencer Watson-Haigh, PhD (Biology) *UYork*, Senior Bioinformatician (commenced 7 March 2011)

Jeremy Crispin Hack, Bioinformatician (commenced 24 December 2010)

Casual Sensory Panel

Lynn Alabaster, Peter Baldwinson, Brian Beggs, Jaqueline Gould, Philippa Hall, Gurinder Khera, Jennifer O'Mahony, Ralph Osborne, Vivianne Rees, Mark Werner, Fiona Woodcock

Students

Andrea Anesi, MBiotech *UniVerona*, PhD Student (7/2/2011-30/09/2011)

Gustavo Cordero Bueso, BA Biology *UniSalamanca*, PhD Student (06/10/2010-30/03/2011)

Diana Gazzola, PhD Viticulture *UniPadua*, PhD Student (10/01/2011-25/04/2011)

Raul Guerrero, PhD (Oenology) *UniCadiz*, PhD Student (18/03/2011-17/03/2012)

Claudio Hidalgo, M (Oenology) *UniRovira/Virgili*, PhD Student (27/04/2011-31/10/2011)

Corine Ting, *UAdel*, Honours Student (01/02/2010-31/08/2011)

Javier Varela, PhD Student (BioChem) (20/12/2010-15/03/2011)

Nicholas Ian Warnock, BBiotech (Hons) *Flinders*, PhD Student

Gal Winter, BSc, MSc (Biochem& FoodSc) *HebUniJerusalem*, PhD Student

Visiting Researchers

David Bellows, PhD *UniVictoria Wellington*, Visiting Researcher (24/05/2011-17/06/2011)

Juami Canals Bosch, PhD, *UniRovira/Virgili*, Visiting Researcher (31/5/2011- 30/5/2012)

Paul Kilmartin, *UniAuckland*, Visiting Researcher (14/07/2010-05/08/2010)

Gerard Logan, *UniAuckland*, Visiting Researcher (08/07/2010-23/07/2010)

Estibaliz Mateo, PhD *UniRovira/Virgili*, Visiting Researcher (27/04/2011-31/10/2011)

Ignacio Nevares Dominguez, PhD *UniValladolid*, Visiting Researcher (15/08/2010-15/09/2011)

Aude Vernhet, *INRA Montpellier*,Visiting Researcher (02/07/2010-18/07/2010)

Industry Development and Support

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

Peter Ronald Dry, BAgSc, MAgSc, PhD *UAdel*, Viticulture Consultant

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

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

Geoffrey David Cowey, BAppSc (WineSc) *CSU*, BSc (Hons) *UAdel*, Senior Oenologist

Matthew Grant Holdstock, BSc *Flinders*, GradDip (Oen) *UAdel*, Senior Oenologist

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

Gemma Ashe West, BAgSc (Oen), *UAdel*, Grad Cert BusAdmin, *Charles Sturt Uni*, Winemaker

Sally Jean Bell, BSc (Ag), PhD *UniWA*, GradDip (WineBus) *UAdel*, Senior Viticulturist (concluded 28 February 2011)

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

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

Mardi Longbottom, BAgSc *UAdel*/Master (Vitic), PhD *UAdel*, Viticulturist (commenced 10 May 2011)

Francesca Blefari, BBus, *UEdithCowan*, Events & Projects Coordinator

Sarah Louise Ballantine, BSc (Chem) (Hons) *UAdel*, Project Officer (concluded 30 July 2010)

Sean Mathew Boden, BA *UAdel*, GradDip (InfoStud) *UniSA*, Systems Librarian

Ingrid Betty-Maud Barratt, Dip (Lib&Info Stud) *TAFE SA*, Library Technician (concluded 9 March 2011)

Anne Dorothy Lord, GradDip (InfoStud) *UniSA*, Library Technician

Emma Louise Kennedy, BSc (CompMod) *Flinders*, Technical Officer

Virginia Frances Phillips, Administrator

Industry Applications

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

Daniel Cozzolino, AgricEng *Uruguay*, PhD *UniAberdeen*, Senior Research Scientist

Richard Anthony Muhlack, BE (Chem) (Hons), PhD *UAdel*, Process/Environmental Engineer

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

Nevil Kamlesh Shah, BSc (Botany), MSc (Biotech) *UniQLD*, Scientist (concluded 24 June 2011)

Ella Margaret Clare Robinson, BA, BSc (Hons) *UAdel*, Project Manager

Commercial Services

Vincent Thomas O'Brien, BE (Chem) (Hons) *UAdel*, PhD *UniQLD*, Group Manager – Commercial Services

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

Warren Keith Roget, BEng (Mechatronic) (Hons) *UAdel*, Technical Manager

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

Leanne Michele Hoxey, BSc *UAdel*, Quality Systems and Laboratory Manager

Randell Leith Taylor, BSc (Hons) *UAdel*, Manager Trace Laboratory

David Rolfe Boehm, BSc *UAdel*, Scientist (concluded 31 December 2010)

Heather Mandy Tosen, BSc *UAdel*, Scientist

Simon Nordestgaard, BE (Chem) (Hons) , BEc, PhD *UAdel*, Project Engineer (commenced 4 August 2010)

Oenone Jean Macintyre, BSc, BE (Chem) (Hons) PhD *UAdel*, Project Officer (concluded 14 December 2010)

Simon Paul Odell, BBiotech (Hons) *Flinders*, GradDip (Oen), PhD *UAdel*, Project Officer (concluded 18 March 2011)

Tina Thi My Tien Tran, BSc (Microbiol/Biotech), BSc (AppBiol) (Hons) *VicUni*, Project Officer

Slavko Matthew Bekavac, BAppSc (Chem& ChemProcTech) *UniSA*, Senior Laboratory Technician

Carlo Mark Congiusta, BSc (Nano) (Hons) *Flinders*, Casual Laboratory Technician (concluded 30 July 2010)

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

Kerry Anita Pinchbeck, BSc (Medicinal Chem) *Flinders*, Phd (Wine Chem) *UAdel*, Laboratory Technician (commenced 10 January 2011)

Timothy James Gordon Reilly, BSc (Nano) (Hons) *Flinders*, Laboratory Technician

Pamela Stepancich, BTech (Forens&Anal Chem), BInnovationEnterprise (Sc&Tech) *Flinders*, Technical Officer

Daniel Scott Tynan, DipAppSc (ChemTech) *UniSA*, Laboratory Technician

Melissa Nutt, BTour HospMgmt, GradCert (HRMgmt) *UniSA*, Customer Service & Marketing Coordinator

Robyn Monica Gleeson, Laboratory Support

Alana Williams, CertII (HospOp) *TAFE SA*, CertIV (JapaneseLang) *VLLC*, Customer Service Officer

Lulie Haldstead – Wine Intelligence (UK)

Staff activities

Sakkie Pretorius is a member of the South Australian Wine Industry Council; the Wine Innovation Cluster Leadership Group; the Wine Industry Technical Advisory Committee (WFA); the Council of the Royal Agricultural and Horticultural Society of SA Inc.; the Wine Committee of the Royal Agricultural and Horticultural Society of SA Inc.; Editorial Board of the following journals: *American Journal of Enology and Viticulture, Annals of Microbiology, Bioengineered Bugs, FEMS Yeast Research* and *Yeast*. He is the Chairman of the Australian Wine Industry Technical Conference Inc. and of the National Wine Research Network (NWRN). He is a member of the International Commission of Yeasts, and the Scientific Board of L'Institut des Sciences de la Vinge et du Vin (ISVV), Bordeaux, France. He is also an Affiliate Professor of The University of Adelaide.

Dan Johnson is a Director and the Treasurer of the Australian Wine Industry Technical Conference Inc. and is a member of the 8th ICCS Planning committee.

Marcus Grant – International Care Centre for Alcohol Policies (USA)

Markus Herderich is a Director of the Australian Wine Industry Technical Conference Inc., member of the Metabolomics Australia Executive Management Group, Industry Collaborative Innovation Program Consortium Committee and Wine Innovation Cluster Research Group. He is also an Affiliate Associate Professor of The University of Adelaide and a member of the Advisory Board of the *Journal of Agricultural and Food Chemistry*.

Eveline Bartowsky serves on the Joint Editorial Board of the *Journal of Applied Microbiology* and *Letters in Applied Microbiology* and serves on the Editorial Review Board of the *Journal International des Sciences de la Vigne et du Vin*. She is a member of The Waite Campus Health and Safety Forum. She was the Poster Coordinator for the 14th Australian Wine Industry Technical Conference (3-8 July, 2010 in Adelaide), and is an Affiliate Lecturer at The University of Adelaide.

Paul Chambers is coordinator of a national Bioplatforms Australia/AWRI, Wine Yeast Systems Biology project, and is coordinator of the Australasian Yeast Group (through its homepage at http://www.ayeastgroup.org/).

Daniel Cozzolino is a member of the honorary editorial board of the *International Journal of Wine Research*, a member of the Editorial Board of *Food Research International* and is a member of the *Council Management Committee of the International Council for Near Infrared Spectroscopy* (ICNIRS).

Bob Dambergs is a member of the Wine Industry Tasmania Technical Committee and the National Wine Research Network (NWRN), a member of the ASVO Board, a member of the 8th ICCS Planning committee, and an Honorary Associate of the University of Tasmania

Leigh Francis is an Associate Editor of the *Australian Journal of Grape Wine Research*, a member of the Editorial Board of the *Journal of the Science of Food and Agriculture*, and is also an Affiliate Lecturer at The University of Adelaide.

Jeremy Hack is a member of the Metabolomics Australia Analytical, Laboratory Information Management System (LIMS) and Informatics working groups.

Paul Henschke is an Associate Editor of the *Australian Journal of Grape and Wine Research*, is a member of the Editorial Review Boards of *Food Microbiology* and *Mitteilungen Klosterneuburg*, and is a member of the local organising committee for the 8th International Cool Climate Symposium to be held in Hobart in February 2012. He is a guest lecturer at The University of Adelaide and Flinders University.

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

Peter Godden was a member of the 14th Australian Wine Industry Technical Conference Planning Committee and the Program sub-committee and participated as a judge at the Royal Adelaide Wine Show and the Limestone Coast Wine Show.

Con Simos is a member of the Wine Industry relations committee and was a member of the 14th Australian Wine Industry Technical Conference Planning Committee, the AWITC Program sub-committee and was Program Convenor for the 14th AWITC Workshop program. Con was one of the 15 successful candidates for the 2010 program intake for 'Future leaders – succession for the Australian wine sector'.

Dr Peter Dry is an Adjunct Associate Professor, University of Adelaide, a member of the Phylloxera and Grape Industry Board of SA and Associate Editor of the *Australian Journal of Grape and Wine Research* and the *Wine and Viticulture Journal*.

Creina Stockley is an Affiliate Senior Lecturer, School of Agriculture and Wine, The University of Adelaide and is the Coordinator of the Wine Science Course entitled *Grape Industry Practice, Policy and Communication*. She is a member of the National Alcohol Knowledgebase Expert Working Group, the Winemakers' Federation of Australia (WFA) Wine Industry Technical Advisory Committee, WFA Wine industry National Environment Committee and the WFA Wine and Social Responsibility Committee. She is also the DAFF nominated Australian delegate for the Organisation International de la Vigne et du Vin (OIV) Health and Safety Commission (IV), and is currently the President of the Food Safety Expert Group. She is also a member of the honorary editorial board of the *International Journal of Wine Research*, as well as a charter member of the International Scientific Forum on Alcohol Research and a member of the Scientific Board of the (European) Wine Information Council. In addition, Creina was also a member of the Scientific Committee for the 2010 International Wine and Health Conference (held in Italy) and the 14th Australian Wine Industry Technical Conference Program Sub-Committee.

Vince O'Brien is an Adjunct lecturer at the University of Adelaide and member of the Winery Engineering Association Conference Planning Committee, Nomacorc Advisory Committee, Wine Industry Suppliers Association Innovation Committee, and was a member of the 14th Australian Wine Industry Technical Conference Planning Committee.

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

Meagan Mercurio is a member of the AusBiotech Committee (SA Branch) and the Metabolomics Australia Analytical Group.

Team reports

Grape and wine composition

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

Staff

Dr Leigh Francis (from September 2010), Dr David Jeffery (to September 2010), Dr Cory Black, Dimitra Capone, Tracey Siebert, Mark Solomon, Natoiya Lloyd, Kevin Pardon, Dr Jason Geue (to March 2011), Dr Christine Mayr (from March 2011).

Collaborators:

Orlando Wines (Nick Bruer); Casella Wines (Steve Warne); Adelaide Hills Vine Improvement Inc (David Coleman); Bests Wines (Adam Wadewitz); Curtin University (Dr Ayalsew Zerihun, Dr Mark Gibberd); University of Auckland (Gerard Logan, Associate Professor Paul Kilmartin); Mt Majura Vineyard (Frank van de Loo); Shaw and Smith Winery (Darryl Catlin); Craggy Range Vineyards (NZ); University of Adelaide (Professor Dennis Taylor, Dr Mark Sefton, Dr Gordon Elsey, Dr David Jeffery).

The compounds responsible for flavour and aroma properties of wines are of major importance in defining wine acceptance. In wines there are a multiplicity of aroma active volatile compounds from different sources, with very wide variations of amounts of different compounds required to generate a sensory effect, and many potent compounds only present at trace concentrations. The analytical challenges to quantify these compounds are considerable, and given the complex interplay among different compounds, the ability to define the sensory significance of identified compounds is also often a difficult task. The measurement of aroma compounds – including both off-flavour compounds and those components with a positive influence on flavour – together with the assessment of factors determining amounts present in a finished wine, is an important feature of AWRI research. Synthetic chemistry knowledge allows compounds to be studied that are not otherwise available, and the close integration of chemistry information with sensory data is also fundamental to progress in this area.

'Tropical' thiol precursors

Varietal thiols are important impact odorants in wines, and are major contributors to the tropical flavour of Sauvignon Blanc and other varieties. 3-mercaptohexan-1-ol (3-MH) is of particular importance with a very low aroma detection threshold, in the low nanogram per litre range.

3-MH is found in grape must in the form of odourless, non-volatile conjugates which act as precursors through being broken down by the action of yeast or enzymes during fermentation to release the aroma active compound. The known precursors to 3-MH are a cysteine conjugate and a glutathione analogue.

Sensitive methods have been developed at the AWRI for measuring both the precursors of 3-MH and the free 3-MH concentration and we have recently investigated the effect of ripening and post-harvest effects on levels of these compounds in Sauvignon Blanc must.

Grapes from five different clones of vines grown in the Adelaide Hills were sampled and analysed for 3-MH precursor levels at approximately 14 day intervals during the growing season. This study was part of a collaborative project with Adelaide Hills Vineyard Improvement Inc. The precursor levels were found to be very small from veraison to mid-ripening, with a slight increase pre-harvest, and a large, approximately 10-fold increase, at the time of commercial harvest. The influence of clone type was smaller but nonetheless important, with two clones having lower levels of the precursors than the other three, and further studies are required to further assess this effect. A sensory study was conducted on wines made from these clones and the tropical fruit

Dimi Capone presenting at a workshop at the 14th Australian Wine Industry Technical Conference (Dr Leigh Francis is seated at the speakers' table).

aroma intensity was related to the level of precursor in the grapes. Harvest timing thus seems to be of critical importance. In a complementary study with Curtin University it was also found that vigour and clone had an effect on levels of 3-MH and tropical fruit flavour in the resultant wine.

From earlier investigations it had found that rupture of berries influences 3-MH precursor concentration. Transportation of machine harvested fruit from the vineyard to the winery has been suggested by some producers to result in wines with more tropical aroma than fruit processed soon after harvest. To investigate this, a commercial scale study was conducted with the assistance of Casella Wines. 3-MH precursor levels were analysed in samples taken from grape bins at harvest and then again in samples taken approximately 12 hours later, after transport to the winery. Results for this experiment are shown in Figure 1. There was a very large increase in both precursors due to the transport of the fruit. These results have important practical implications to producers, as they highlight the fact that there is an opportunity to manipulate tropical thiol precursor concentrations in must, to achieve appropriate levels in the finished wine. This work complements that of microbiological studies, where different yeast strains have been found to have a significant variation in ability to release 3-MH from these precursors.

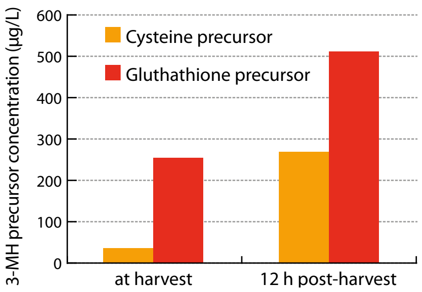


Figure 1. Concentration of the precursors of the 'tropical' thiol 3-MH for machine harvested Sauvignon Blanc fruit before and after transportation.

Eucalyptol

The minty/eucalyptus flavour that can be evident in some red wines has been shown to be caused by the compound eucalyptol (also known as 1,8 cineole). Eucalyptol is a major constituent of eucalyptus leaves and eucalyptus oil. Earlier work at the AWRI showed that proximity of vines to eucalyptus trees was the main factor giving rise to this compound in resultant wines, with wine made from those vines closest to trees having the highest levels, and vines further from eucalyptus trees giving wine with progressively lower levels.

While it was initially shown that airborne transmission of volatile organic compounds from nearby trees was a cause of the compound being present in grapes, leaves and stems, it was found in recent experiments that the presence of a small amount of eucalyptus leaves or woody material in harvested grapes has a dramatic effect on the final eucalyptol concentration in wine. With wine made from berries with no stalks or stems present - from a vineyard in close proximity to eucalyptus trees - levels of eucalyptol were very low, and below the sensory detection level. The same fruit with stems and some grape leaves had levels three times higher, above the sensory threshold. The fruit fermented in the presence of a small quantity of eucalyptus leaves had 15-fold higher levels than the berries-only wine, which is sufficient to give a very clear minty/eucalyptus flavour. The study showed that for those wine producers wishing to reduce the level of this flavour in their wines, avoidance of eucalyptus tree debris in harvested grapes would have a large effect.

Rotundone and Shiraz flavour

The compound rotundone, which was first identified as an important wine odorant by the AWRI, is a highly potent compound with a very low sensory threshold, giving a black pepper/spicy aroma. Interestingly, in common with some other aroma compounds, a sizeable minority of the population is unable to perceive an aroma or flavour from rotundone except when it is present at very high levels. While rotundone is known to be grape derived, being of a class of compounds called sesquiterpenes, there is little known about what factors influence its concentration in wines except that it is more evident in wines from cool climates.

In studies conducted with wine company collaborators, and notably with Gerard Logan of the University of Auckland, we now have a much improved understanding of the various viticultural and winemaking effects on rotundone levels.

There was a remarkable effect of Shiraz berry ripening on rotundone levels, with only low concentrations found in grapes up to a time point close to harvest, with a large increase in the late stages of berry ripening. Clonal effects and differences in sites within vineyards, relating to vigour and soil type, were also found. In assessing sets of wines from different vintages it has become apparent that there can be very large seasonal variations, with some vintages resulting in wines with negligible concentration of rotundone, with the preceding or following vintages having high levels. A large increase in rotundone was also observed during fermentations, reflecting extraction from skins.

A detailed investigation was conducted to find the most important aroma compounds in two premium Shiraz wines, one from a cooler climate and one from a warmer region. There were a number of notable differences found between the two wines. The cool climate wine's flavour was influenced by rotundone, while the warmer climate wine had higher levels of the grape derived compound beta-damascenone, the compound dimethyl sulfide, and oak derived compounds such as *cis*-oak lactone. This work highlighted that a relatively small number of the hundreds of volatile compounds present in the wines were of sensory significance and is a further step towards defining quality markers for this variety.

Effects of nitrogen application in the vineyard

The treatment of Shiraz vines in a salt affected vineyard with applications of nitrogen has been studied over four seasons. The results from the 2010 vintage confirm previous years' results, with high nitrogen in the vineyard being associated with wines having elevated hydrogen sulfide and boiled egg/sewage aroma, together with elevated fermentation esters and a confectionary aroma.

Amongst other findings, this study demonstrated that the rate of nitrogen applied as conventional practice for correcting a nitrogen deficiency on a non-saline site may not be appropriate for saline sites. At the same time, application of a rate of nitrogen above that which is considered optimal for non-saline conditions is not practical from an economic or an environmental perspective. Application of early season nitrogen in the vineyard increased vine nitrogen status but at the same time changes in vine mineral nutrients were observed in some seasons.

Smoke glycosides

A major priority is the exploration of smoke-taint and its associated compounds. It is now well known that the unpleasant-smelling phenol and methoxy-phenol related compounds that are present in smoke are bound up in the grape upon smoke exposure as non-volatile glycosides. These compounds are subsequently released during winemaking as well as over time in the bottle. Following the discovery of the most prevalent smoke taint glycoside precursor syringol gentiobioside, a need arose to prepare this compound as a major marker for determining levels of taint for the wine industry. Both deuterium-labelled (d_3) and unlabelled syringol gentiobioside were prepared in low quantities, initially only suitable for analytical purposes. In order to ensure a suitable supply of these important compounds the seven-step preparative method was significantly improved on, resulting in greater yields and highly pure quantities of both precursors. The AWRI now has a significant supply of many of the known smoke taint precursors, having also prepared the mono-glucosides of *m*-, *o*- and *p*-cresol, syringol, d_3-syringol, guaiacol, d_3-guaiacol, 4-methyl guaiacol, 4-methyl syringol and phenol.

Phenolics and their contribution to wine composition and sensory properties

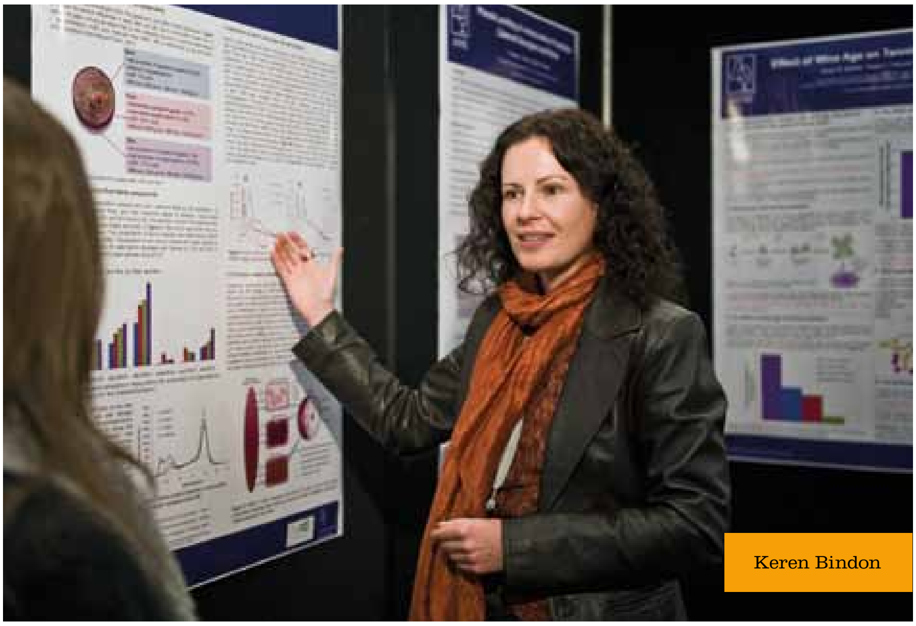
Staff and students

Dr Paul Smith, Dr Liz Waters (until 15 April), Dr Keren Bindon, Dr Yoji Hayasaka, Dr Helen Holt, Dr Jacqui McRae, Dr Raul Guerrero (Visiting post-doctoral fellow), Assoc. Professor Joan Miquel Canals Bosch (Visiting scientist), Stella Kassara, Mango Parker

Collaborators

Accolade Wines (Chris Bevin); Orlando Wines (Kate Lattey); SARDI (Dr Michael McCarthy, Amy Richards); The University of Adelaide (Dr Sue Bastian, Dr Chris Ford, Caroline Payne); Flinders University (Dr Ingo Koeper); University of Melbourne (Professor Tony Bacic)

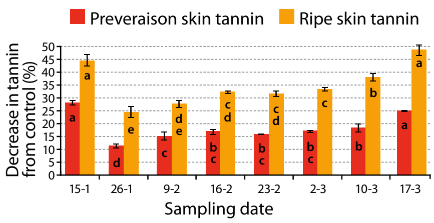
This suite of projects has the objective of determining the function of phenolic compounds in grapes and wine. Of specific interest is identifying phenolic compounds that have importance with regard to wine colour, mouth-feel, and taste. We also aim to develop an understanding of grape and wine phenolic attributes related to consumer wine preference. With this in mind, the effective management of these components in the vineyard and winery to achieve a targeted wine composition, or style, is the desired outcome. Finally, the verification of potential and risks associated with novel practices and new technology are considered critical aspects to the success of the projects.



Keren Bindon

Tannin extractability

We have recently completed a study of the interaction of grape skin and flesh cell walls with grape tannins, collected from Cabernet Sauvignon grapes over two seasons. This work was part of a broader project which has sought to understand cell wall-tannin interactions in regulating tannin extractability from grapes to wine. Model studies of cell wall interaction with tannin, sourced from preveraison (green) grape skins and ripe skins were performed. The use of two tannin types was based on earlier findings that the interaction with cell walls differs depending upon tannin ripeness (AWRI Publication #1280). The findings have shown that changes in flesh cell wall structure during ripening has a limited effect on its binding for tannin. On the other hand, larger differences were found with skin cell wall material, as the skin cell wall properties changed with grape ripening (see Figure 2). Riper skins were found to have a higher affinity for tannins of both types tested, over two seasons. A detailed study of selectivity of skin cell walls for tannin showed that as the skin cell walls ripened, there was increased selection for tannins of higher molecular size. A collaboration has been undertaken with Professor Tony Bacic at the University of Melbourne, where we undertook linkage analysis of cell walls. This showed that, in agreement with previous research on grape ripening, that the progression of ripening caused a progressive loss of pectic polysaccharides, namely galacturonic acid and arabinogalactan I. This trend was consistent for both flesh and skin cell wall materials. A complicating factor in the interpretation of results, is that skin cell wall affinity for tannin increased as ripening progressed, while for flesh it did not. Additional analysis of the cell walls looked at lignin composition and insoluble tannin. Both of these did not change significantly during ripening, but were significantly higher in skin cell walls. These factors may influence the changes in skin cell wall porosity and flexibility, and thus surface area for tannin binding, in addition to the loss of pectic polysaccharides. The significance of cell walls in the winemaking process is two-fold. Firstly, cell wall tannin interactions may control tannin extractability from the skins, but secondly, may also selectively fine tannins solubilised during vinification (AWRI Publication #1236). This concept has recently been used to explore the use of organic waste materials from vinification, i.e. fibre extracted from grape marc, as an alternative fining agent for wine phenolics. The preliminary results are positive, and this continues with support of a visiting scientist from Spain, Dr Raul Guerrero who has a postdoctoral scholarship from the European Union. He is currently undertaking experiments to verify and optimise the use of grape fibre as a novel, 'green' fining agent.



Tannin cell wall interaction shown as % decrease from a 2 mg/mL solution after addition of a skin cell wall extract. Sampling dates were preveraison (green) grapes on 15-1, veraison on 26-1, commercial harvest on 17-3. Histograms show mean ± standard error; ANOVA; n =3; different letters indicate significant differences where $P<0.05$.

Figure 2. Decrease in tannin following reaction of skin cell wall extracts from different ripeness stages with either preveraison or ripe skin tannin in model wine solution.

Another component of this project has sought to explore relationships between grape maturity and wine composition. Initially this has looked at tannin extraction, and has shown that the extractability of grape skin tannins changes with ripeness, and correlates positively with the concentration of total tannin in wines. Further experiments will incorporate additional factors which influence this relationship, in order to build an extraction model, based on tannin-polysaccharide interactions.

This project has recently expanded its scope significantly and the experimental wines have undergone comprehensive chemical analyses: organic acids, colour, tannin concentration and composition, polysaccharides, methoxypyrazines, norisoprenoids, monoterpenes, fermentation-derived alcohols and esters, low molecular weight sulfur-containing compounds; and glycerol. The sensory team at the AWRI has performed sensory and consumer studies on the wines, and collated these with the chemical data. This enables us to explore compositional factors that may explain wine quality and consumer preferences in lower alcohol wine, made from grapes after harvest at lower sugar ripeness.

AWRI Publication #1280. Bindon, K.A., and Kennedy, J.A. (2011). Ripening-induced changes in grape skin proanthocyanidins modify their interaction with cell walls. J. Agric. Food Chem. 59 (6): 2696-2707.

AWRI Publication #1236. Bindon, K.A., Smith, P.A. Holt, H. and Kennedy, J.A. (2010). Interaction between grape-derived proanthocyanidins and cell wall material 2. Implications for vinification. J. Agric. Food Chem. 58 (19): 10736-10746.

The relationship between wine quality and the chemistry of grapes and red wine

A project was completed on the relationship between red wine chemistry and winemaker assessment of quality and this work has now been published (AWRI Publication #1302). Following up this detailed analysis, investigations have been undertaken into the polysaccharide concentration and composition. No correlation was found between polysaccharide concentration and winemaker-assessed quality, however trends were observed in the proportion of grape-derived and yeast-derived polysaccharides in high and low quality wines. Further investigations are currently underway to determine the cause of this difference and the impact polysaccharide composition might have on wine quality.

AWRI Publication #1302. Kassara, S.; Kennedy, J.A. Relationship between red wine grade and phenolics. 2. Tannin composition and size, J. Agric. Food Chem. 2011, 59 (15), 8409-8412.

Astringency: tannin formation and structure

To determine the impact of pH and oxygen exposure in the bottle on the kinetics of wine tannin formation from grape tannins, we have started an ageing experiment. This experiment will determine how much impact pH and oxygen exposure have during bottle storage on the structure and composition of wine tannins. Wine was made using cabernet grapes from the 2010 vintage, separated into three batches after malolactic fermentation and the pH was adjusted to 3.2, 3.5 and 3.8 just prior to bottling. The wines were bottled, sparged with nitrogen gas and capped under two different closures for each pH. The closures used were SaranTin, as a representative screw cap, and Saranex, with a similar oxygen transfer rate to natural cork. The standard wine parameters and levels of dissolved and headspace oxygen were measured immediately after bottling and again after six months of bottle ageing with a view to repeat the measurements annually for another four years. Tannin was also isolated from each replicate at both time points and fractionated using SPE. The structure of the total and fractionated tannin was analysed using GPC and phloroglucinol to determine the relative size and composition of each isolated tannin fraction from the different pH wines with the different closures. At this stage, neither pH nor level of oxygen exposure has greatly impacted upon wine tannin formation or structure.

Last year we reported that tannins isolated from older wines are more weakly bound to proteins, using a technique known as isothermal titration calorimetry (ITC). This research (AWRI publication #1255) demonstrated the impact of changes in tannin structure upon wine ageing on the interaction with a peptide similar to salivary proteins with poly-(L-proline), suggesting that such older wine tannins might be perceived as less astringent. These observations may, at least in part, explain why red wine 'softens' with age. In building on the success of the ITC results, an assay has been developed that correlates the solubility of a tannin sample with the strength of the binding with polyproline. Further work is underway to correlate these results with sensory data and further ITC analysis, as well as surface plasmon resonance (SPR) investigations to be carried out in collaboration with Dr Ingo Köper at Flinders University. Visiting Scientist Associate Professor Joan Miquel Canals Bosch, from the Faculty of Oenology, Universitat Rovira i Virgili in Spain has joined the AWRI and is investigating the interaction of tannins with salivary proteins using advanced analytical techniques. In addition, a review of current research on wine and grape tannin interactions with salivary proteins and their impact on astringency has been prepared and published (AWRI publication #1298).

The structure of wine tannin has always been a large unknown in this field of research. To address this uncertainty, methods have been developed to break apart tannin for easier identification using NMR techniques. Tannins were reacted with phloroglucinol under normal conditions, which cleaves around 30-40% of the tannin. The non-hydrolysed portion of the tannin was then recovered and reacted under different conditions to break the tannin apart further (Figure 3). Progressive cleavage reactions mostly produced fragments that could be identified as catechin-derived monomers, which did not warrant further structural elucidation, however the non-hydrolysable core of the tannin was of great interest. The proportion of the non-hydrolysable core was found to be substantially greater in aged wine tannins than young wine tannins and has shown a substantially reduced affinity for polyproline than the original tannin. This suggests that although aged wine tannins are larger than young wine tannins, the larger proportion of this non-hydrolysable core present in the tannin structure may be responsible for decreasing the binding affinity of the tannin.

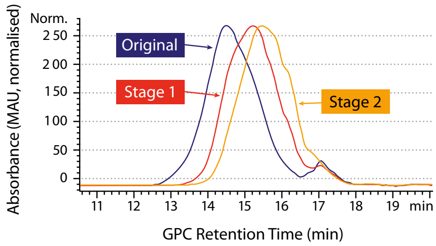


Figure 3. The molecular mass distribution of young wine tannin determined by GPC before and after cleavage reactions; Original: The tannin as isolated from the wine; Stage 1: The non-hydrolysed portion of the tannin after normal phloroglucinolysis; Stage 2: The tannin from Stage 1 after further acid-catalysed cleavage. Larger samples elute earlier on the GPC column.

AWRI publication #1255. McRae, J. M.; Falconer, R. J.; Kennedy, J. A. Thermodynamics of grape and wine tannin interaction with polyproline: Implications for red wine astringency. J. Agric. Food Chem. **2010**, *58*, 12510–12518.

AWRI publication #1298. McRae, J. M.; Kennedy, J. A. Wine and Grape Tannin Interactions with Salivary Proteins and Their Impact on Astringency: A Review of Current Research. Molecules 2011, 16, 2348-2364.

Rapid tannin measurement in grapes

In an extension of the project on innovative phenolic analysis techniques, we have further progressed a calibration developed in collaboration with the Industry Applications team to measure grape tannin. An UV-Vis spectral calibration for prediction of tannin in ethanol homogenate extract already used for anthocyanin analysis in grapes has been validated and shown to perform very well. The calibration is a multiple linear regression (MLR) calibration that uses only three wavelengths, and was developed using samples from Riverland, Langhorne Creek, Coonawarra, Padthaway and Barossa Valley (n= 98). The validation set (n=69) gives an R^2=0.93 and a standard error of prediction (SEP) of 0.03 g/L. It is interesting to note that using only one wavelength, A280 nm (used traditionally to measure total phenolics), gives only an R^2=0.51, demonstrating that total phenolics measurements do not necessarily predict tannin well. The development and validation of this calibration for grape tannin may now allow far simpler access to grape tannin concentration and allow winemakers and viticulturists to monitor tannin development during the growing season.

Factors influencing white wine mouth-feel perception

Polysaccharides are the most abundant macromolecules in dry white table wines. While their presence is usually associated with longer juice settling times and reduced filtration efficiency, they are also thought to aid protein and tartrate stability and to positively contribute to the perception of palate fullness. Earlier work showed that augmenting white wines with low to moderate levels of native polysaccharides resulted in only weak and inconsistent increases in fullness and no significant reduction in their phenolic taste. However there was some evidence that increasing polysaccharide content in white wine reduced the perception of hotness due to alcohol.

The extraction of polysaccharides from white wines was optimised by taking steps to both minimise the initial pickup of phenolics and oligomeric sugars, and by applying a novel method to remove residual impurities resistant to other classical methods. Overall, purity of up to 94% was achieved with a novel counter-current chromatography step that removes phenolics and tartrates.

The method was used to obtain significant quantities of highly purified polysaccharides from both commercial Riesling and unoaked Chardonnay. These were added back to a highly phenolic wine made from heavy pressings, and the same wine after it had been mostly stripped of its phenolics using a food grade resin. The addition of polysaccharides resulted in small but consistent increases in perceived viscosity as assessed by a trained sensory panel.

Significantly, the addition of both Riesling and Chardonnay polysaccharides also resulted in significantly lower palate hotness of both the high and low phenolic base wines. This result suggests that improved palate texture and reduced perceived alcohol hotness could be achieved by using winemaking practices that favour polysaccharide extraction and retention.

To this end, winemaking practices that influence polysaccharide extraction were investigated. The distribution of polysaccharide types and total polysaccharide content of Riesling wines made from the same fruit but from free run juice, various press fractions, and following moderate and heavy fining have been evaluated. Pressings wines contained up to 42% more polysaccharides than did free run wine, with a direct relationship between skin contact and polysaccharide content. The rise was mainly due to lower molecular weight polysaccharides which generally derive from skins. Fining the wine with either gelatine or

PVPP at moderate to very high levels did not alter either the type or amount of polysaccharides in the wine. The effect of skin contact, pressings, maceration and hyperoxidation on polysaccharide composition is being explored further using Chardonnay, Riesling and Viognier wines made for the white wine phenolic project. The use of a wider set of varieties over two vintages will allow the previous conclusions to be generalised.

Correlative work by others assessing commercial white wines have recently implicated certain polysaccharide types as contributing to increased 'thickness' of white wine. We have isolated these and other polysaccharide types from 50 litres of white wine using preparative scale size exclusion chromatography in order to find the classes of polysaccharide responsible for the previously observed reduction of alcohol hotness and increased viscosity. The knowledge regarding winemaking effects on the polysaccharide profile of white wine could then be used to provide direction to winemakers as to which winemaking processes can enhance palate weight and reduce alcoholic hotness.

'Phenolic' taste in white wines

The ultimate aim of this project is to gain a greater understanding of how post-harvesting procedures and wine processing affect 'phenolic taste' in white wines and hence wine quality. We consider the best approach for this project is to focus on identifying the compounds responsible for 'phenolic' taste. Once we have the target compounds, we will be able to then more easily and efficiently generate data on specific processing methods that change the levels of these specific compounds of interest.

The first step in this strategy has been to generate an appropriate sample set of white wines that differ primarily in 'phenolic' taste and not other attributes. Experimental winemaking was undertaken in 2010 in order to generate these wines. Small scale wines were made in triplicate ferments from Barossa Chardonnay, Eden Valley Riesling and Adelaide Hills Viognier. Each of the varieties were made using whole bunch pressing, standard crush and press, light and heavy pressings, and following cold maceration on skins. The juices obtained following the standard crush and press, and those after hard pressing were also subjected to hyperoxidation prior to fermentation. The treatments were chosen to represent extremes in potential phenolic pick-up and represented a variety of both widely used and experimental Australian white wine making practices.

The attributes normally associated with 'phenolic taste' in white wines were profiled by a trained panel. For the Riesling and Viognier wines, perceived viscosity increased. However, astringency decreased in wines despite the expected increase in phenolic content. At the same time we noticed that the greater contribution of skin extraction also naturally resulted in higher pH, which was confounded with the phenolic content in the wines. Therefore, the observed effects of winemaking practice on astringency and viscosity could not be specifically attributed to phenolic levels. The Chardonnay wines were similar in pH and these showed increased levels of bitterness with increased skin influence, but astringency and perceived viscosity were unaffected. The same winemaking experimental plan has been executed in 2011 but with the addition of a high-solids ferment, and one that provides for a commercially realistic (10%) level of fermentation on skins. The acidities of the wines have been adjusted to minimise any possible textural effects due to pH.

The second was to fractionate these wines and use sensory analysis of the fractions to guide identification of the compounds responsible for 'phenolic' taste. As a prerequisite to achieving this target, we required improved separation techniques to isolate the phenolic fractions and identify individual compounds. The two most abundant phenolics in white wine, caftaric acid (tartaric ester of caffeic acid) and its oxidative derivative with glutathione, GRP (grape reaction product), were extracted and fractionated in sufficient quantities to conduct a large scale sensory trial. This was the first time that these two compounds have been separated in sufficient quantities to enable their taste profiles to be determined.


Leigh Francis

The fractionation required isolation of whole phenolic extracts from a total of 80 litres of Riesling, Viognier and Chardonnay wines. Then, GRP was fractionated from the whole extract using a sophisticated liquid/liquid extraction system, counter-current chromatography. Caftaric acid was subsequently isolated from the remaining phenolic pool using a second counter-current chromatography run. The Riesling and Viognier wines yielded high levels of caftaric acid and GRP respectively. Size-exclusion chromatography showed that the GRP fraction contained some small molecular weight non-phenolic impurities. However, these would not be expected to influence the textural profiles of the fractions under investigation. A panel of 11 experienced tasters was trained to describe the phenolic tastes of caftaric acid and GRP and their mixtures. The reported extinction coefficients were used to determine the amount of fractionated material required to represent wine realistic concentrations of these compounds (Low=30ppm and High=60 ppm). All possible combinations were presented in triplicate in model wine. After identifying those tasters who were both consistent and in general agreement with others, the presence of caftaric acid and GRP was observed to enhance bitterness and palate oiliness of the low alcohol (10% v/v) model wine. However, the presence of these two compounds tended to reduce the astringency of the model wine (presumably masking dryness caused by acid and alcohol). This result was surprising as previous work showed that supplementing a Chardonnay and Riesling wine with the whole phenolic pool taken from three different wines increased their astringency. This suggests that phenolic compounds other than caftaric acid and GRP are responsible for perceived astringency in white wine. The interactions between GRP and caftaric in eliciting phenolic tastes were found to be complex and are currently the subject of further analysis.

AWRI's Tasmanian node

Staff and Students

Dr Bob Dambergs, Anna Carew (PhD student, University of Tasmania), Angela Sparrow (PhD student, University of Tasmania)

Collaborators

Tasmanian Institute of Agricultural Research (Dr Dugald Close, Dr Kathy Evans, Dr Joanna Jone, Fiona Kerslake); The Australian Centre for Research on Separation Science, University of Tasmania (Dr Robert Shellie); Central Sciences Laboratory, University of Tasmania (Dr Thomas Roderman); Wine Industry Tasmania (Sheralee Davies); Tamar Ridge Estate (Dr Andrew Pirie and Dr Richard Smart); Croplands Ltd (Sean Mulvaney); Flextank International (Peter Steer); Frogmore Creek (Nick Glaetzer); Pooley Wines (Matt Pooley); Moorilla (Conor van der Rees); Jansz (Natalie Fryar); Winemaking Tasmania (Julian Alcorso); Meadowbank Estate (Gerald Ellis); Clover Hill (Karina Dambergs); Tolpuddle Vineyard (Geraldine Colombo); Josef Chromy (Jeremy Dineen).

The Tasmanian node of the AWRI is housed within the Tasmanian Institute of Agricultural Research (TIAR), in the School of Agriculture at the University of Tasmania and is in the third year of operation. The Tasmanian node performs a research function as part of an AusIndustry-funded industry collaborative innovation program, but also acts as a conduit for general AWRI research and extension activities. The regional collaborative research program has a practical focus on viticulture and winemaking aspects of sparkling wine and Pinot Noir production; the foremost wine styles produced in the cool climate of Tasmania. The projects aim to generate practical outcomes and work is performed in close collaboration with industry partners. There is a strong focus on manipulation of phenolic profiles in the vineyard and winery, for both sparkling wine and Pinot Noir red wine production. A wine laboratory has been established at TIAR in Sandy Bay and more recently at the TIAR Mt Pleasant laboratories near Launceston.

Manipulation of phenolic profiles for sparkling wine production

The phenolic profiles of sparkling base wines are important aspects of their sensory quality. Premium sparkling producers aim for minimal phenolic extraction, yet maintain low levels required to obtain desirable mouthfeel and allow optimal bead and foam stability. Viticultural management is a critical determinant of cool climate grape quality.

We examined the influence of pruning method (cane versus spur), crop load regulated by pruning and leaf removal from the fruiting zone, on the phenolic profiles of grapes and wine. Trials were performed on Chardonnay and Pinot Noir at two sites. Base wines were prepared using a custom designed flat-bed press with fine control of extraction rates, critical for sparkling wine production. The most dramatic effects were observed with Chardonnay, particularly with the leaf removal treatment. Leaf removal at veraison had the strongest effect, compared with pre-flowering and at pea-size. Although there was no difference in grape analysis in terms of crop level, berry size, TSS, pH, total acidity and total phenolics (as measured by absorbance at 280 nm), wines made from this fruit showed differences in UV spectral fingerprints, related to treatments. The relevant UV spectral region is dominated by phenolic compounds in wine, so this implies treatment effects on phenolic profiles. When the spectral loadings for this treatment separation were examined, the traditional simple measure of total phenolics (absorbance at 280 nm) was not important, suggesting that we should reconsider how we measure phenolics in lightly extracted juice and wines. Base wines from these trials were tiraged to examine longer term treatment effects on sparkling wine quality.

A second aspect to the work on sparkling wines is maturation and we could demonstrate that the UV spectral region is also important for monitoring sparkling wine maturation. During maturation of tiraged wines on yeast lees, peptides and nucleic acid fractions are released; as with phenolics these compounds have a strong UV fingerprint and this may form the basis of methods for monitoring wine maturation based on spectral fingerprinting.

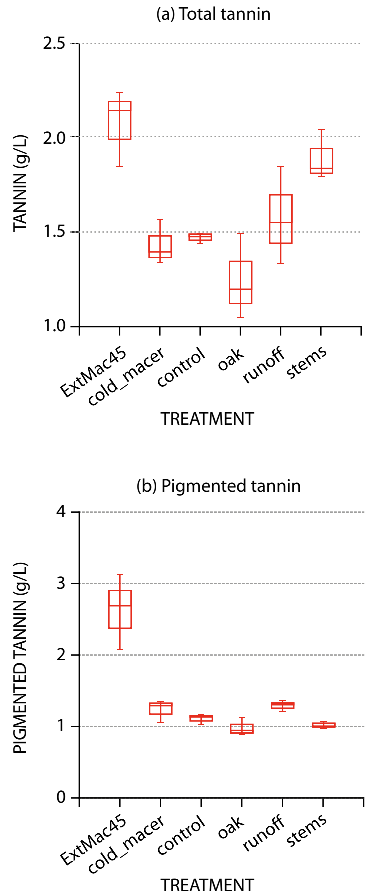
Manipulation of red wine phenolic profiles

Pinot Noir is a difficult variety to work with when making red wines, due its unusual anthocyanin and tannin profiles. Pinot grapes have low anthocyanins concentrations and the anthocyanins are non-acylated, so may be less stable. While Pinot Noir grapes are high in tannin, with similar levels to Cabernet Sauvignon, yet the wines tend to be low in tannin, probably due to the fact that Pinot has a low skin to seed tannin ratio. In an effort to overcome these problems, Pinot winemaking methods tend to focus on maximising tannin and pigment extraction and stabilisation.

Using small-lot winemaking on a laboratory scale, we have examined the influence of winemaking methods such as pre- and post-ferment maceration, enzyme treatment, addition of stems, oak, and saignee on tannin and pigment profiles in wines. The highest tannin concentrations were achieved using stem additions and post-ferment maceration. Extended skin contact initially yielded red wine with reduced colour density and low free anthocyanins, but it resulted in the highest levels of stabilised colour in the form of pigmented tannin (Figure 4).

In addition to working with Tasmanian producers, links have been made with other cool climate Pinot producers in Victoria, again with the focus being on understanding tannin and pigment development during the winemaking process and their role in determining wine quality.

Understanding the outcomes of the various maceration methods will allow Pinot producers to have better control in driving wine styles and is also applicable to other red varieties.



ExtMac45 = 45 day post-ferment extended maceration; *cold_macer* = 4 day pre-ferment maceration at 4 °C; *control* = standard submerged cap ferment with destemmed, crushed fruit; *oak* = oak dust addition during standard ferment; *runoff* = pre-ferment removal of juice; *stems* = addition of bunch stems. The same batch of fruit was used in all ferments, yet total tannin levels varied up to two-fold, depending on maceration method. Extended maceration and addition of stems resulted in the highest total tannin levels, but only extended maceration stood out as yielding the highest pigmented tannin levels.

Figure 4. Effect of maceration method on Pinot Noir red wine total tannin (a) and pigmented tannin (b).

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

Staff

Dr Yoji Hayasaka, Gayle Baldock, Mango Parker

The members of the Mass Spectrometry team work collaboratively across the AWRI and also with external researchers. Their collaborative activities are included elsewhere within this report, however, the highlights from the year 2010/2011 are shown here.

Investigations of taint problem using mass spectrometry

Collaborators

Winemaking and Extension team of AWRI's Industry Development and Support Group

An investigation into a musty tainted warehouse containing sparkling wine undergoing tirage prompted the further development of the AWRI's air sampling and analysis capability. Tetrachloroanisoles and pentachloroanisoles were found in wine and crown seal liners as well as wood from pallets, insulation and cement flooring. Air analysis was carried out by various air sampling techniques including active sampling and passive air sampling using stationary adsorbent surfaces (SPME-exposed solid phase micro extraction fibres; TWISTER- sorbent stir bars as well as polyethylene sheets). Comparison of air quality between a nearby unaffected room in the warehouse (control room) and two tainted cold rooms in the warehouse was carried out using all four sampling methods followed by GCMS analysis (Figure 5). All analyses confirmed the presence of chloroanisoles in the air in the two cold rooms that were tainted, confirming that the compounds where migrating from contaminated materials within the warehouse, through the air and into the product. All results (from both active and passive sampling techniques) confirmed that Cold Room 1 air had a higher concentration of both chloroanisoles than Cold Room 2 and that in all cases; the concentration of pentachloroanisole was higher than that of tetrachloroanisole. The analysis of other tetrachlorophenols and pentachlorophenols was more challenging, but it could be demonstrated that both tetrachlorophenol and pentachlorophenol were present in Cold Room 1 and 2.

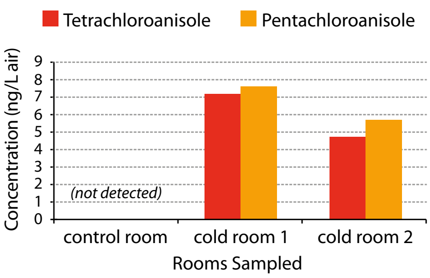


Figure 5. Results of Active Air Sampling metred.

Mass spectrometric techniques were also applied to various separate taint investigations during the year. These included the analysis of a paraffin wax, a sample of PVPP and a red wine with suspected hydrocarbon taints. Wines with earthy aromas, millipede taint and rubber hose-derived taint were also analysed. A series of wines potentially affected by a propylene glycol based brine contamination were also investigated.

Investigations into smoke-affected grapes and wine

Collaborators

The AWRI Industry Development and Support, Flavour and Sensory teams and Commercial Services, Dr Kerry Wilkinson's group of the University of Adelaide, and Industry partners.

Wine made from grapes exposed to bushfire smoke in vineyards is often characterised by objectionable 'smoky', 'burnt', 'ash', 'ashtray' and 'smoked salmon' aromas, with 'an excessively drying' back-palate and a retronasal 'ash' character (2003 AWRI annual report). Such sensory characteristics can result in significant reductions in the wine market value or even make the wine not fit for sale. In fact, the financial loss due to the 2006-07 bushfires on north east Victoria's Wine Industry alone was estimated to be $75-90 million as value of wine.

In response to the increasing incidence of bushfires in proximity to wine grape growing regions as experienced in 2003, 2007 and 2009, the AWRI has been investigating the effect of smoke on grapes and wine. The research challenges are to develop winemaking practices to minimise or reduce the undesirable smoke-affect characters of wine made from smoke-affected grapes, and to measure smoke exposure in grapes prior to winemaking (smoke diagnostic assay).

The research focus of the Mass Spectrometry team is to develop a smoke diagnostic assay to estimate the potential of smoke-exposed grapes to produce smoke-affected wine, in order to assist the wine industry's critical decision making processes with regard to harvesting, purchasing and winemaking.

Development of diagnostic assay for smoke exposure

Initially, guaiacol and 4-methylguaiacol have been used in Australia and overseas as markers to assess the degree of smoke-affected grapes and wine because their concentrations in wine were reported to be strongly correlated with the overall sensory panel rating of the intensity of the smoke effect (2003 AWRI annual report). However, when some significant concentrations of these marker compounds are found, we still cannot fully rule out the potential of these grapes to produce smoke-affected wine. Additional challenges are that guaiacol can be found in some non-smoked grapes as a natural component (up to 5 µg/kg levels in some varieties), and is extracted into wine from toasted oak (up to 100 µg/L in oaked wine) making interpretation of wine data complicated. These observations suggested that better markers were needed for a smoke diagnostic assay to assess the extent of smoke exposure on grapes and wine.

Recent studies at the AWRI revealed that phenolic glycosides in grapes have great potential as smoke markers to indicate the degree of exposure to smoke (Hayasaka et al. 2010a and 2010b, 2010 AWRI annual report). This is because volatile phenols including guaiacol, methylguaiacol, syringol, methylsyringol, *o*-, *p*- and *m*-cresol, and phenol are major smoke components and are metabolised into a broad range of glycosidic forms following grapevine exposure to smoke. These phenolic glycosides were found to be present in smoke-affected grapes and wines at significantly greater concentrations compared to those in the non-smoked control grapes and wines which contained only trace levels. Also, in grapes and wine from the 2009 bushfires, significantly higher concentration of phenolic glycosides were detected, while the concentration of volatile phenols were only present in trace amounts.

To investigate the potential of phenol glycosides being used as smoke markers, a robust and reliable method for the quantification of the glycosides in grape and wine samples was developed using APCI (atmospheric pressure chemical ionization) based HPLC-MS/MS analysis and a labeled compound (*d3*-syringol gentiobioside) as internal standard. The diglycosides including glucosylglucoside (GG), glucosylpentosides (PGs) and rutinoside (RG) of guaiacol (Gu), methylguaiacol (MGu), syringol (Sy), methylsyringol (MSy), cresol (Cr: as sum of isomers) and phenol (Ph) were targeted for quantification. (Hayasaka et al. 2010b). Concentrations of individual glycosides were determined using a calibration function of syringol gentiobioside (SyGG).

Chardonnay, Pinot Noir, Cabernet Sauvignon and Shiraz grapes (three different samples for each variety), which were suspected of smoke exposure during the 2009 bushfires, were subjected to quantitative analysis using the new HPLC-MS method. Relative abundance (%) of the individual glycosides was calculated based on the quantitative values (Figure 6). The concentration of the glycosides varied considerably between the samples of all varieties ranging from 330 to 4310 µg/kg as sum of all glycosides, most likely due to the individual grapevines being affected by different intensities and/or durations of smoke exposure. In spite of these variations, the relative abundance of most glycosides was relatively consistent within the same variety as well as between the varieties. Syringol gentiobioside was the most abundant glycoside, followed by methylsyringol gentiobioside (in all the smoke-affected samples) but most other disaccharides were either not detected or detected only in trace amounts. Multiple isomers of PG conjugates were found to be the most common glycosides. RG conjugates were also commonly found with the exception of SyRG and MSyRG. These results demonstrated that the volatile phenols taken up by grapes were metabolised in a similar fashion regardless of grape variety with some exceptions.

To investigate the applicability of the HPLC method for quantifying phenolic glycodise to corroborate smoke exposure of grapes to the smoke diagnostic assay, grapes suspected of smoke exposure from 2009 bushfires and control grapes with no history of smoke exposure were analysed (Figure 7). Trace amounts of phenolic glycosides are known to be present as natural components in grapes. For that reason, small peaks derived by these glycosides were observed in the control grapes and their intensities were quite consistent (Hayasaka et al. 2010a and 2010b). The smoked grape samples exhibited the glycosides with great concentration ranges of 76-1623 and 28-610 µg/kg for SyGG and MSyGG in Shiraz, and 7-19, 13-43, 23-86 and 25-106 µg/kg for PhRG, GuRG, CrRG and MGuRG in Chardonnay, respectively. These concentrations were considerably greater than those of the control samples as seen in Figure 7. On the other hand, low concentrations of free guaiacol (2-3 µg/kg, detection limit: 1 µg/kg) and 4-methylguaiacol (<2 µg/kg) were found in half of the smoked grape samples analysed. In some cases, non-smoked grapes contained free phenols up to 5 µg/kg levels in some varieties. Therefore, this investigation revealed the difficulty in making the decision on whether grapes were smoked or not, based on free guaiacol and 4-methylguaiacol analysis alone. The clear distinction between non-smoked and smoked samples demonstrated by the measurement of the glycosides has led to the use of the new HPLC-MS/MS method as a core tool for reliable diagnostic strategies to assess the impact of smoke exposure in grapes and wine.

The AWRI team has also developed a method for the quantification of numerous volatile phenols in grapes and wine using GC-MS, which can be useful to see a profile of smoke-related aromas and is available through Commercial Services. Measurement of phenolic glycosides offers a much more robust way of detecting smoke exposure in grapes and wine, and provides an essential risk management tool for making decisions regarding whether suspected smoke-affected grapes are suitable for winemaking.

In summary, we have developed and validated recently two new diagnostic assays to assess the level of smoke exposure in grapes and wine. These diagnostic assays are based on measurement of (1) volatile phenols, in addition to guaiacol and methylguaiacol, that are present in significant abundance in bushfire smoke (GC-MS analysis), and 2) numerous bound forms (glycosides) of the volatile phenols that are formed in grapes following smoke exposure (HPLC-MS/MS analysis). These diagnostic markers have been found in elevated levels in smoke affected grapes and wine, but some are naturally present in trace amounts. Concentrations of these smoke marker compounds can greatly vary due to differences in the intensity of smoke exposure and smoke composition.

In order to make robust decisions about potential smoke exposure, we must understand the natural abundance of these compounds. As part of an on-going study we are surveying, in collaboration with Industry partners, the natural abundance of free and bound volatile phenols in non smoke-affected grapes from major varieties grown in various grape-growing regions. The results of this baseline study will allow us to identify at-risk batches of grapes, i.e. grapes that have significantly higher concentrations of free and glycosidic phenols. Analysis and data interpretation are in progress.

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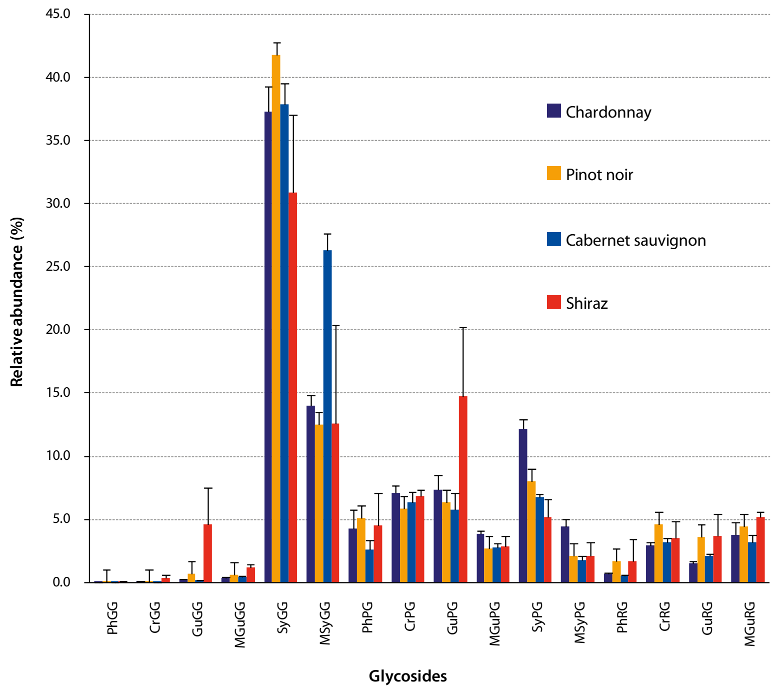

Figure 6. Relative abundance of volatile phenol glycosides found in grapes suspected of smoke exposure.

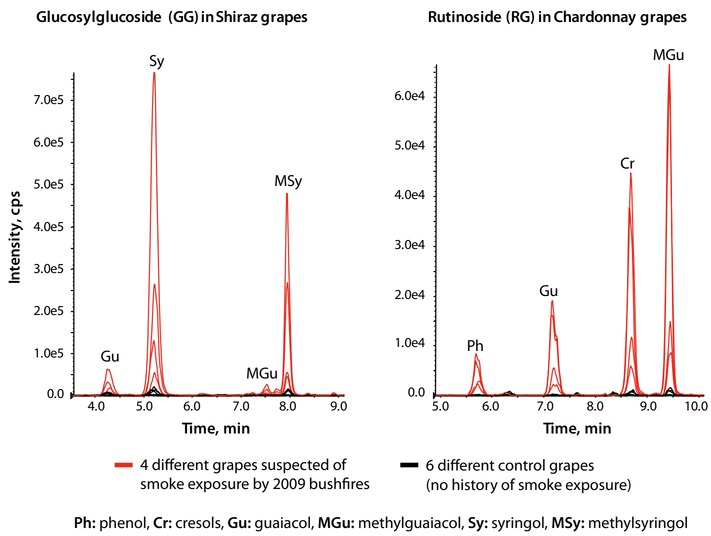

Figure 7. HPLC-MS/MS chromatograms of smoked and control grapes.

Improving microbial performance, wine diversity and wine quality

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Visiting scientists and students

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454 Life Sciences, A Roche Company (Dr Michael Egholm); AB Mauri, Australia (Dr Anthony Heinrich); Australian Genome Research Facility (Professor Sue Forrest, Dr John Stephen); Australian Proteome Analysis Facility (Professor Mark Baker, Dr Peter Hoffman, Dr Alamgir Khan); Bioplatforms Australia (Andrew Gilbert); Brock University, Canada (Professor Debra Inglis); Flinders University (Dr Peter Anderson); IASMA, Italy (Dr Giuseppe Versini); Laffort Australia (Dr Paul Boyer, Dr Tertius van der Westhuizen); Lallemand (Dr Ann Julien-Ortiz, Dr Sibylle Krieger-Weber, Dr Andrew Markides); Melbourne University (Professor Tony Bacic, Dr Ute Roessner); Murdoch University (Professor Matthew Bellgard); Stanford University, USA (Dr Barbara Dunn, Associate Professor Gavin Sherlock, Professor Michael Snyder); Universitat Rovira i Virgili, Spain (Professor Albert Mas); The University of Adelaide (Professor David Adelson, Dr Paul Grbin, Associate Professor Vladimir Jiranek); University of Central Queensland (Professor Grant Stanley); University of New South Wales (Prof Marc Wilkins, Simone Li); University of Pamplona, Spain (Professor Carmen Ancin-Azpilicueta); University of Queensland (Professor Lars Keld-Nielsen, Dr Jens Kroemer); University of South Australia (Dr Miguel de Barros Lopes); University of Toronto, Canada (Professor Charles Boone); University of Western Sydney (Dr Vince Higgins); The Yalumba Wine Company (Louisa Rose, Simon Dillon)

Cristian Varela

Bioscience research at the AWRI aims to improve microbial performance in wine fermentations and enhance wine quality. The fields of biology that are brought to this include: physiology, genetics, molecular biology, biochemistry and systems biology; all of which are harnessed to: identifying and generating novel yeasts with improved winemaking and sensory-imparting properties; optimising fermentation outcomes by developing improved yeast nutrient supplementation regimes; improving robustness of wine yeasts and MLF bacteria; utilising MLF to enhance wine quality; and developing 'low-alcohol' yeasts. The following is an overview of the activities of the Biosciences team.

Strategies for reducing alcohol levels in wine

For reasons associated with health, taxation and product quality, the wine sector is actively seeking ways to facilitate the production of wines with lower alcohol content. Last year we developed an 'AWRI Fact Sheet', which gave recommendations and described opportunities for winemakers and grape growers to adjust alcohol concentration; this information can be accessed on the AWRI website by Australian grape growers and winemakers.

Current research efforts at AWRI have taken a multidisciplinary approach to assess the impact of harvesting time and grape maturity on sugar (and therefore alcohol) content, wine quality parameters and consumer preference.

Another strategy to lower alcohol concentration in wine is to develop wine yeasts that produce less alcohol than those currently available to winemakers. We are applying both, non-genetically modified (non-GM) and genetically modified (GM) approaches to generate novel wine yeasts that metabolise sugar in such a way that substantially less ethanol is produced while maintaining high wine quality.

GM approaches are being used for research purposes to improve our understanding of what might be possible. Indeed, yeast cellular metabolism is so complex and highly integrated that when one aspect of metabolism is changed it can impact on other aspects of yeast biochemistry. In winemaking such coincidental changes can lead to increased production of compounds associated with undesirable sensory attributes, such as acetic acid or acetaldehyde. Obviously additional steps or modifications can be considered in order to return acetic acid or acetaldehyde levels to concentrations considered 'normal' in wine, but these steps are, in turn, likely to generate additional coincidental changes. Therefore approaches that consider all processes within the yeast cell and that are able to integrate 'global' cellular information are crucial for the development of novel yeast strains with targeted changes that do not impact negatively on wine quality. The approaches used to this end come under the banner of Systems Biology.

Systems Biology for the development of low-alcohol yeasts

One of the key challenges for yeast strain development is to obtain a detailed picture of yeast physiology and to apply this knowledge to develop novel strains with improved traits. Traditional approaches typically involve detailed studies of individual biological components, and this has benefited yeast development programs enormously. However the more we learn about the parts that make up cells, the more we appreciate the complexity of yeast cell physiology and biochemistry, and the clearer it becomes that we need new approaches to explore and reveal the complex interactions operating within the yeast cell.

Fortunately, new technologies and requisite computational tools and expertise have emerged that enable analysis of the inner workings of cells in a more complete, holistic way. This is Systems Biology and it involves simultaneous monitoring of numerous biological processes using 'omics technologies (i.e. technologies that attempt the analysis of complete sets of cellular components, such as proteins or metabolites, in a single experiment) and high powered computing for the formulation of mathematical models that describe cellular processes. With robust mathematical models of yeast cellular functions, we will be able to design and trial the performance of prototype novel yeast strains *in silico* (i.e. using computer models) rather than going through time-consuming, costly fermentations.

Supported through funding from Bioplatforms Australia (BPA), we are leading a *Wine Yeast Systems Biology Consortium* that focuses on wine yeast fermentation. The aim of this project is to harness the expertise, infrastructure and technologies available across BPA to develop systems-based mathematical models of yeast metabolism, which will be used to inform the design of new strains with improved, wine relevant, traits such as a low ethanol production.

To-date we have studied a wine yeast fermentation using different omics technologies; transcriptomics (which attempts to quantify all of the mRNA transcripts present in a cell at a given state), proteomics (attempts to quantify all of the proteins present in a cell at a given state), and metabolomics (attempts to quantify all of the metabolites present in a cell at a given state). To illustrate the complexity of yeast metabolism during a wine fermentation, metabolite concentrations were used to build a metabolic map covering central carbon metabolism, nitrogen and aminoacid metabolism, fatty acid biosynthesis and the formation of flavour-active compounds (Figure 8). Integration of datasets from the different platforms is underway and will be key for the development of mathematical models which enable us to make informed predictions for the development of improved, 'low-ethanol', wine yeast strains.

Interactive effects of juice oxygen and lipids on formation of fermentation products

In contemporary winemaking, the admission of oxygen is carefully controlled according to the type and style of wine being made. Oxygen exposure of juice/must and wine can lead to loss of protective antioxidants, such as glutathione, sulfur dioxide and ascorbic acid, and the concomitant inactivation of susceptible flavour compounds. Furthermore, oxygen exposure can lead to the formation of some aromatic compounds, which are undesirable except in certain wine types.

Oxygen is, however, a powerful fermentation stimulant, especially when used in conjunction with high Brix clarified musts containing suboptimal nutrients, which typically slowly or fail to attenuate to specification. Although yeast are well adapted to carry out fermentation in the complete absence of oxygen, it is well established that certain biochemical pathways are unable to function due to their dependency on molecular oxygen. For example, yeast cannot fully oxidise hexose sugars and consequently a large concentration of ethanol quickly accumulates, which leads to growth inhibition and the slowing, and sometimes, premature cessation of fermentation. Lack of oxygen also inhibits the biosynthesis of unsaturated lipids, which confer greater membrane stability to better protect the cell from the deleterious effects of ethanol accumulation.

It is also well known that yeast are more robust in high solids ferments, in part due to the presence of associated grape berry lipids. These phyto-lipids can partially substitute for yeast lipids and act by stabilising the structure and function of cell membranes as conferred by yeast *de novo* synthesised lipids. Due to the common observation that highly clarified musts are more susceptible to incomplete fermentation, the solids level is generally adjusted prior to fermentation to achieve an appropriate balance between the risk of suboptimal fermentation and unwanted flavour effects, such as coarseness, which can arise from associated phenols.

Despite these important technological benefits, which have become common winemaking practices over recent decades, the role of oxygen and lipids on the formation of yeast aroma compounds is not well documented. A series of experiments are being undertaken in collaboration with the Wine and Oxygen Team to define the impacts of these key yeast nutrients on not only wine aroma immediately post fermentation but also the longer term affects of these practices on wine flavour stability and ageing characteristics. This report will focus on an initial model experiment conducted in a synthetic medium to reveal the interactive effects that oxygen and lipid addition have on the formation of the fermentation products, esters, alcohols and volatile fatty acids.

The results of a factorial design fermentation experiment are shown in Figure 9. This design allowed us to study four different fermentation conditions: no lipids/no air (NLNA), lipids/no air (LNA), no lipids/air (NLA), and lipids/air (LA). The results are summarised to highlight the effect of fermentation conditions on the three major groups of volatile fermentation aromas.

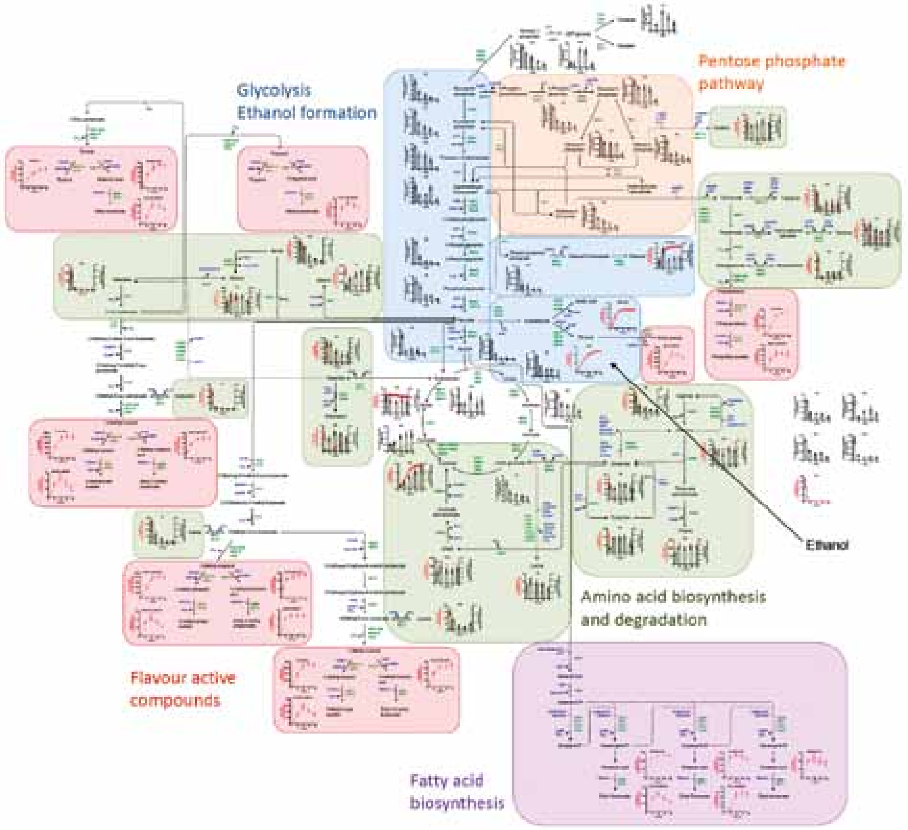
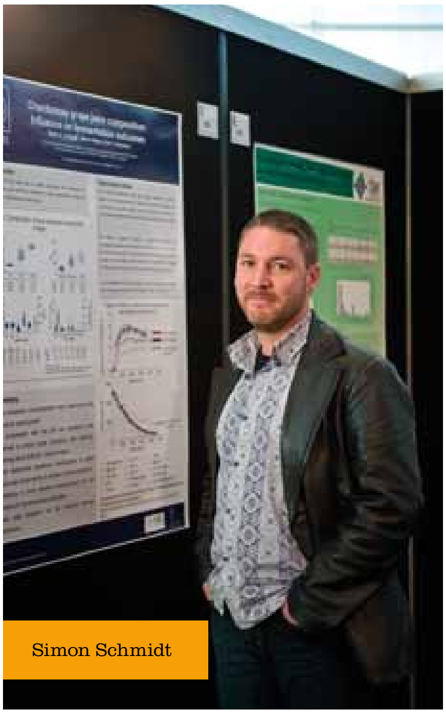


Figure 8. Snapshot of part of a wine yeast metabolome. A metabolome is the cell's full complement of metabolites – the small molecules of a cell, including organic acids, fatty acids, amino acids, small sugars, alcohols, thiols, and more – many of which shape the flavour, aroma, mouth-feel and colour of wine. Ethanol production is a small, but critical, part of the yeast metabolic map.



Simon Schmidt

The esters, which are composed of acetates and ethyl and branched chain esters, and are major contributors to wine aroma, particularly in young wines, were strongly influenced by lipids and oxygen. The medium chain fatty acids, which also contribute to wine aroma, were likewise modulated by lipids and oxygen. When compared to the control treatment

Chris Curtin presenting at a workshop at the 14th Australian Wine Industry Technical Conference (Dr Paul Henschke seated at the speakers' table)

(NLNA), the addition of lipids (LNA) stimulated to the greatest extent total ester and volatile fatty acid production. The combined addition of lipids and oxygen (LA) partially suppressed total esters and volatile fatty acids. The ethyl esters, especially ethyl-butanoate, -hexanoate, -octanoate, -decanoate and -dodecanoate were important contributors to increased ester production. Similarly, the concentration of total acids was the result of an increase in the concentration of medium-chain fatty acids (MCFAs), especially hexanoic, octanoic and decanoic acids. The addition of air alone (NLA), when compared to the control (NLNA), did not affect ester or fatty acid concentrations.

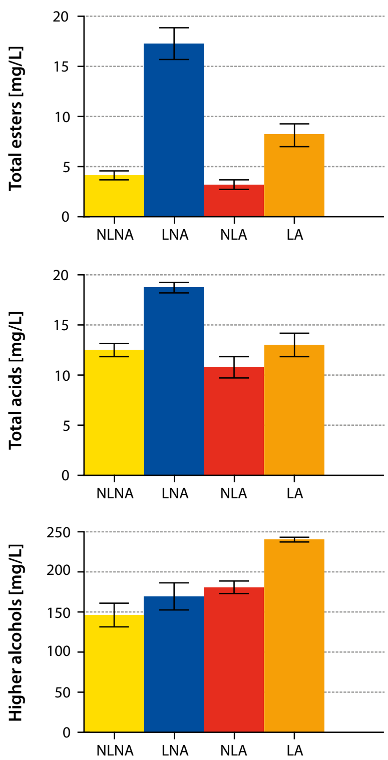


Figure 9. Concentration of yeast volatile fermentation products that contribute to wine aroma: esters, volatile acids and higher alcohols. The effect of oxygen and lipid addition to model medium was investigated under four conditions: no lipids/no air (NLNA), lipids/no air (LNA), no lipids/air (NLA), and lipids/air (LA).

Higher alcohols add aromatic complexity when present at moderate concentrations, typically below 300 mg/L. Compared to the control (NLNA), the combined addition of lipids and air (LA) had the strongest impact on the production of higher alcohols but moderated impact on the esters and volatile fatty acids. The addition of air (NLA) or lipids (LNA) alone only slightly increased higher alcohol production. Overall, lipids, which in winemaking are derived from grape solids, strongly increase the production of aromatic yeast products whereas oxygen ameliorates the lipid effect.

As a next step these results, which were obtained in model media, will be verified in authentic grape juice. They do however suggest another tool for modulating wine aromatic profile while increasing the fermentative robustness of wine yeast. The addition of grape solids would appear to increase aroma intensity whereas the addition of oxygen is relatively neutral, giving winemakers flexibility in the use of oxygen for stimulating sluggish fermentation with little impact on the aromatic profile which results from esters, volatile fatty acid and higher alcohols. Work is also in progress to investigate effects of oxygen, solids and liquids on volatile sulfur compounds, which are associated with the wine 'reductive' character.

Relationship of juice composition to suboptimal fermentation performance and wine quality

The 2009 vintage saw the establishment of a Chardonnay juice bank (i.e. a collection of over one hundred Chardonnay juices that were sampled by winemakers immediately prior to inoculation and then frozen) at the AWRI. The aim of this was to perform chemical analysis of the juices to improve our knowledge of Australian Chardonnay juice composition and to provide a foundation for the exploration of the impacts of juice composition on fermentation performance. Given that the relationship between grape juice sugar and nitrogen concentration on fermentation performance is already well understood we chose, for this work, to focus on juice elemental composition. The influence of variation in juice elemental composition on fermentation outcomes was explored for a variety of yeast strains. This was done using a defined medium, the recipe for which was based on Chardonnay composition. Observations made in defined medium experiments were then substantiated using Chardonnay juices from the juice bank.

Our exploration of Chardonnay juice identified juice pH and potassium concentration as critically impacting on fermentation performance and wine quality (AWRI publication #1290). In addition, it was found that sensitivity to pH and the minimum requirement for potassium was yeast strain-dependent. The least robust strains (i.e. those which performed sub-optimally at low pH and low potassium concentrations) also produced wines with high volatile acidity when potassium concentration and pH were compromised; increasing pH and supplementing with potassium alleviated this problem.

Variations in the concentration of other major elements such as magnesium, calcium or zinc, previously reported to have an impact on fermentation performance, were found to have no effect within the concentrations normally found in Chardonnay juice. How widely dispersed the susceptibility to low pH is within the population of commercially available wine yeast is the subject of ongoing work.

Grape juice and wine yeasts are complex, and their interaction to produce wine reflects this. For example predicting, with accuracy, the quality of a wine from its starting ingredients can be a rather hit and miss affair, and the problem of suboptimal fermentations still takes winemakers by surprise from time to time. Results from the above work on grape juice composition (particularly when aligned with comparative yeast genomics described elsewhere in this report), will enable more informed strategies for winemakers so that they can make the best choice when matching grape juice and wine yeast. We are already in a position to say that, at least for Chardonnay juice, if the pH is low, you can minimize the risk of a stuck or sluggish fermentation by choosing the appropriate, robust, strain.

Development of low-VA producing yeast strains

Volatile acidity concentration in finished wine is affected by a range of factors including nutritional status (for wine yeast) of the grape must, the activity of acetic acid bacteria, and, as observed in experiments on the Juice Bank (described above) choice of yeast strain. Our understanding of why some yeast strains produce more or less VA is limited. Nonetheless, using classical (non-GM) techniques we have developed variants of the widely used yeast strain, Maurivin PDM, that produce between 50 and 90% less VA. One of these strains, AWRI 2051, has been successfully trialled in Chardonnay during the difficult 2011 vintage.

We discovered that several of the strains developed by us contain a mutation in the gene *YAP1*, which is a regulator of other genes. Interestingly these other genes are largely involved in protecting the cell against oxidative damage; the link between *YAP1* and volatile acidity is not clear at this time. Targeted introduction of the *YAP1* low volatile acidity conferring mutations into another yeast strain partly conferred the ability to produce less VA, thereby confirming this unexpected link.

Work is on-going to assess low volatile acidity yeast variants generated in this project in low pH, low potassium juice (see report on 'Relationship of juice composition to suboptimal fermentation performance and wine quality') to test their potential for fermentation of juices that are at risk of generating sub-optimal fermentations.

Searching for novel genes involved in sulfur aroma compound formation

Formation of sulfur compounds that impact positively on wine flavour (e.g. tropical polyfunctional thiols such as 3-mercapto-hexan-1-ol) and those associated with reductive aromas (e.g. H_2S, methane-thiol), is strongly influenced by yeast, and appear to be interconnected through yeast metabolism. We have observed that complex yeast rehydration nutrients that contain high concentrations of glutathione influence formation of H_2S and 3MH. Using systems approaches we also discovered that the effect on H_2S formation cannot be attributed to the principal pathway for production of this compound – the sulfate assimilation sequence. Genes involved in this pathway were in fact down-regulated by the glutathione-containing rehydration medium. These results focused our attention on the effects of glutathione on yeast metabolism, and led us to develop a novel high-throughput screening method from which we can detect H_2S formation from various sources. Using this novel method we have screened a standard laboratory yeast gene deletion library (a systematic collection of yeast strains, each with a different gene deleted) and also the wine yeast gene deletion library developed at the AWRI (see report below 'Wine yeast comparative and functional genomics'). This led to the discovery of several novel genes that appear to be involved with sulfur aroma compound formation through yeast metabolism.

Wine yeast comparative and functional genomics

Understanding the genetics of wine yeast is vital for the continued strategic development of new strains with improved wine making performance. We are pursuing a two-pronged approach to first identify, and then understand the variation that exists between yeast strains.

In order to characterise the natural variation which exists within yeast we have recently applied cutting-edge next-generation genome sequencing and comparative genomics to explore the genetic differences that exist between several industrial yeast strains. These strains included commercial wine yeasts (Lalvin-QA23, Vin13, VL3 and AWRI796), beer (ale) yeasts, and strains used for the production of biofuel. This work identified the genetic variation

Toni Garcia Cordente

that is present across strains used in different industries, but also highlighted that fact that many wine strains contain significant genetic variation which may be responsible for important phenotypic characteristics. Given the important knowledge gained from this work, we are continuing to explore genome sequencing and comparative genomics of wine yeast and bacteria as a means to discover new genetic elements which may contribute to improved winemaking characteristics and to provide the raw material for functional genomics studies.

The second facet of our approach is aimed at understanding the relevance of genetic variation in a wine context, through the use of functional genomics. Whereas genome sequencing can identify novel genetic variation and make predictions as to its role, functional genomics provides direct evidence of the phenotypic consequence of this variation in the cell. The foray into functional genomics research at the AWRI begun in 2007 with the initiation of the wine yeast gene deletion library (WYGDL) project as a collaboration with Prof. Charles Boone from the University of Toronto. The WYGDL library had the ambitious goal of systematically deleting individual genes from a wine yeast strain such that a large collection of strains would be produced in which each strain in the collection was missing a single gene. This work is now reaching fruition, with the first iteration of the WYGDL, with over 3000 individual strains, currently being used by researchers at the AWRI to characterise genes that are important to several relevant winemaking characteristics.

Whole genome sequencing of *Dekkera (Brettanomyces) bruxellensis*

Through the early 2000s, the AWRI disseminated actively a comprehensive 'Brett' control strategy, which enabled Australia's winemakers to gain the upper hand in prevention of spoilage by the yeast *Dekkera bruxellensis*. In order to future-proof the widely adopted control strategy that has been so effective, we have undertaken whole genome sequencing of the three major strains of this yeast found in Australian wineries. Assembly of the sequence for AWRI 1499, which has a relatively high level of sulfite tolerance and is one of the most common strains in Australia (comprising 85% of all isolates), has been completed. The focus now is upon understanding how this strain tolerates much higher concentrations of sulfite than the next two most common strains, and finding 'chinks in its armour'. This will enable us to provide Australia's winemakers with additional tools to fight 'Brett' should new, more robust, strains evolve.

Oenococcus oeni and malolactic fermentation

Oenococcus oeni is the principal lactic acid bacterium (LAB) involved in malolactic fermentation MLF. In addition to reducing wine acidity, MLF also provides microbial stability and offers the opportunity to modify sensory properties of the wine. However, MLF is notoriously fickle and one of the objectives of MLF research at the AWRI is to improve its reliability and efficiency.

Long established winemaking protocols for MLF induction generally involve inoculation of bacterial starter cultures post alcoholic fermentation, however, more recently there has been a trend to introduce bacteria earlier in the fermentation process. A vintage trial has investigated the timing of MLF inoculation in Shiraz grape must on wine quality parameters that define red wine, including wine colour and phenolics, and volatile fermentation-derived compounds.

Malolactic bacteria were inoculated into Shiraz grape must at various stages of alcoholic fermentation (beginning of alcoholic fermentation [co-inoculation, with yeast], mid-alcoholic fermentation, at pressing and post alcoholic fermentation). Co-inoculation greatly reduced the overall fermentation time by up to six weeks (Figure 10), the rate of alcoholic fermentation was not affected by the presence of bacteria and the fermentation-derived wine volatiles profile was distinct from wines produced where bacteria were inoculated late or post alcoholic fermentation. An overall slight decrease in wine colour density observed following MLF was not influenced by the

MLF inoculation regime. However, there were some differences in anthocyanin and pigmented polymer composition, with co-inoculation exhibiting the most distinct profile (Figure 11). Differences in yeast and bacterial metabolism at various stages in fermentation are proposed as the drivers for differences in volatile chemical composition.

This study demonstrates, with an in-depth analysis, that co-inoculation of yeast and bacteria in wine fermentation results in shorter total vinification time and produces sound wines, thus providing the opportunity to stabilise wines more rapidly than traditional inoculation regimes permit and thereby reducing potential for microbial spoilage. This study is described in AWRI publication #1301.

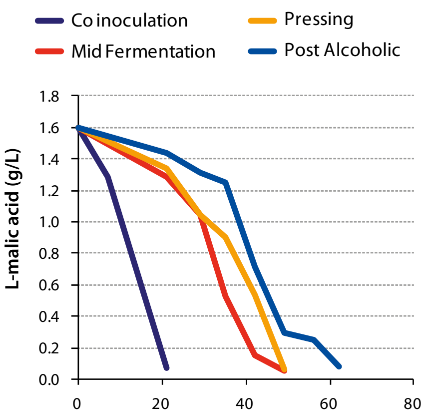


Figure 10. Effect of different timing of bacterial inoculation on the metabolism of L-malic acid by Oenococcus oeni *during fermentation of Shiraz grape must.*

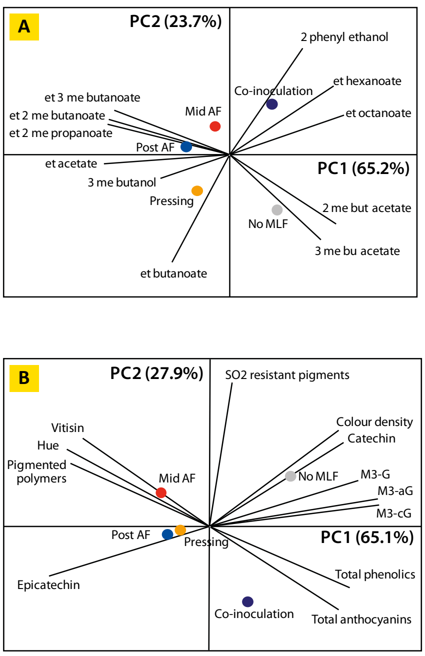


Figure 11. Principal component analysis of volatile fermentation-derived products (A) and colour and phenolics components (B) in Shiraz wine following different MLF inoculation regimes.

Harsh wine conditions pose numerous challenges for *O. oeni* to grow and conduct MLF efficiently. Much research has focused on physiological approaches to understanding differences between *O. oeni* strains for insights into how *O. oeni* copes with the wine environment. More recently, however, we have adopted a genomic approach (Annual Report 2009 and AWRI publication #1224).

In order to understand how *O. oeni* has adapted to a wine environment, the genome of a different (in fact the only other) *Oenococcus* species has been sequenced by us and compared with that of *O. oeni*. *Oenococcus kitaharae* is a LAB isolated from composting distilled Shochu residue. Comparison of the genomes of the different *Oenococus* species show that the genome of *O. kitaharae* contains many genes with predicted functions in cellular defense (bacteriocins, antimicrobials, and restriction-modification systems) and these are lacking in *O. oeni*. The two species also display several differences in metabolic pathways such as amino acid biosynthesis and carbohydrate utilisation which would predict to have direct phenotypic consequences.

In all, these data point to a scenario where the species have adopted very different survival techniques to adapt to their unique environmental niches (*O. oeni* to wine and *O. kitaharae* to shochu compost). The genome of *O. oeni* reflects that it has little competition from other bacterial species (hence the lack of the defences which are found in *O. kitaharae*), and that it can access at least some, otherwise essential, nutrients from its environment. For example it uses peptidases to access amino acids from wine rather than making its own and therefore has not retained genes for all of the biosynthetic pathways found in its close relative. This knowledge is critical to our understanding of the biology of an essential wine microorganism and will be of great value in any research aimed at developing new strains for improved reliability and efficiency of MLF.

AWRI Wine Microorganism Culture Collection

The AWRI wine microorganism culture collection (AWMCC) is a comprehensive repository of microorganisms. A major role of the AWMCC is to maintain a world-class repository of diverse, wine-relevant strains of yeast and bacteria that can be readily accessed by the Australian wine producers and for research purposes. The AWRI culture collection is a member of the World Federation of Culture Collections and with other Australian microorganism collections has recently become part of the Atlas of Living Australia.

Currently it contains over 2000 yeast and bacterial strains, including reference strains, winery isolates, research strains and experimental isolates. The AWMCC is an invaluable resource for Australian wine producers and in the past 12 months 450 new strains have been added. A large number of the yeast and bacterial strains in the AWMCC can be provided to Australian wineries, national and international research institutes, Australian teaching institutions and commercial companies. Wineries are able to deposit and store their yeast and bacterial strains in the AWRI collection; several Australian wineries are currently taking advantage of this service.

Processing steps to optimise wine quality and development in bottle

Staff and students

Dr Liz Waters (until 15 April), Dr Paul Smith, Dr Martin Day, Mr Richard Gawel, Dr Matteo Marangon, Dr Maurizio Ugliano (until 16 August 2010), Steven Van Sluyter (until 13 August), Mariola Kwiatkowski (until 16 August 2010), Alex Schulkin, Professor Ignacio Nevares (Visiting scientist, University of Valladolid, Spain)

Collaborators

WIC Winemaking Service (Gemma West); Flinders University (Dr Peter Anderson, Dr Ian Menz); Treasury Wine Estates (Dr Vanessa Stockdale); INRA UMR-SPO, France (Dr Aude Vernhet); Nomacorc PL, Belgium (Olav Aagaard, Jean-Baptiste Dieval, Dr Stéphane Vidal); Pernod Richard Pacific (Leon Deans, Kate Lattey); University of Melbourne (Professor Antony Bacic, Dr Filomena Pettolino); University of Padua, Italy (Diana Gazzola, visiting PhD student); University of Queensland (Dr Robert Falconer)

The main aim of this suite of projects is to improve winemaking processes after fermentation. The current focus is on two broad areas: protein stabilisation and oxygen management.

Protein stabilisation

In order to meet consumers' expectations, white wines always need to be brilliantly clear. However, bottled white wines can turn hazy and form sediments. Research and experience have led to the understanding that haze formation in white wine is associated with the presence of residual grape proteins and with elevated temperatures during storage or transportation. Grape proteins in wines, being unstable under certain conditions, can aggregate into light-dispersing particles to make wines appear turbid. Consequently these proteins, and particularly chitinases and thaumatin-like (TL) proteins, need to be removed before bottling. Protein removal is achieved by fining wines with bentonite, an effective but inefficient step which is why alternatives are sought.

So far the search for alternatives to bentonite has not yet resulted in commercially viable solutions able to compete with the efficacy and low cost of bentonite. We believe that a better comprehension of the causes for haze is needed in order to succeed, since a thorough understanding of the mechanisms of protein haze formation has the potential to lead to the development of novel, efficient and environmentally sustainable winemaking processes to prevent haze from forming.

Through continuation of our collaboration with Dr Robert Falconer at the Australian Institute for Bioengineering and Nanotechnology, University of Queensland, we were able to answer the question of whether precipitation and aggregation of the unfolded TL-proteins and chitinases is linked (i.e. if co-precipitation occurs) and whether there are differences in the way that the two classes of proteins form haze in wine (AWRI publication #1273). We have been able to show that chitinases are the dominant protein in haze from real wine and are the most prone to precipitate.

We also continued collaborating with Dr Vernhet's group (Montpellier SupAgro, France) to investigate the role played by ionic strength and sulfate towards the aggregation of TL-proteins and chitinases upon heating (AWRI publication #1272). Grape proteins were purified and identified at the AWRI before the project started. Experiments were carried out in France by dissolving the purified proteins at a wine-like concentration in artificial wine and, upon heating/cooling cycles, measuring their aggregation by dynamic light scattering (DLS). The effect of ionic strength on protein aggregation was investigated and for chitinases, aggregation occurred during heating with ionic strength values of 100 and 500 mM/L, depending on the isoform. This aggregation immediately led to the formation of large particles (and visible haze after cooling). TL-protein aggregation was only observed with ionic strength of 500 mM/L; it mainly developed during cooling and led to the formation of smaller aggregates that remained invisible. With sulfate in the medium chitinases formed visible haze immediately when heat was applied, while again TL-proteins aggregated during cooling but not into particles large enough to be visible to the naked eye. Our data show that the aggregation mechanisms of TL-proteins and chitinases are different, and influenced by the ionic strength and the ionic content of the model wine. Under these conditions, we confirmed that chitinases were more prone to precipitate and form haze than TL-proteins. Figure 12 shows a proposed mechanism of haze formation.

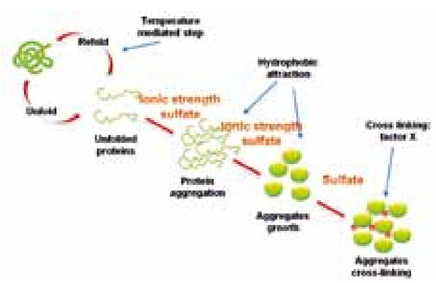


Figure 12. Proposed mechanism of haze formation.

The GWRDC Science and Innovation Award for Young People in Agriculture, Fisheries and Forestry was awarded to Dr Matteo Marangon in 2011. This award allowed us to lease a qNano System, an instrument that uses a technique called scanning ion occlusion spectroscopy to detect nanoparticles, such as proteins, tannins and polysaccharides. The availability of this tool, combined with the visit of Diana Gazzola (Padua University, Italy) allowed us to collect data on protein aggregation that we were not previously able to obtain. The qNano was used in reconstitution experiments to study protein aggregation in model systems and the two main wine proteins showed very different behaviours, with chitinases more easily unfolded by heat and more reactive with other wine macromolecules (polysaccharides and phenolics) than TL-proteins. In summary, using a range of techniques, we have confirmed that chitinases are the class of protein that mostly account for haze formation in wines, due to their heat sensitivity and tendency to aggregate with other wine components to give very large aggregates.

From our studies on the mechanisms it appeared likely that protein unfolding might provide the key to successfully using proteases in wine to degrade these haze forming proteins. An unfolded structure might make the peptide backbone more accessible to a proteolytic enzyme.

We have demonstrated that protein unfolding is a temperature mediated step and that different wine proteins have different unfolding temperature. This knowledge, together with the availability of a food grade protease, which is active at wine pH and at high temperatures, informed our development of a practical method to stabilise juices, in collaboration with the AWRI Industry Applications group. Knowing the unfolding temperature of chitinases and TL-proteins allowed us to tailor a flash pasteurisation treatment sufficient to unfold these proteins and for the protease to degrade the unfolded proteins (see Figure 13). Pilot-scale trials undertaken this vintage have been very successful. Two heat unstable juices were heated to 75°C for approximately one minute, with and without prior addition of protease. Preliminary results showed that the heat treatment alone reduced the total protein content of the juices by >45%, whilst the combined heat and protease treatment resulted in reductions of protein in the juice of >85%. These results are the most promising and the most commercially viable application of a protease that we have seen in more than 20 years of work on protein instability.

Figure 13. Schematic representation of the effect of flash pasteurisation coupled with protease on grape protein structure.

AWRI publication #1272. Marangon, M., Sauvage, F-X., Watres, E.J., Vernhet, A. (2011). Effects of ionic strength and sulfate upon thermal aggregation of grape chitinases and thaumatin-like proteins in a model system. J. Agric. Food Chem., 59 (6), 2652–2662.

AWRI Publication #1273. Marangon, M., Van Sluyter S.C., Neilson, K.A., Haynes, P.A., Waters, E.J., Falconer, R.J. (2011). Roles of grape thaumatin-like protein and chitinase in white wine haze formation. J. Agric. Food Chem., 59 (2), 733–740.

Oxygen management at bottling and during bottle storage

Does winemaking stop when a wine is bottled? The answer is clearly no. Choices made at bottling can be as significant as other choices made throughout the grapegrowing and winemaking process. In other words, winemaking can continue after bottling and a great deal of this is related to oxygen management.

A critical part of oxygen management is the ability to measure the real content of oxygen during the winemaking process. All of the commercial oxygen meters use technologies based on indirect measurement of oxygen partial pressure and are typically calibrated with water. For realiable oxygen measurement in winemaking it is necessary to utilise corrections based on the different solubility of oxygen in juice or wine. The effect of sugars and also ethanol content in these liquids have to be considered. Professor Ignacio Nevares, a visiting scientist from University of Valladolid (Spain) has been reviewing the state of the art in dissolved oxygen measurements in grape juice and wine with particular focus on identifying suitable correction factors to estimate the impact of varying sugar and ethanol concentration on oxygen solubility at different temperatures.

Oxygen management and shelf life in Sauvignon Blanc and Shiraz wine

Previously, we reported that compositional factors in Sauvignon Blanc, such as metals and glutathione content, can determine the ability of a wine to develop hydrogen sulfide (H_2S), one of the compounds contributing to reductive aroma, during storage. At the same time, oxygen exposure is a powerful modulator of H_2S accumulation and we have now completed a study about the impact of oxygen, copper and glutathione on thiols and low molecular weight sulfur compounds in the Sauvignon Blanc wine (AWRI publication #1283). The main points from this research are:

- Oxygen exposure post-bottling influences wine development, copper can act as a pro-oxidant (stimulating oxidation) and, as expected, glutathione can act as an antioxidant (preventing oxidation).
- The amount of oxygen entrapped in the closure is significant and impacts on wine development, particularly in the first six months.
- Copper addition at bottling reduces the levels of fruity thiols and doesn't prevent H_2S accumulation over time. In fact, copper addition at bottling appears to enhance H_2S accumulation over time.

Shiraz: micro oxygenation (pre-bottling oxygen) and oxygen ingress (post-bottling oxygen)

In a further study, this time with Shiraz wine, oxygen exposure pre-bottling, through micro-oxygenation (MOX), was compared to oxygen exposure post-bottling, through ingress through the closure.

What we were interested in exploring was whether the timing of the exposure to oxygen made a difference to the outcome. The MOX treatment was performed in tall 'cigar-shaped' tanks, at 0.5 mg/L/week for seven weeks. The experimental design for bottling is described in Figure 14. The 'MOXed' Shiraz and untreated Shiraz wines were sealed with closures filled with air or pre-conditioned in nitrogen and then the bottles were stored either in nitrogen or air. This gave three oxygen exposure storage conditions: the lowest being bottles sealed with closures filled with nitrogen and stored in nitrogen, an intermediate exposure treatment from bottles sealed with closures filled with air and stored in nitrogen, and the highest from bottles sealed with closures filled with air and stored in air. The intermediate oxygen exposure treatment essentially was oxygen exposure only from desorption from the closure.

What impact did these oxygen exposure differences have on red wine development? This can be illustrated by the outcomes of sensory analysis undertaken six and 12 months after bottling (Figure 15). The wine generally showed some 'reduced' aroma no matter which exposure treatments were imposed, indicating that this wine was likely bottled with a degree of reductive flavour. After six months, there were significant differences in the perceived *reduced*, and also *overall fruit* characters. With increasing oxygen exposure at the six months time point, the *reduced* scores decreased and the *overall fruit* scores increased. Both pre- (MOX) and post-bottling oxygen influenced the *reduced* scores. The greatest scores for *reduced* were in the wines without MOX and sealed with closures filled with nitrogen and stored under nitrogen. At this time point, MOX treatment resulted in less of this reductive character in the wines, in other words, the effect of pre-bottling oxygen was evident. The perceived *oxidised* character in the wines was very low and not different among the treatments. This was also the case after 12 months of bottle storage.

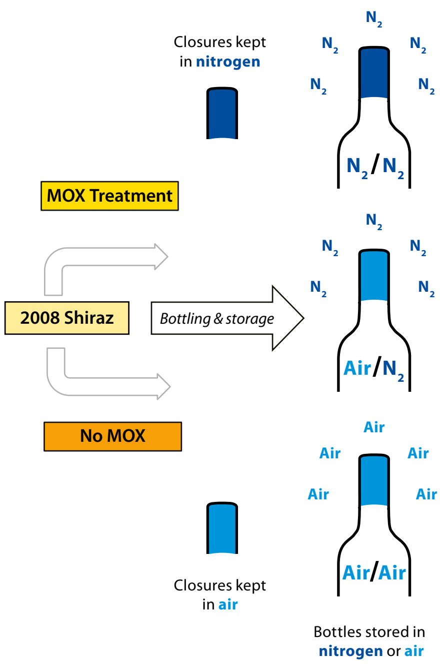


Figure 14. A schematic of the treatments used for the Shiraz micro-oxygenation (MOX) bottling trial.

After 12 months of bottle storage, the pre-bottling oxygen (MOX) effect was no longer seen, and the level of *reduced* character in the wines was only governed by the storage environment. As we saw at six months, the *overall fruit* character increased and the *reduced* character was lessened with increasing oxygen exposure.

If 12 months was the planned release date for this wine, the winemakers might ask themselves whether MOX would be beneficial. It might be possible to get a similar effect, after bottling, to MOX before bottling, by selecting a closure with an appropriate OTR. Of course MOX needs to be monitored and can be terminated after a period of time, but it is not possible to switch closure OTR off. Nevertheless it appears possible to tailor closure OTR and optimal oxygen exposure to the likely sell by date for certain wines.

In the Shiraz study, the impact of oxygen exposure on the development of *reduced* characters was demonstrated, and it appears that the impact of oxygen post-bottling through ingress through the closure can, in time, have a similar effect compared to oxygen pre-bottling through micro oxygenation.

In summary both the Sauvignon Blanc and Shiraz studies demonstrate the following points:

- In the first six months after bottling, the contribution of the oxygen trapped in the closure and in the headspace is relevant to wine development and should not be ignored.
- After six months bottle storage, ingress through the closure is generally more important than headspace or closure oxygen.
- The effects of oxygen ingress in white wines are modulated by wine composition :
  - Glutathione protects thiols responsible for varietal character in Sauvignon Blanc from oxidative losses.
  - Copper addition at bottling may reduce the levels of these tropical thiols.
  - Copper addition at bottling, 'just in case', may not prevent reductive characters developing post-bottling in Sauvignon Blanc.
- Oxygen added before bottling to red wines (MOX) may play a role in wine development, that is similar to oxygen if 'added' post-bottling through the closure.

Oxygen management at bottling is indeed another winemaking tool that can be used to sculpt a wine's development. Our research has given some examples of varying oxygen exposure through winemaking practices before bottling, such as micro oxygenation, through bottling practices, such as headspace treatment, and through closure choice, such as selecting closures with known OTR. The nature of the chemical and biochemical processes determining H_2S accumulation during ageing remains to be established and is an ongoing area of research.

AWRI publication #1283. Ugliano, M., Kwiatkowski, M., Vidal, S.P., Capone, D., Siebert, T., Dieval, J.-B., Aagaard, O. and Waters, E. J. (2011) Evolution of 3-mercaptohexanol, hydrogen sulfide, and methyl mercaptan during bottle storage of Sauvignon Blanc wines. Effect of glutathione, copper, oxygen exposure, and closure-derived oxygen. J. Agric. Food Chem. 59, 2564-2572.

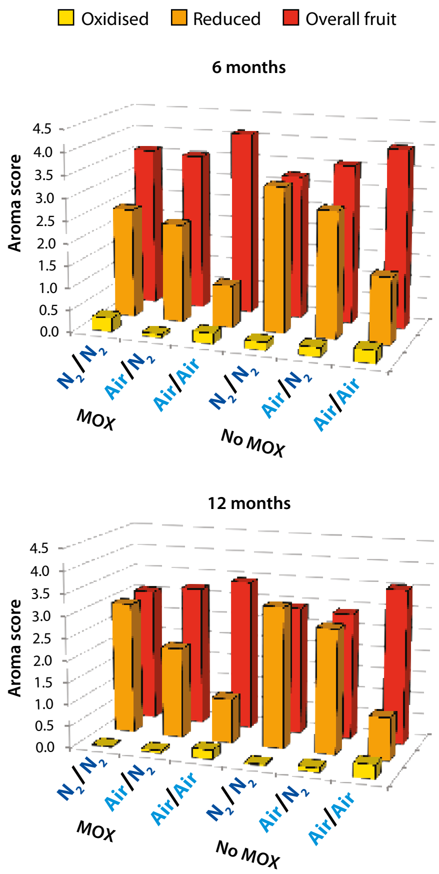


Figure 15. The effect of pre-bottling oxygen (micro-oxygenation; MOX) and post-bottling oxygen (closure and storage treatments) on the sensory properties of Shiraz wine at six and twelve months post-bottling.

Wine in society

Wine quality and consumer needs

Staff

Dr Leigh Francis, Patricia Osidacz, Dr Helen Holt, Belinda Bramley, Jennifer O'Mahony, Dr Christine Mayr, Dr Jason Geue (to March 2011)

Collaborators

University of South Australia (Dr Simone Mueller, Prof Larry Lockshin); University of Adelaide (Dr Sue Bastian); Sensory Insights (Mark Stevens); Orlando Wines (Kate Lattey, Shane Hanna); Accolade Wines (Chris Bevin); Adelaide Hills Vine Improvement Inc. (David Coleman); Curtin University (Dr Ayalsew Zerihun, Dr Mark Gibberd)

An important aspect of wine science is the evaluation of how a wine appears visually, how it smells and most importantly how it tastes in comparison to other wines; as well as the measurement of how the consumer feels about it. Sensory science involves complex procedures to ensure reliable and valid data on sensory aspects of wines is generated. The specialist AWRI sensory team uses trained tasters to objectively describe the properties of wines, expert judges to assess overall quality and style, and wine consumers to evaluate preference. Using our dedicated sensory laboratories with controlled environments and computerised data acquisition systems, numerous studies are conducted for research projects run by the AWRI and for producers wishing to have sensory data on their wines.

The AWRI technical quality panel has evaluated 319 individual wines for client wineries. This included 11 sets of bottled wine assessed for the incidence of taints or faults. Twenty triangle tests were run as part of contract research projects, including investigations of a range of closures in red and white wine as well as storage time and temperature variables. The difficulty of extracting closures from bottles was also evaluated from a consumer point of view. As part of the PinotG project reported in the Industry Applications report, a dedicated PinotG panel assessed 204 wines over 17 sessions for the purpose of developing and delivering the innovative labeling service.

Sensory science for research studies

There have been numerous research studies conducted through the year (reported elsewhere in this report) which had a significant sensory component. Eighteen major sensory descriptive analysis studies have been completed using the AWRI trained and highly experienced panel. Studies have included: effect of white wine phenolics and polysaccharide compounds in wine flavour and mouth-feel; the effect of clone, vigour and yeast strain on Sauvignon Blanc sensory properties (with Curtin University); a smaller Sauvignon Blanc study on clone effects (with Adelaide Hills Vine Improvement Inc.); effect on Sauvignon Blanc aroma of genetically altered strains; a yeast nutrient study with Cabernet Sauvignon; effect of microxygenation, bottling and storage atmosphere on Shiraz from two regions; a malolactic strains study on two wines from two regions; and several studies on smoke taint affected wines and release of smoke flavour from precursors while tasting.

In addition to these projects, a flavour compound addition study was run to assess the sensory significance and contribution of three sulfur compounds. Two, hydrogen sulfide and methane thiol, are well known as contributors to undesirable off-flavours in both white and red wines, while the third compound studied, benzene methane thiol, is less well understood. In this study the compounds were added singly and in combination to address the question of what sensory attributes they give to wines, and whether there is an enhancement effect of the several compounds together. The compounds were each added at a low and high concentration.

The results showed that as expected, hydrogen sulfide gave rise to a cooked egg/rotten egg aroma, while also contributing to a sewage/cooked cabbage-like aroma. Methane thiol did not affect the cooked egg aroma, but contributed to the sewage/cabbage attribute rated by the sensory panel. The benzene methane thiol compound conferred a struck flint, struck match/smoky aroma, and did not contribute to the more highly undesirable aroma properties. There was a clear additive effect of the

Patricia Osidacz

methane thiol and hydrogen sulfide, with the wines with these compounds added together at the higher level having the highest off-flavour levels (Figure 16). There was also a suppression or masking effect of hydrogen sulfide when added at low levels, so that the sewage/cabbage aroma was not evident when a low concentration of hydrogen sulfide was added with methane thiol at a high level.

The results showed for the first time the relative importance of these three compounds, and provides guidance when assessing measured levels of sulfur compounds. The compound benzene methane thiol is particularly interesting as low levels of this compound are likely to have a positive effect in aged wines, especially in styles such as aged Semillon or sparkling wines, but it is probably less desirable when present at high amounts.

The AWRI has an active research effort currently into gaining a comprehensive insight into the causes and control of these potent and generally unpleasant flavour compounds through viticulture, winemaking and bottling practices. In addition, the Commercial Service analytical laboratory offers to measure hydrogen sulfide and methane thiol for wine companies, using AWRI's routine method for trace sulfur compounds.

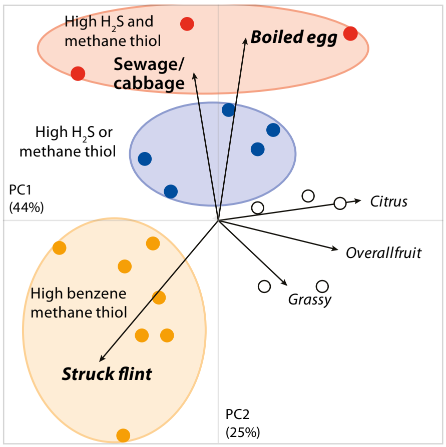


Figure 16. Sensory effect of adding hydrogen sulfide (H_2S), methane thiol, and benzene methane thiol to a white base wine. Samples plotted to the top of the figure were perceived as highest in 'boiled egg' and 'sewage/cabbage', while those to the bottom left of the figure were highest in 'struck flint' aroma.

Consumer based sensory studies

A consumer based study to assess the effect of wine education on consumer preference has been completed. Consumers assessed six Shiraz wines of different sensory properties, and in a subsequent week undertook the standard red wine National Wine Centre red wine appreciation course, after which they again assessed the same six wines. The six wines were also characterised by the AWRI sensory descriptive panel.

There was a moderate effect of the wine appreciation course on the consumers' liking responses. Liking scores were generally higher after the course, presumably due to an increased intellectual and emotional involvement with wine. However some wines that were previously intermediately well liked, including complex, super-premium wines, were being less liked after the course. This indicates that the slightly negative sensory aspects of these wines, such as low level bitterness or oxidative flavour, became more important to the consumers after the course.

Following the course there was a shift in liking away from older wines, with relatively high astringency, acidity and bitterness, and towards more fruity wines, probably reflecting a higher degree of analytical awareness. More consumers appreciated deeply coloured wines with a higher degree of dark fruit flavour after the education session. There was a group of consumers who before the course appreciated the more astringent wines with a degree of bitterness (46% of the sample), and this group decreased in size to 32% after the course.

The least liked wine before the course, a low priced, very high sales wine, remained least liked after the course, while the most liked wine before the course, a $30-retail rich Barossa Valley Shiraz with relatively high alcohol and high oak flavour, was even more appreciated after the course. One explanation for this behaviour is that upon exposure to a wide range of wines of different varieties and sensory properties in the course, the consumers then tended to prefer 'safe', palatable wines of familiar sensory properties.

Overall the conclusion of both this study and the earlier 'exposure' study discussed in the last annual report, is that consumers cannot be 'trained' into appreciating wines that some experts might consider excellent, but that with either exposure or education, preferences can change in the short term.

Both studies strongly show that rich, high fruit and oak wines are generally preferred over more subtle, lower alcohol wines, and that well liked Shiraz wines are well balanced in terms of fruit, oak flavour, acidity and astringency. Wines with detectable bitterness, excessive astringency, oxidative flavour due to bottling ageing, or low fruit flavour will not be well liked by consumers, even if wine industry experts might consider such wines highly acceptable. Care by wine producers to avoid such attributes – especially bitterness – would have large benefits. Assistance is available to wine companies from the AWRI to control these attributes.

As a side element to the project, consumers were asked to complete a questionnaire in a conjoint designed study. It was found that there was a somewhat negative response to wine labelled as biodynamic, organic or carbon neutral. Also, wines labelled with alcohol levels of 15% were less likely to be selected over those from 13.5 to 14.5%.

The results of these experiments confirm that rather than being a slow process, preferences can change in the short term. Strategies to allow wine drinkers to try wines are likely to increase liking of certain wine types.

The optimal time for harvesting grapes is of perpetual concern for producers, and will vary from season to season and from vineyard to vineyard. The trend for red grapes to be picked at high soluble solids levels, resulting in elevated alcohol levels in some wines, has highlighted the need for more information about the very important harvesting decision.

A consumer test was conducted on a sample set of wines made from Cabernet Sauvignon grapes picked at different maturity levels, discussed elsewhere in this report. Harvest was carried out from an early harvest point (wine alcohol of 11.8%) to a stage where the wine produced had an alcohol level of 15.5%. The wines made from fruit at the earliest harvests were least liked by most consumers, with the highest degree of liking found to be at the intermediate ripeness level, with alcohol concentration of 13.6%. Consumer preferences did not change significantly from the intermediate to later harvested wines (Figure 17). Cluster analysis showed three groups of consumers with distinct preference patterns, and the intermediate harvest was well accepted by all clusters. The main positive drivers for liking were 'dark fruit', colour intensity, and viscosity, while acidity had a strong negative effect.

Surprisingly similar results were found in a complementary set of Shiraz wines (12.5% to 15.7% alcohol) produced under commercial conditions by Orlando Wines, also made from grapes from a vineyard with different degrees of maturity. The highest ripeness wine had a moderate degree of residual sugar (3.9 g/L) and was rated moderately sweet by the sensory descriptive panel. In this sample set the highest liking was for the sweet wine, but excluding this sample, the preferred wine was at 14.2% alcohol, similar to the Cabernet Sauvignon set. Together, the results show that highly acceptable wines can be produced from grapes harvested at moderate ripeness levels.

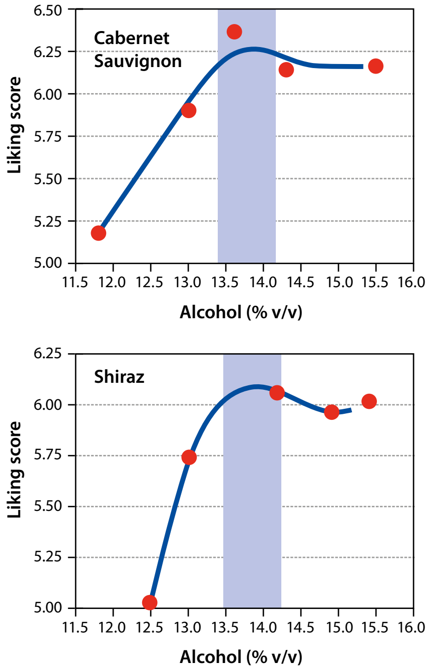


Figure 17. Consumer liking scores (n=104) for wines with different alcohol levels (% v/v) made from grapes harvested at different ripeness levels. Two different samples sets were studied, a 2010 Langhorne Creek Cabernet Sauvignon and a 2008 Padthaway Shiraz. The blue band indicates an optimal liking range.

Phil Ruthven – IBIS*World*

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

Staff
Creina Stockley

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

One of the activities of the AWRI has been to provide health and nutritional advice and assistance to the Australian wine sector, through Creina Stockley, the Health and Regulatory Information Manager. From 1 July 2010 until 30 June 2011, 67 information health and nutrition requests were received by the Health and Regulatory Information Manager from industry, the general public and government.

Committee membership

During the year, support to the sector has been derived from the Health and Regulatory Information Manager's membership of the following government and industry committees: the National Alcohol Knowledgebase Expert Working Group; and the Winemakers' Federation of Australia Wine and Social Responsibility Committee. She is also the DAFF nominated Australian delegate for Organisation International de la Vigne et du Vin (OIV) Health and Safety Commission (IV), and is currently the President of the Food Safety Expert Group. She is also a member of the honorary editorial board of the *International Journal of Wine Research* (Dove Medical Press), a charter member of the International Scientific Forum on Alcohol Research, a member of the Scientific Board of the [European] Wine Information Council, and a member of the Advisory board for WineHealth 2010, Fourth International Congress on Wine and Health.

Health and nutrition issues

During the year, the database of research on the beneficial and detrimental health effects of alcohol, and in particular wine, has been added to and these records are available online for levy paying members of the Australian grape and wine sector. This is facilitated by the subscription to relevant medical and scientific journals, and by the formal and informal exchange of information between complementary organisations, both national and international. The journals have been regularly scanned, and articles have been prepared for inclusion in the AWRI's publication, *Technical Review,* and for other Australian wine sector and international alcohol industry newsletters. Articles and other material have also been prepared for the electronic and print media (see Appendix 5). For example, one article has been prepared for the monthly *Australian and New Zealand Grapegrower and Winemaker,* four for *AIM-Alcohol in Moderation,* and two articles for the bimonthly *Technical Review.* In addition, a chapter entitled *The biology of intoxication* and a case-study entitled *Indigenous Australians and alcohol* for the book entitled *Expressions of drunkenness (Four hundred rabbits)* was published by Routledge on behalf of DrinkWise Australia and the International Centre for Alcohol Policies. A 63-page chapter entitled *The potential therapeutic value of wine from a clinical and scientific perspective* for the three volume book entitled *Handbook of enology: principles, practices and recent innovations* was published by Asia Technical Publishers and Distributors. Also, a chapter entitled *Controlling the highs and the lows of alcohol in wine* for the book entitled *Wine: types, production and health* was prepared for publication by Nova Science Publishers, in conjunction with the members of the AWRI's Alcohol Content Advisory Group. Five media interviews were conducted (see Appendix 4). An information series on wine and health issues was also developed for the wine and health section of the AWRI website to complement *The A-Z of information on wine and health issues* booklet.

In addition, the Health and Regulatory Information Manager prepared a successful project application for funding by the Australian Wine Foundation entitled *Effect of resveratrol in red wine on cognitive function in older adults - a pilot study* with Professor Andrew Scholey of the Brain Sciences Institute, Swinburne University. The project will assess the impact of resveratrol-enhanced red wine on cognitive function in an aged Australian population. Another project application entitled *Tracking the metabolome of grapes into wine* which was prepared with Professor Fulvio Mattivi of the Edmund Mach Foundation, Italy was successful in securing funding from the Department of Premier and Cabinet, Government of South Australia and the provincial government of Trento, Italy. This project aims to identify, quantify and potentially characterise compounds in grapes that are transferred to wine which may have therapeutic effects in humans in order to demonstrate the role of wine as part of a healthy diet and lifestyle.

Invited presentations (see also Appendix 1) were made at WineHealth2010 International congress on wine and health in Friuli, Italy on 6 October 2010, the University of Melbourne's Lecture series: Food for a healthy plant - bioactive phenolic compounds on 25 October 2010, Premium Wine Brands' wine seminar on 24 March 2011 and Pernod Ricard's inaugural Responsib'ALL Day on 23 May 2011.

The Health and Regulatory Information Manager also developed Session II of the 14th Australian Wine Industry Technical Conference entitled *Wine – harmful or healthy? Who is listening?* which was held on 4 July 2010, and prepared the presentations for publication in the Conference Proceedings.

Project coordination

The project entitled *Resveratrol in the chemoprevention of colorectal neoplasia* funded by Cancer Australia has continued. Professor Finlay Macrae Head of the Department of Colorectal Medicine and Genetics at The Royal Melbourne Hospital and the AWRI's Health and Regulatory Information Manager, are the Co-Chief Investigators of the project. 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. The effect of resveratrol on proteins and cell mechanisms involved in controlling cell growth and thus cancer potential will be measured from blood samples and from tissue samples taken from the bowel.

The project entitled *Determination of the beneficial cardiovascular effects of red wine and the three primary wine-derived phenolic compounds and their metabolites in humans* has commenced. Professor Arduino Mangoni of the University of Aberdeen, Scotland, UK and the AWRI's Health and Regulatory Information Manager, are the Co-Chief Investigators of the project. The project is investigating the effects of grape-derived resveratrol, administered in a moderate amount of red wine on specific and sensitive biomarkers for cardiovascular disease in an elderly patient population who are at increased risk of cardiovascular disease; an aim is to attribute any beneficial effects to resveratrol and/or its metabolites.

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

Staff
Creina Stockley

One of the activities of the AWRI has been to provide regulatory and technical advice and assistance to the Australian wine sector, through the Managing Director, the Health and Regulatory Information Manager and the Industry Development and Support group of which the Health and Regulatory Information Manager is a member. During the year, 121 independent regulatory, science and technical-related information requests were received by the Health and Regulatory Information Manager from the wine sector, the general public and government.

Industry committee membership

During the year, support to the wine sector has been derived from the Health and Regulatory Information Manager's membership of the Winemakers' Federation of Australia (WFA) Wine Industry Technical Advisory Committee and the Wine Industry National Environment Committee. The Health and Regulatory Information Manager is also a Department of Agriculture, Forestry and Fisheries-nominated Australian delegate for Organisation International de la Vigne et du Vin (OIV) Expert Group meetings. The Health and Regulatory Information Manager, together with members of the Industry Development and Support group, also had input into the draft *WFA-WISA Code of practice for raw materials - quality documentation.*

Technical and regulatory issues

The technical and regulatory support to the Australian wine sector is ongoing as issues are regularly raised by industry or government, both in Australia and internationally, and often span several years. During 2010/2011, technical and regulatory information and/or issues that have been reviewed, and material prepared includes: the use of synthetic tartaric in export markets; the impact of fluoridated water on wine; implications of the chemical control of locusts; the use of phosphorous acid in Australian vineyards and regulatory requirements in export markets, gelatin and other proteinaceous fining agents residues in wine; gluten sources from oak barrels and implications for allergen labelling; potential for human pathogenic bacteria in flood-affected wine and wine cellars; potential toxicity of millipede inadvertently added in winemaking; and legality of the addition of grape-derived resveratrol to wine.

In addition, the Health and Regulatory Information Manager developed and chaired the 14th Australian Wine Industry Technical Conference workshop entitled *The A-Z of national and international labelling for wine* on 5 July 2010 and provided presentations on allergen and health warning labelling. She also presented at the Adelaide Hills and Langhorne Creek seminar on 25 May 2011. One article has also been prepared for the bimonthly *Technical Review* (Appendix 5).

In addition, the Health and Regulatory Information Manager continued as a member of three OIV working groups — *Taskforce on additives and processing aids in China*, *Protocol for the evaluation of the risks related to food safety for new oenological treatments* and *Taskforce on allergens,* the latter of which she is chair. The former is preparing scientific and technical dossiers on the additives and processing aids not currently permitted for winemaking in China and hence not permitted to be present in Australian wine exported to China. The dossiers will be submitted to the Chinese government in order to vary Chinese Standard GB 2760. The aim of the latter has been to coordinate analytical and clinical research into the potential for residual protein in protein-fined wine and its significance for human health, which has been undertaken by Australia, France, Germany and Italy. A further extension of the temporary derogation was granted. Updated submissions have been subsequently prepared and submitted to the European Commission and the European Food Safety Authority to provide for a permanent derogation for wine on allergen labelling for egg and milk products.

Furthermore, the information in the AWRI databases *Analytical specifications for the export of Australian wine* and *Approved additives and processing aids for winemaking in Australia and internationally* have been updated and made available on the AWRI website. The former database contains specifications for 38 markets and the latter for 15 markets.

The Health and Regulatory Information Manager also coordinates Course 3005WT *Grape industry practice, policy and communication* for the School of Agriculture, Food and Wine at The University of Adelaide. In its fifteenth year, 18 students enrolled in the Course, which exposes students to organisational, commercial, environmental, political, societal and technical issues relating to the wine sector's operating environment.

Industry Applications

Staff

Peter Godden, Paul Smith, Daniel Cozzolino, Richard Muhlack, Wies Cynkar, Ella Robinson, Nevil Shah, Bob Dambergs and Emma Kennedy

Collaborators

ADVID, Portugal (Antonio Graca); Bruker Australia (Andrew Bales); CAMO Australia (Brad Swarbrick); Cellarmaster Wines (Mark Robertson, Stuart Robinson); Casella Wines (Laura Thompson); Cato Purnell Partners (Sandra Muir, Tara Power); Charles Sturt University (Jim Hardie, Peter Torley); De bortoli Wines (Rob Glastonbury, John Coughlan, Tarek Heiland, Sharon Adams, Anna Williams); Diageo, USA (Pete Salamone); Flinders University (Prof. Joe Shapter); ISVEA (Stefano Ferrari); Jeffress Engineering (Colin Jeffress); McWilliams Wines (Jim Brayne, Andrew Higgins, Simon Crook, Jenna Brayne); Orlando Wines (Kate Lattey, Leon Deans); Riverina Wine Grape Marketing Board (Kristy Bartrop); Stefano di Pieri; Treasury Wine Estates (Kevin McCarthy, Alex Hill, Joanna Marsh, Chris Hatcher, Sue Hodder, Vanessa Stockdale, Allen Jenkins, Catherine Kidman, Paul Petrie, Brenton Porter); University of Adelaide (Steve, Peter Ashman, Philip van Eyk, Gus Nathan, VinIdea (Gianni Trioli); The Yalumba Wine Company (Brian Wash, Louisa Rose, Claire Doughty)

The Industry Applications (IA) Group was formed in 2009, and has quickly become established as part of the fabric of the AWRI. IA essentially takes primary responsibility for the 'D' in the AWRI's RDE&C business model; with the aim of bringing research findings through to technologies which can be readily applied by grape and wine producers, and then commercialised by the AWRI's Commercial Services division. The team works closely with other AWRI teams, external research collaborators and with industry partners on projects across the entire value chain from vineyard soil to point of sale, and in bottled wine. These projects aim to more effectively bridge 'gaps' that might exist between research and application, and the team also seeks to understand and to break down barriers to the uptake of new technologies.

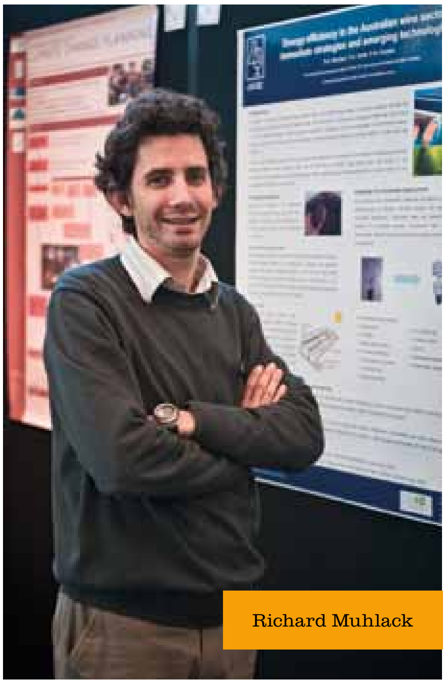
Industry Applications works under four main project headings, among which there is substantial integration:

- Economic and Environmental Sustainability and Process Improvement
- Regionality
- Smart Technologies
- Integrated Solutions

Establishment of the AWRI Riverina Node

Among the AWRI's strategic imperatives is the establishment of regional 'nodes' of activity around Australia. The first AWRI node, with an initial focus on Pinot Noir and sparkling wine research, was successfully established in Tasmania and is now entering its fourth year of operation. The AWRI intends to build on that success, and the strong encouragement evident from industry associations and wine producers in each of New South Wales, Victoria and Western Australia, to create nodes of regional activity in those states.

In November 2010 the second of the AWRI's regional nodes came into being, when Process and Environmental Engineer Dr Richard Muhlack relocated to Griffith in NSW. From July 2011 both nodes will operate as part of the Industry Applications group, reinforcing their importance in developing practical solutions to match regional priorities. In each instance, node staff work closely with local industry members to adopt or test new practices, and the Riverina Node has a particular focus on optimising process efficiency and reducing energy inputs. Richard Muhlack has a long association with the Australian wine industry, having worked for a large wine company for many years, and brings to the Riverina expertise in process efficiency, environmental engineering and carbon management, together with local and immediate access to the wider expertise and cutting edge resources of the AWRI.



Richard Muhlack

The NSW wine industry accounts for more than 30% of Australia's wine production, and is home to seven of Australia's top 20 wine exporters. More than half of NSW's wine grapes are grown in the Riverina district, the region surrounding the town of Griffith. For this reason, Griffith was selected as the location for the new AWRI node.

The primary objective of the Riverina Node is to extend the resources and expertise of the AWRI and partner organisations to deliver relevant regional solutions to the Australian wine industry, and to the Riverina district in particular. In doing so, the node will seek to provide support towards maintaining the sustainability, profitability and competitiveness of the Australian wine industry, through improving the efficiency and control of processing operations and environmental sustainability, while maximising wine quality through 'precision winemaking' technology.

Accordingly, the node will act as a multiplier on previous industry investments in R&D, by combining existing and novel research outputs into 'integrated solutions'; packages which are ready for industry adoption

AWRI Riverina node objectives

- Local and immediate interface for industry to the full capability, resources and world-class expertise of the AWRI and partner organisations
- Increased industry access to application-ready technologies which:
  - add value and reduce costs during the grape and wine production process, leading to improved process efficiency and productivity; and
  - improve winemakers' understanding and control of the grape and wine production process, leading to improved wine quality and consistency
- Improved industry access to process engineering and environmental-impact reduction expertise, together with strategies and technologies which reduce costs and maximise sustainability
- Specific demonstration of benefits of the application of process engineering and environmental impact minimisation principles
- Assessment of commercial and emerging rapid analytical technologies for potential adaptation to the wine industry
- Applied research into the relationships between grape and wine composition and impacts on wine quality, to elucidate key impact parameters
- Increased knowledge and capability of industry personnel in these areas
- Proof-of-principle assessments of methodologies currently used by other industries, which have potential application in the grape and wine industries.
- Improved access to AWRI's Commercial Services and tailored fee-for-service technical support
- Increased understanding of the key compositional and processing variables that impact on wine quality and consumers' perceived value

Planning for environmental and business sustainability

With uncertainty surrounding currency movements and rising energy and labour costs, the capability to increase throughput and reduce operating costs (energy, labour, additives and consumables, product loss and rework and waste disposal) whilst maintaining product quality, is more important than ever. Water shortages continue to pose a threat, and ongoing access to irrigation water remains a growing concern across many sectors of the community.

These pressures are already affecting business activities, so efficient, low-cost solutions are needed for immediate deployment. The AWRI firmly believes that ongoing business and environmental sustainability is possible for the Australian grape and wine sector despite these pressures, and so has positioned itself to assist the industry with process adaptation to a low-carbon future.

Process improvement and efficiency gains across a range of areas are critical to the sustainability response, and consequently the AWRI has been active in developing and promoting practical tools and process solutions. By involving government and industry stakeholders, collaborators at the AWRI's Riverina and Tasmania nodes and within the Wine Innovation Cluster (WIC), continue to provide support and leadership in pursuit of a long-term sustainability strategy.

For example, engineering tools and process knowledge are available right now to meet the environmental sustainability needs of many businesses. Potential winery process areas where significant high impact and/or low cost improvements are typically possible include refrigeration control, process heating and waste heat recovery, hot water generation, air compressor performance and wastewater treatment. Process opportunities in these areas were presented as technical factsheets (available from the AWRI website) and through workshops during the 14th Australian Wine Industry Technical Conference, as well as at AWRI roadshows and seminars throughout the year. Process improvement business case studies have been refined in consultation with industry partners at the AWRI Riverina node, and a Riverina-based regional industry technical group has been established to identify and develop new project opportunities, and demonstrate application ready improvement initiatives, with direct benefits for the local region as well as the wider industry. Producers who adopt these initiatives early will be well placed to reap maximum benefits from their investments in sustainability.

For example, current fermentation management places huge demands on winery resources. Those demands range from daily sample collection, laboratory analysis and winemaker tastings, to infrastructure constraints such as equipment availability, energy and water use, and refrigeration capacity. Process efficiency is further impacted by stuck and sluggish fermentation, with additional resources and logistical management being required as a result. The ability to reliably and accurately monitor and control fermentation in real-time, and to identify and predict problem fermentation behaviour is therefore crucial to minimising operating costs whilst maintaining wine quality. So how can the process be improved?

To make correct decisions on how to act, information on process conditions must be combined with knowledge of how a process behaves. From an engineering perspective, this knowledge comes not only from human experience, but from accurate modelling and simulation of how the process responds under various process conditions. Understanding this process response then allows for controlled intervention to a desired endpoint. Several physical and mathematical models have been developed for predicting wine fermentation kinetics under different conditions, however these models will generally assume perfect mixing and uniform conditions throughout the fermentation vessel, and so ignore real-world hydro-dynamic and heat transfer effects which can drastically (and negatively) affect performance. This issue is being addressed by ongoing research at the AWRI, particularly at the Riverina node, to develop suitable models and software tools to simulate primary fermentation processes as part of a broader strategy to provide wineries with site-wide vintage control and monitoring solutions.

After extensive testing, a break-through prototype fermentation simulation model for predicting problem ferments was completed and distributed through the Riverina node to local wineries for evaluation during the 2011 vintage. The simulation package was 'trained' on commercial-scale fermentation data sourced from multiple sites across several vintages, and during development was found to successfully predict commercial fermentation performance under various different operating conditions (Figure 18), including temperature, yeast strain, wine type, nutrient levels, and fermenter size. The simulation package also incorporates variable tank mixing and fermentation heat load, as well as capability for 'what-if' analysis that allows winemakers to assess the impact of alternative fermentation management strategies such as temperature adjustment, yeast nutrient addition, and tank agitation regime.

Development is now underway to expand the software to encompass multiple concurrent ferments and staggered fruit intake for a global winery ferment model. An upgrade to allow modeling of other fermentation analytes such as colour and tannin, together with additional engineering metrics (including refrigeration, energy demand and electricity network tariff structures) is also planned, for continued industry evaluation during vintage 2012.

As described in previous Annual Reports, opportunities also exist for wineries to add value to process waste streams through renewable energy technology such as the generation of electricity from process biomass, and from anaerobic digestion and solar thermal systems. Recent increases in industrial electricity tariffs, together with the prospect of carbon pricing and associated assistance packages for early adopters of renewable energy will all continue to show those sorts of clean energy technologies as genuine cost reduction alternatives for progressive wine producers.

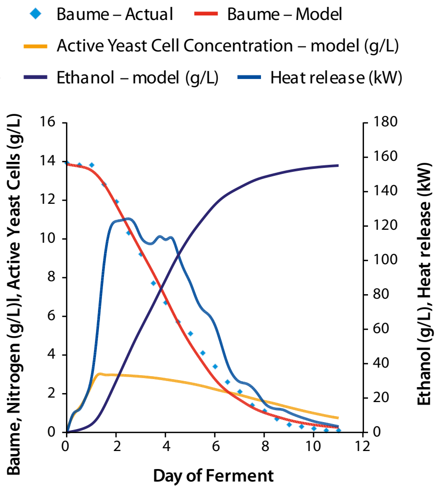


Figure 18. Demonstration of prototype ferment simulation package.

Further economic evaluation of potential renewable energy scenarios, for consideration by industry, has continued throughout the year, with assistance and input from both winery technical staff as well as collaborators at the University of Adelaide Centre for Energy Technology. Various scenarios for energy cost reduction have been considered, including electricity generation from biomass and solar thermal, as well as solar thermal or biomass powered absorption chillers to supplement or replace existing refrigeration equipment. Combinations of solar and biomass technology options have been assessed for supply of vintage and/or non-vintage demand and for refrigeration and/or non-refrigeration energy requirements, to assess potential technology combinations and process synergies.

Biomass options for electricity generation appear to be the most economically attractive at this point with the shortest simple payback together with the greatest electricity cost savings (upwards of 25-50% in some cases). Updated analysis of anaerobic digestion technology for electricity generation shows a similar payback scenario, and a watching brief on grant opportunities for producers which offset capital costs (and reduce payback time), is in place. Analysis suggests that solar thermal options which focus on non-fermentation energy loads are less economically attractive than biomass at this time; however the technology is more mature and easier to deploy. Renewable energy technology options which cover ferment loads appear far from economic (simple payback in excess of 20 years in most cases).

As further evidence of the value of this work to the grape and wine sector, during the final quarter of 2010/2011 Tarac Technologies together with Murrumbidgee Irrigation issued an invitation to tender for the design and construction of a large-scale 10MWth grape marc bioenergy facility to be

Peter Godden

located in Griffith, NSW. Tarac Technologies (a collaborator in AWRI's 2009 DAFF bioenergy project) has sufficient confidence in not only the economic merits of grape marc bioenergy technology, but also the mitigation strategies necessary to overcome process issues identified in AWRI research (refer to the 2010 AWRI Annual Report), that they are now willing to take the project to the next stage and call for invitations to tender. With the AWRI now having promoted renewable energy to the wine industry for over three years, and provided objective data on various options on which business cases might be based, this is a significant development as it greatly de-risks the technology, and will hopefully provide necessary momentum for similar developments in other wine regions. A project of this nature will be a tremendous boost to the Riverina region and shows strong business confidence in the ongoing strength and viability of regional Australia; a further endorsement of AWRI's presence through the new Riverina node.

Application of these process innovations and other emerging opportunities will allow our industry to tap into unrealised value that reduces costs and minimises environmental impact whilst maintaining superior product quality. Such initiatives will be crucial to maintaining our competitive advantage while we adjust to the carbon and water constrained economy of the future.

Process improvement - Trials of a protease enzyme as a potential replacement for bentonite

The AWRI's chemistry team has been pursuing the possibility of using enzymes to remove heat-unstable protein from wine for some time, and recently Matteo Marangon and Elizabeth Waters began small-scale experiments with an enzyme called proctase. The results demonstrated that addition of proctase to clarified juice, combined with heating, could remove heat unstable protein. Proctase is manufactured in Japan where it is registered for human consumption, but it should be noted that, as yet, it is not a permitted additive for wine in Australia.

For the 2011 vintage the Industry Applications team joined forces with the chemists and WIC Winemaking Services to trial proctase on a one thousand litre batch of Sauvignon Blanc juice. The pilot-scale process for evaluation was a continuous treatment at the juice stage, with proctase inline dosed into clarified juice (dose of 15 mg/L), followed by heating of the juice to 70-75°C in a flow-through pasteuriser before rapidly cooling the juice down to 5°C. Heating in conjunction with the proctase addition allows the proctase to act on the proteins in the wine to make it heat stable. A continuous inline treatment process at the juice stage would provide wineries with significant process efficiency gains (savings upwards of 85% when compared with batch bentonite treatment) however evaluation at a larger winemaking scale to confirm the modeling is required.

For the 2011 vintage trial, the juice was split into four treatments: an un-heated control; an un-heated portion to which proctase was added; a portion heated with proctase, and; a portion heated without proctase, with the heating treatments being performed at a commercial pasteurisation facility. To minimise heating and cooling requirements, juice exiting the pasteuriser was used to pre-heat incoming juice using a juice-juice heat exchanger. A second heat exchanger was then used to finish the juice cooling back down to down to 5°C, noting that if the juice were treated inline on its way to fermentation, cooling to normal cellar temperature would be all that was required.

Analysis of the proteins remaining in the juice after the treatments had been applied, demonstrated that in the treatment heated without proctase, and in the unheated treatment to which proctase was added, some of the heat unstable protein was removed. However, in the portion heated with proctase, all of the heat unstable protein had been removed.

Triplicate fermentations were performed with all the treatments, and the wines have been bottled with sensory evaluation scheduled to commence in August 2011.

While the results to date are extremely promising, it is considered that three important technical hurdles would have to be cleared before proctase could be hailed as an alternative to bentonite. Firstly, it has to be ascertained that heating juice in this way creates no negative differences in the wine. Secondly, it must also be established that proctase addition does not adversely affect juice or wine processing in any adverse way, for instance its filterability. Thirdly, it is presumed that proctase remains active in wine after the treatment has been completed (a situation that is considered no different to any other winemaking enzyme), and therefore it must be established that any residual proctase activity has no later adverse effects on the wine.

Helping to define regionality Exploring the concept of spectral fingerprinting

The Industry Applications group encompasses the Rapid Analytical Methods (RAMS) team, which is the world leader in the spectral analysis of grapes and wine, and has developed the concept of *spectral fingerprinting*. Spectral fingerprinting involves taking scans of samples across various parts of the electromagnetic spectrum, thereby encompassing many compositional variables of the sample; rather than looking at a few specific variables as is done with traditional grape and wine analysis. The resulting data, when combined with multi-variate data analysis, can be used to group samples according to the similarity of their 'fingerprints', and the technique is seen to have many potential applications. Many examples of the ability of this technology to differentiate between wines by variety, region, country, and wine style, have been demonstrated.

Industry Applications maintains a Regionality project, and team members travelling to regional Australia see a common theme of producers wishing to objectively differentiate their wines from those of their competitors, both within their own region and from other regions.

During the year the same techniques have also been explored for product integrity and authenticity testing.

The most high profile example of the application of spectral fingerprinting to date is the PinotG Style Spectrum.

The Spectrum is a labeling scale for Pinot Grigio and Pinot Gris wines which informs consumers of the style of the wine in the bottle at point of sale or before opening, with a wine's style being classified by the AWRI using an MIR spectral scan. The Spectrum was developed in response to industry demand from producers who were concerned that the two names being used for the same grape variety, and the wide range of wines styles being offered, was causing confusion in the marketplace.

During the year this world's first labeling innovation has been made available to all wine producers, and commitments have been received from Australian wine producers to label up to 1.2 million units (bottles and casks) from the 2011 vintage with the PinotG Style Spectrum. Additionally, several other producers have shown strong interest in using the scale next vintage, both in Australia and overseas.

Trademark applications for the PinotG Style Spectrum have been lodged in Australia, New Zealand, the UK, the USA, France and Italy; and via Wine Australia, the Tax and Trade Bureau in the USA (the TTB), have provided advice that it will allow the Spectrum to be used on wine labels sold in the USA. A Style Guide has also been developed by Industry Applications staff, which ensures that the appearance of the Spectrum on labels, or in advertising and promotional materials, remains consistent no matter what colours are used, and also that the Spectrum be referred to consistently in print and when wines' classifications are discussed.

Whilst the trademark applications necessarily include the term PinotG, the AWRI emphasises that it seeks no trademark rights over that term alone. The AWRI is working with Wine Australia, however, to consider how the term might be protected so that it can only be used for wines made from at least 85% Pinot Grigio / Pinot Gris.

A PinotG Style Spectrum marketing group has been formed with representatives of the major wine producers that collaborated on the project, and a joint marketing plan is under development. Additionally, Stefano di Pieri, co-founder of the Australian Alternative Varieties Wine Show in Mildura, which is considered to have been instrumental in bringing the Pinot Gris / Pinot Grigio variety to prominence in Australia, has agreed to act as a honourary ambassador to promote the Spectrum.

The launch of the PinotG Style Spectrum generated considerable media attention in both the electronic and print media, with substantial articles published in *The Sydney Morning Herald*, *The Melbourne Age* (x2), *The Australian Financial Review, The Adelaide Advertiser* and the *Qantas* magazine.

Rapid measurement of phenolics in grapes and wines

The AWRI's 2010 Annual Report reported on progress made in the rapid measurement of phenolics in wine, including tannin, via the AWRI Tannin Web Portal.

The portal uses six wavelength values from a UV-Vis spectrophotometer to calculate tannin, total phenolics and total pigment (colour) values, which are the three most important phenolics values.

Sample preparation is simple, results are available to winemakers straight away and the hard work of maintaining a calibration is taken care of by the AWRI. Users simply dilute samples in acid, leave them for three hours, and then read the absorbance at the specified wavelengths. The absorbance readings are entered into a web interface which returns results for tannin, total phenolics and total pigment immediately. A quality control process is built into the system, and users are provided with a QC standard to measure with every batch analysed.

The portal allows winemakers to quickly determine tannin concentration in their own facilities as long as they have a single-read or scanning UV-Vis instrument, and such instruments are widespread in the Australian wine industry. A 'benchmarking' function in the portal also allows the client to recall any of their previous vintages' results and compare them to results from the current vintage. In addition, results can be put into broader context by accessing the built-in database of tannin values from more than 3000 Australian red wines that are searchable by vintage, region and variety. This means that single pieces of data can more easily be turned into knowledge to support the decision making process. Tannin is a driver of wine style and regional character and this means that winemakers who are trying to define a certain character, or to characterise a particular region or style, can use tannin concentration as part of the answer.

While a method using a standard UV-Vis spectrophotometer may be advantageous for a smaller laboratory that does not have access to NIR or MIR devices, using the IR wavelength regions has the advantage that many other analyses can be performed simultaneously. For example, RAMS team members have now demonstrated that with the same Vis-NIR scan, anthocyanins, tannins, total dry matter, water content, total soluble solids and pH can be rapidly measured in red grapes. As appropriate equipment and software becomes more affordable and more versatile, these methods are expected to become main-stream in industry.

Work in this area has continued during the year, and as more winemakers use the portal, more information is being gathered which demonstrates the usefulness of this measurement for winemakers. In collaboration with the AWRI phenolics research team, the Industry Applications team also demonstrated that grape tannin can be measured in homogenate samples using the same technology, and work has begun to add a grape tannin measurement option to the portal. Other analytes which might potentially be added to the portal are also being examined.

Working in conjunction with the AWRI Commercial Services team, Industry Applications members have also shown that tannin in non-Australian wines can be measured with the portal, which now has users in Italy, New Zealand, Portugal and the USA. Not only will any surplus generated by such commercialisation be re-invested in the infrastructure and capability of the AWRI for the benefit of the Australian wine industry, information on the way in which overseas partners are adding value to their businesses through the use of rapid phenolic measurements will also be communicated within Australia.

Affordable, multifunctional instruments for rapid grape and wine analysis

During the year members of the RAMS team extended trials of MIR ATR technology for rapid grape and wine analysis using a Bruker Alpha instrument, and have worked with the AWRI Commercial Services team to develop a grape analysis service based on this technology. As previously reported, in 2009 and 2010 the team developed a calibration for yeast assimilable nitrogen (YAN) using this technology, with an Adelaide Hills based wine company, and that concept has now been extended to the Riverina. Nearly 400 juice and fermentation samples were collected by the Riverina node during the 2011 vintage, and scanned using Bruker Alpha MIR ATR instruments placed in collaborating winery laboratories. The samples were then frozen and shipped to the AWRI where reference analysis of YAN was performed. The results are promising, with the standard error achieved being similar to that of the enzymatic reference method.

The RAMS team presented two workshops related to assisting grape and wine producers adopt rapid measures at the 14th AWITC; *Hands on in Rapid Analytical Methods* and *Data mining,* in addition to presenting five posters.

In summary, despite the extremely harsh economic conditions being experienced by much of the Australian wine industry, during the last year the Industry Applications team has made significant progress in fostering the adoption of new technologies by Australian wine producers. Additionally, it has continued to explore technologies which have the potential to add substantial value and competitive advantage to the Australian wine sector in future, across the entire value chain, as well as working to ensure awareness of technologies on offer in regional Australia, particularly via the AWRI nodes in Tasmania and the Riverina.

Winemaking and Extension Services – Technical problem solving and consulting

Staff

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

The Winemaking and Extension Services team provide a range of services to the Australian wine sector; such services includes a range of advisory, problem solving, extension and information services. In addition to its extension and information transfer activities, which are discussed elsewhere in this report, the Winemaking and Extension Services team provides a technical problem solving and analysis service to levy-payers within the Australian wine sector. The primary aim of the service is not only to provide diagnoses of various problems, but to offer preventative and remedial advice based on the cumulative problem solving and practical winemaking experience of the staff. As previously reported, it is clear that quality loss during wine processing and packaging represents a major cost to the Australian wine sector. Consequently, all the activities of the Winemaking and Extension team, in terms of problem solving, extension and information transfer, aim to address this issue in a targeted manner. This is exemplified by the consistent problems associated with packaging of wines which were the catalyst for the development of the current preventative workshop titled 'A guide to trouble free bottling for winemakers'. This workshop is currently being delivered to wine regions around Australia.

The technical problem solving and analysis service represents a significant proportion of the team's workload and is provided according to strict Terms and Conditions. Client confidentiality is an important aspect of the provision of the services. This facilitates a frank exchange of information between the AWRI and its clients, which in turn allows the maximisation of the knowledge gained from the provision of these services. If a particular problem is considered to be of interest to the wider wine sector, the results of investigative work are made available through forums such as eNews and eBulletins. An example where this forum proved invaluable was during the difficult 2011 vintage where winemaking strategies to combat botrytis infected fruit was provided rapidly to industry. This is discussed further elsewhere in the report.

Compared with the previous year, the figures for 2010/2011 (Table 1) show a 6% increase in the total number of enquiries received. The number of enquiries received from wineries continues to be significant and indicates that a large number of Australian wine producers continue to regard the AWRI as a trusted, reliable, and an important source for quality technical information and problem solving solutions. The nature of the queries continues to be varied and these are tracked through the Winemaking and Extension Services access database where queries are assigned to keywords, allowing trends and spikes to be

Table 1. Enquiries received by Winemaking and Extension Services advisory staff in the period 2008/2009 to 2010/2011.

	2008/ 2009	2009/ 2010	2010/ 2011
Wineries	1024	829	897
Government organisations	36	19	26
Other	160	149	132
Students	16	4	7
Total	1236	1001	1062

monitored, and appropriate responses coordinated and executed. An example where this was utilised was the wet 2011 vintage, where almost one in every five queries received during the 2011 vintage being related in someway to botrytis infection. This is discussed further elsewhere in the report.

Another output that is available from the Winemaking and Extension Services access database, is looking at where our queries are coming from. Not only can we identify what state and what region the queries are coming from (as well as who these wineries are), but the size of the winery that is using the service. The data reveal that not only do a lot of our queries come from the very large wineries (>20000T), which there are very few of, but a high proportion of our queries are spreadout amongst wineries who crush less than 1000T per annum (Figure 19).

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

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

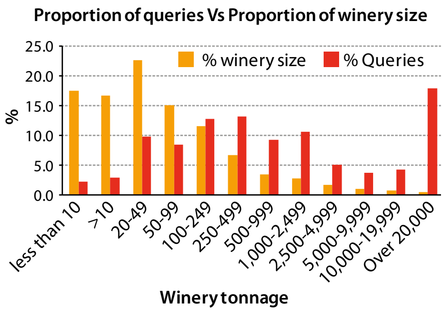


Figure 19. Proportion of queries from wineries versus winery size in tonnage, for the period 2010/2011. Note that additional queries from universities, legal bodies, winery suppliers and other groups have not been included.

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

The figure for the number of investigations conducted during 2010/2011 is 13% lower than the figure for the previous year, whilst the total number of samples analysed as part of these investigations has actually increased by 20% from the previous year (Table 2). Interestingly,

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

Type of investigation	Investigations conducted and samples analysed		
	2008/2009	2009/2010	2010/2011
Identification of hazes and deposits	64	84	77
Microbiological investigations	27	23	15
Sensory assessments	67	70	50
Taint problems	31	23	28
Other investigative analyses	31	40	37
Closure-related investigations	6	1	2
Total number of investigations	226	241	210
Total number of samples analysed	1042	1000	1197

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

State	Number of investigations conducted	
	2009/2010	2010/2011
SA	111	95
VIC	49	42
NSW	41	36
WA	28	21
ACT	-	2
TAS	7	5
QLD	5	9

the actual number of investigations for the past four years appears to be relatively steady (Table 2). The decrease in the number of investigations was spread across the states, with all but ACT and Queensland having lower numbers of investigations than the previous year (Table 3). Interestingly, the number of investigations conducted per state as a percentage of the total (Figure 20), is approximately the same as the percentage of the state production of winegrapes as a percentage of the total winegrape production data (source 2011 The Australian and New Zealand Wine Industry Directory).

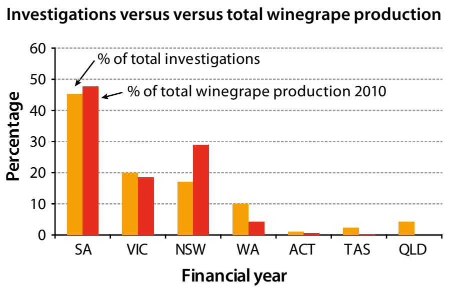


Figure 20. The number of investigations conducted by the Winemaking and Extension Services team for a particular state, presented as a % of the total, versus the % of the total wine grape production for that particular state in the year 2010.

The number of investigations conducted into wines affected by hazes and deposits has pleasingly decreased slightly from the previous year, and is slightly lower than the long term average of 80. This is discussed further later in this report. These types of problems continue to represent a considerable percentage (35% for 2009/2010 and 37% for the 2010/2011) of the total number of investigations performed. Consequently, issues related to such instability problems continued to be addressed by the Winemaking and Extension Services team during AWRI's Roadshow workshops and via the Winemaking and Extension Services section of the AWRI's website, where there is a webcast related specifically to identifying hazes and deposits.

The number (15) of investigations conducted into microbiological instabilities, has continued the downward trend and again remained low, with a decrease of 35% from the previous year. This low number is relative to the period from 1999/2000 to 2004/2005, during which the average number of microbiological investigations conducted per year was 62. If we take the average number of microbiological investigations conducted per year from the past four financial years, 27, then the low figure obtained this year is still considered very low and encouraging. Despite the encouraging downward trend in the frequency of this type of investigation, greater than 50% of these investigations involved refermentation, post packaging, which can result in a haze or deposit, or even spoilage in some cases, forming after bottling. Awareness around how to avoid these issues continues to be addressed at regional workshops, as bottling issues have represented a large proportion of the queries received by the Winemaking and Extension Services team in recent years.

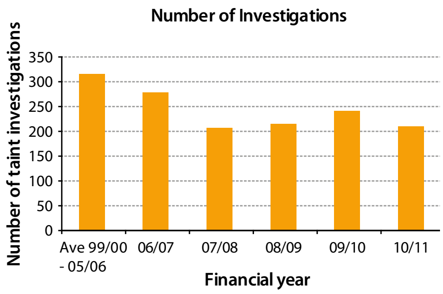


Figure 21. The number of investigations conducted by the Winemaking and Extension Services team during the period 2006/2007 to 2010/2011 and the average number of these types of investigations for the period 1999/2000 to 2005/2006.

The substantial increase in the number of investigations conducted under the category 'Sensory assessments' during the previous financial year was not sustained this financial year with a decrease from 70 to 50 (Figure 22). Although this is a decrease, the number of investigations conducted under the category 'sensory assessments' is still considered high. The types of investigations carried out under the 'Sensory assessments' category vary from year to year, winery to winery, and this year was no different with relatively even numbers of samples being submitted exhibiting 'reductive' characters; wines reported to be affected by 'unknown' or 'unusual' sensory characters; wines showing 'deterioration' or bottle to bottle 'variability' after packaging; or wines that might have been the subject of a 'customer complaint' with TCA and 'other' types of taints. Sensory evaluation is an important analytical and research tool, and is also commonly used in problem solving investigations classified under other categories, such as 'Microbiological investigations', 'Taint problems' and 'Other'.

The number of 'taint' investigations conducted has steadily decreased since the 2005/2006 financial year, when there was a 'spike' in the number due to investigations into 'plastic/chemical-like' taints, the majority of which were due to the use of a particular batch of tartaric acid that was tainted with 2,6-dichlorophenol. The number (28) of taints investigated in the past 12 months was slightly higher than the previous year (23), and is still below the average figure (45). Note that the number (23) of investigations in the previous 12 months was the lowest number of taints ever recorded in a 12 month period (Figure 23). Note that there were three investigations in the past 12 months where winemaking additives or aids were investigated for suspected taint. These data might indicate that, at least in part, the strategies for avoiding taints and contaminations advocated in the 'The avoidance of taints and chemical instabilities during winemaking' workshop, which we delivered as part of the AWRI's Roadshows from 2006 to 2009, are still continuing to being adopted by the Australian wine sector.

Sources of some of the taints observed during the year were varied and included TCA and TBA from cork closures and additives, naphthalene and hydrocarbon taints from transport environments, chemical like taints from winery hoses and microbiological related taints such as mousiness and indole. It is encouraging that the number of post-bottling cork-type taint investigations are low for the second year in a row, suggesting that the incidence of this type of problem might be decreasing, which could be related to the number of wines bottled under screw-cap closures, however it is slightly concerning that the presence of TCA type contaminations are still occurring from mechanisms unrelated to cork.

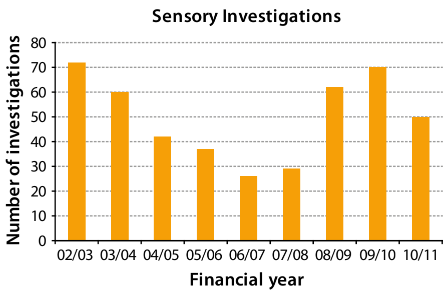


Figure 22. The number of investigations conducted into wines affected by unknown sensory problem during the period 2002/2003 to 2010/2011.

An interesting taint related investigation that was carried out during the year was a wine bottled under screw-cap closure that contained variable TCA contamination, a scenario that had not been investigated before. The winemaker contacted us indicating that he had a made a white wine, bottled under screw-cap, and now stored in two different locations showing signs of variable mustiness. The winemaker indicated that the wine stored off-site was showing a high incidence of variable taint, described as being musty, however the samples that were stored elsewhere were not, or at least they had not identified any with mustiness at that point. Early in the investigation, it was established that the taint was TCA through sensory and GCMS analysis for chloroanisoles, then by analysing a number of the wines we identified that the taint was variable, and ranged from not detected, to obvious concentrations of 10 ng/L. We also showed that the variable TCA was not limited to the one storage area, but in fact it was throughout both storage areas, suggesting that the storage environment (which can often be a source of such contaminations) was unlikely to be responsible for the taint.

Simon Tam – Independent Wine Centre (China)

Interestingly the wine had been transported to the bottling site in two plastic *pallecon* containers and then bottled directly from these containers without mixing, one directly after the other, however it could not be confirmed that this was the source of the contamination. It was not possible from a bottling traceability point of view to determine where this change over between *pallecon* containers occurred, and subsequently did not allow targeting specific bottles for TCA analysis to occur. Further sample testing was conducted on pre-transport holdback samples, bottling retention samples and rinse water from the bottling site. No detectable TCA was observed in any of these samples. The nature and type of taint was able to be identified (TCA), however unfortunately, the source of the taint and ultimate responsibility was not able to be identified due to limited quality assurance around bottling traceability. This investigation highlighted the importance of bottling records, taking holdback samples and ultimately traceability. This is an area which is highlighted and discussed during the current workshop titled 'A guide to trouble free bottling for winemakers', currently being delivered to wine regions around Australia.

Investigations into sparkling wines and carbonated beverages (nine investigations) was again solid although sightly down on the number (12) for the previous year, however again the types of problems investigated were varied and included hard to remove corks, gushing, hazes and deposits, riddling problems, taints, re-fermentation, loss of carbon dioxide, variable levels of carbon dioxide and variable sugar levels. Sparkling and carbonated beverage products have increased in popularity in recent times, and therefore more wineries are producing such products. It is possible that we will start to see more problems associated with these types of products in coming years, and the wide range of problems investigated and experience gained over previous years will become invaluable for addressing such issues.

Interestingly, there was also a number of leakage cases investigated this year. Most cases involved bottled products, which had either been over-filled or exposed to high temperatures during storage or transport. One investigation involved a wine that was leaking due to poor quality cork, and another investigation involved wine that had leaked from a container during bulk transport. Reasons for leakage, as mentioned above, plus others, are well addressed in a number of presentations delivered as part of the workshop titled 'A guide to trouble free bottling for winemakers'.

The Winemaking and Extension Services (WES) team is in a unique position in that we are able to investigate unusual problems that the average winery or winemaker may not encounter in a lifetime of winemaking. This year the WES team conducted a taint investigation whereby wine became tainted via a mechanism not previously observed at the AWRI.

The investigation was conducted into a large batch of tiraged sparkling wine closed with crown seals suspected of being tainted. The wine had been on tirage for about 14 months and the winemaker indicated the wine exhibited a musty-like taint that had not been observed during an earlier tasting of the tiraged wine. Sensory analysis conducted at the AWRI confirmed the 'musty' nature of the taint and analysis of two bottles of the wine by gas chromatography–mass spectrometry (GC-MS) revealed they each contained 9 ng/L of tetrachloroanisole (TeCA), and traces of pentachloroanisole (PCA). Whilst the threshold of TeCA has been reported to be 14 ng/L in table wines (Duerr 1985), a tasting conducted at the AWRI of an un-tainted 'control' sparkling wine spiked with TeCA confirmed the taint was obvious when spiked with 7 ng/L and very strong when spiked at 14 ng/L.

The presence of TeCA suggested the possible involvement of the wood preservative pentachlorophenol (PCP), which usually contains some tetrachlorophenol (TeCP) and traces of trichlorophenol (TCP). Mould growth on wood treated with PCP can lead to the production of pentachloroanisle (PCA), tetrachloroanisole (TeCA) and trichloroanisole (TCA). It was therefore hypothesised that the taint in the sparkling wine had arisen as the result of aerial contamination followed by migration of tetrachloroanisole through the crown seals during storage. That is, it was suspected that the wooden storage bins in which the wine was stored had been treated with pentachlorophenol (PCP) in the past and that mould growth had resulted in the production of TeCA. The TeCA could have then volatilised, perhaps along with PCP and TeCP, to form a tainted storage environment. Exposure of the crown seals to the tainted environment over a period of several months could have allowed for migration of the taint compounds through the crown seals into the wine.

The results of extensive testing, including analysis of air samples (discussed elsewhere in this report) and wood shavings from different storage environments, unused crown seals and those from tainted bottles, as well as other materials, showed that aerial contamination followed by migration of TeCA into the wine as indeed the mode of tainting. This is the first time musty taint has been shown to occur via this mechanism in the wine industry.

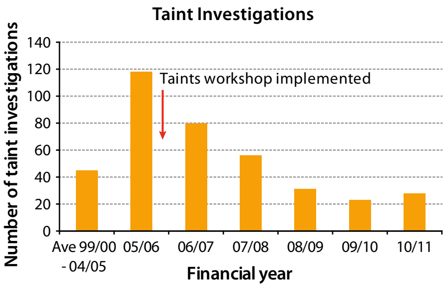


Figure 23. The number of investigations conducted into wines affected by taints during the period 2005/2006 to 2010/2011 and the average number of these types of investigations for the period 1999/2000 to 2004/2005.

Another interesting investigation involved two red wine products that were exported to China, which upon arrival and inspection contained large deposits. The winemaker indicated that the wines spent considerable time on the 'cold port' in China and requested an investigation into why they had thrown such large deposits. Interestingly, the client in China believed the problem "may actually be bacterial". In summary, the investigation compared the wines that had been transported overseas to the same domestic stock that had been stored in a controlled environment here in Australia through sensory, chemical and microbiological analyses. Both wines contained deposits, consisting of mostly amorphous material (suspected to consist of protein, pigments and phenolic material) as well as bacteria, and some yeast in the exported sample only. Microbiological analysis indicated that both samples did not contain any viable microrogansims. As expected, the exported wine contained significantly more deposit than the domestic stock, and a large proportion of this deposit was fine needle like crystals which were identified as being potassium bitartrate or KHT crystals. Data provided by the winery showed that the exported wine was exposed to temperatures of minus 3 degrees celcius for more than a day and half, which is considered outside typical conditions that a red wine would be expected to be exposed to and would explain why this sample contained KHT crystals. The wines that had been stored in Australia did not contain any crystalline material, and were also tested as being cold stable, and it was therefore concluded that the extreme low temperatures that the exported wines had been exposed to is most certainly responsible for the large amount of deposit observed in them. A report for insurance purposes was prepared for this investigation.

WES staff continued to address the issue of smoke-derived taint during the year, in collaboration with the AWRI's Research team and the University of Adelaide. As indicated in last year's Annual Report, a research program was initiated to help us understand the relationship between free guaiacol and other smoke-related volatile organic compounds in grapes and wine. The contribution and significance of non-volatile smoke-related organic compounds to smoke-derived taint was also investigated during the year and the results of this research are discussed elsewhere in this report.

A comprehensive workshop covering all the important issues associated with smoke-derived taint in grapes and wine was coordinated by the WES team during the year for presentation at the 14th Australian Wine Industry Technical Conference. The program included presentations from researchers from the University of Adelaide and the department of Agriculture and Food Western Australia, as well as the AWRI. A number of tastings were also included in the workshop and include line-ups of 'real' smoke-affected wines, smoke-affected research wines and wines 'spiked' with key smoke-taint compounds recently investigated by the AWRI, which are discussed elsewhere in this report. A representative of the Western Australian Department of Environment and Conservation has also prepared a presentation and outlined how the issue of prescribed burning is being tackled by the department and how they are working towards solutions with the wine industry. WES staff also presented a number of seminars on the subject of smoke taint during the year.

Duerr, P. (1985) Wine quality evaluation. Proceedings of the international symposium on cool climate viticulture and enology. 25-28 June, 1985, Eugene, OR & Corvallis, OR: Oregon State University; 257–266.

Transfer of knowledge relating to winemaking

Staff

Con Simos, Geoff Cowey, Adrian Coulter, Matt Holdstock, Emma Kennedy, Virginia Phillips, Francesca Blefari, Ella Robinson and Sarah Ballantine (until 31 July 2010).

The technical problem solving services are supported by communication, educational and extension activities also offered by the Winemaking and Extension Service team. Queries, advice and assistance are offered by a small group of qualified winemakers through the problem solving service. The team then has the unique ability to monitor each month the type and nature of queries and investigations conducted against industry trends observed over the last 20 years. This allows the team to observe, to react to and communicate any current sector issues to Australia's grapegrowers and winemakers, to enact any required emergency response, conduct small scale applied winemaking trials or communicate internally any additional research that may be needed to be conducted by the AWRI research team. Any required industry educational needs are then produced and made available through development of workshops or seminars to aid in prevention of future events or make available information for future occurrences.

The team communicates with industry through the AWRI's *Technical Review*, *eBulletins*, *eNews*, *The_AWRI* twitter account, Facebook and wine industry magazines and journals and through educational services such as: the national roadshow seminar and workshop program; AWITC workshop program; the Advanced Wine Assessment Course; Research to Practice®; web-based resources; and tailored workshops or seminars on request by sector associations. The team also provides presentations for external seminars and conferences; produce educational material and resources for winemaking in the *Winemaking Resources* section of the AWRI website and also provides 12 hours of lectures to Oenology students at the University of Adelaide (see the Appendices for further details).

In what turned out to be the wettest season on record for many grapegrowers, the 2011 growing season saw increased fungal disease pressures in the vineyard which flowed onto significant challenges for winemakers in the winery at all stages of production. Almost one in every five requests for assistance from AWRI's winemakers was related in some way to the presence of Botrytis and laccase. This was observed as spikes during March till May during monthly monitoring of queries received by the Technical Problem Solving team on our Queries database Figure 24. Technical requests ranged from estimating botrytis-infected fruit in the vineyard, processing botrytis-infected fruit, measurement of botrytis and laccase in juice and wine, interpretation of laccase results using a number of commercial available test kits, and options for treatment of affected wines.

The team responded to these issues through AWRI email bulletins (*eBulletin*). Following on from viticulture alerts for Powdery Mildew released during November and December 2010, the Winemaking team released three *eBulletins*: the first in December detailed a pre-vintage warning about fungal diseases and appropriate winemaking strategies to implement for the impending difficult vintage. This was followed by another produced in conjunction with the GWRDC detailing information and Fact Sheets for Powdery Mildew, Botrytis and Non Botrytis moulds. In April, an *eBulletin* was distributed specifically regarding Botrytis and due to industry difficulties experienced with the interpretation of laccase results. Appropriate treatment options including pasteurisation were also detailed, as well as information obtained through Viticulture, Winemaking and Commercial Service trials conducted over the course of the vintage exploring better predictive assays for botrytis infection, appropriate pasteurisation treatments for juice and wine and the impact on wine quality. Issues with wine clarification and filtration due to Botrytis-derived glucans as well as high malic acid and titratable acidity levels in wines from this harvest were observed this year. Information regarding appropriate treatments for glucans, as well as deacidification procedures for such wines has also been prepared for publication to industry throughout July and August 2011.

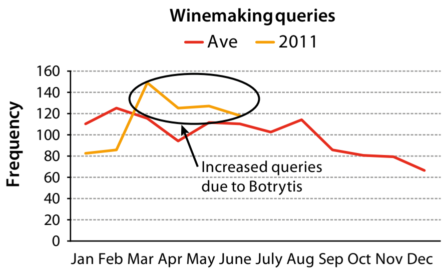


Figure 24. Increased frequency of Technical Problem Solving queries during March till May 2011, compared to the 2005-2010 monthly average, due to Botrytis related enquiries.

Presentations were specifically developed and delivered in key areas including the Yarra Valley, Rutherglen and the Goulburn Valley and the cooler Central regions of New South Wales, Canberra, Orange and Mudgee. The seminars were developed to address the issues faced by industry and to detail practical information on management strategies relating to botrytis and other diseases in the vineyard and winery.

The team also offers information through AWRI's *eNews* with the Winemaking team using this vehicle to communicate these Botrytis related issues to industry. Two articles detailed updates regarding Botrytis and laccase: *2011 Pre-vintage warning about fungal diseases – winemaking strategies* and *Challenges with Botrytis, laccase and glucans – thanks to a wet harvest*.

Eight other *eNews* articles were also produced this year in response to trends observed throughout the year. *What's in your water* highlighted a variety of taints and contaminations that have been observed in water used in wineries this year; *Removing salt from wine without the hypertension* highlighted a new AWRI publication discussing non-commercial independent assessment of Electrodialysis (ED) as a means of removing excess salt from wine; *It's filtration time – prevent those uninvited guests* was released at a time when most wineries were bottling wine, and highlighted an article discussing variable *Brettanomyces* sp. yeast growth, that can occur post-bottling with ineffective filtration. Additionally, the AWAC and Extension roadshows were communicated to the wine sector through this medium.

The National Roadshow seminar and workshop program are currently made on a rotating basis to locations covering Australia's winemaking zones and regions. The seminar program attends Griffith once per year and all remaining locations once every two years. The workshop program is presented to all locations over a three year period. The Roadshow schedule is available on the AWRI website as well as advertised through the national wine press, various publications and through the local wine association websites.

During the year, 15 days of roadshow seminars and workshops were held throughout Australian winemaking zones and regions including: Adelaide Hills (Langhorne Creek), Gippsland, Hunter Valley, Margaret River, Mount Barker (WA), Mornington Peninsula, Pemberton, Swan Valley and Yarra Valley. Gippsland was visited for the first time this year. Since roadshow attendance records officially began in 2002, over 3,500 grapegrowers, winemakers and industry members have attended an AWRI roadshow.

Roadshows seminars are organised in conjunction with winemakers' and growers' regional associations. These associations select the presentations to be made from a range of AWRI research topics covered by the AWRI, in order that the seminars are closely tailored to the interests and needs of the audience. Botrytis proved to be a popular topic this year. Seminars are presented by appropriate AWRI staff members based on the selected topics from all of AWRI's research steams.

Roadshow workshops are presented by our winemakers, and are tailored to deliver practical winemaking advice to the wine sector to address current industry concerns, technical issues or challenges. The workshops are interactive in nature and involve tastings, diagnostic tests and practical exercises. The current workshop *A guide to troublefree packaging for winemakers* which has been delivered 11 times, provides practical information regarding preparing wine for bottling, controlling microbiological activity, both through filtration and chemical measures, packaging operation, closure and package choice and wine storage and transport. The workshop was developed on industry request due to a gap in knowledge or available information resources regarding best practice packaging.

The positive impact of these workshops can be observed through our database of the type and nature of queries and investigations conducted by the team over the last 20 years. The first AWRI workshop program *Trouble free winemaking - avoidance and management of common wine instabilities*, was initiated more than 10 years ago and was prepared to address the majority of calls that the Technical Problem Solving group received which were regarding common winemaking instabilities such as heat and cold unstable wines and microbiological deposits. After the initial development phase, the workshop was then presented to Australian key winemaking regions. A notable decrease in these types of issues was observed in industry at the conclusion of the series in the 2005/2006 financial year (Figure 25).

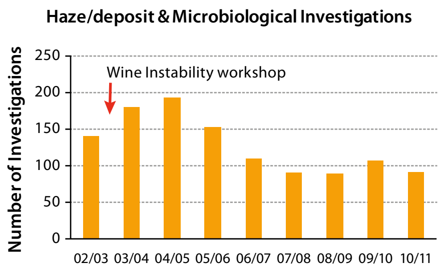


Figure 25. Declining number of haze, deposit and microbiological investigations conducted by AWRI Winemaking & Extension Services after implementation of The avoidance of taints and chemical instabilities during winemaking workshop.

Additionally, in conjunction with our *Brettanomyces* research program ran by this team at the time, a workshop called *Brettanomyces - latest research and control strategies* was developed to address these industry concerns and communicate winemaking strategies that would allow winemakers to manage *Brettanomyces* in wineries. A clear impact of this workshop and additional seminar events was noted through an annual survey of wines conducted as a part of this project. A decrease in mean 4-ethylphenol concentrations in Australian wines was observed, as well as a corresponding increase in wines with 'not detectable' levels of 4-ethylphenol (Figure 26).

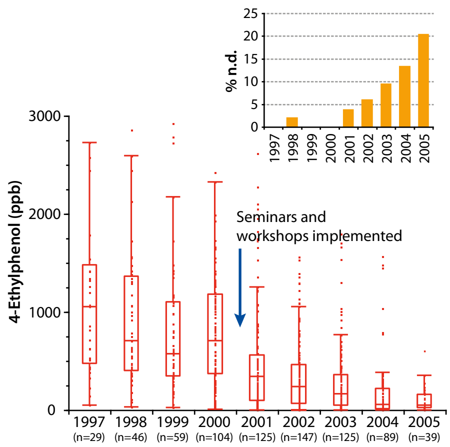


Figure 26. Declining 4-Ethylphenol concentration in Australian wines from five regions. Insert with corresponding increase in wines measured with 'not detectable' concentrations of 4-ethylphenol.

The workshop *The avoidance of taints and chemical instabilities during winemaking*, was developed to address new key taints that had a great impact on several producers in the wine industry throughout 2005 and 2006. The workshop had a particular reference to preventing taints that originate from wine additives and processing aids. A declining number of taint investigations conducted by AWRI Winemaking & Extension Services was observed (Figure 27) after implementation of *The avoidance of taints and chemical instabilities during winemaking* workshop, to levels even lower than that observed before the 2005 and 2006 taint incidents.

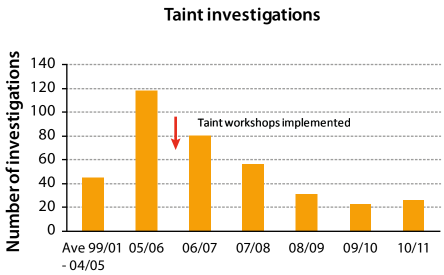


Figure 27. Declining number of taint investigations conducted by AWRI Winemaking & Extension Services after implementation of The avoidance of taints and chemical instabilities during winemaking workshop.

In addition to roadshow workshops, staff members presented a number of external seminars, tastings, or presentations at the specific request of industry bodies, this year including Yarra Valley, Rutherglen and Goulburn Valley (organised by the Victorian Wine Industry Association) and Canberra, Orange and Mudgee (the Central regions of New South Wales wine associations), The Institute of Masters of Wine, The Wine & Spirit Education Trust, Fosters Wines, Premium Wine Brands and the SA Minister of Agriculture (Appendix 1).

Sensory assessment was a key focus this year with external seminars predominantly based around this topic, including: *Simulated tainted/faulty wine tasting* (two occasions); *Wine Sensory Evaluation. Wine aromas, flavours, faults and taints and Australian Wine Show Judging;* and a two hour workshop and tasting entitled *The avoidance of taints and contaminations during winemaking.*

Additional workshops can be requested by industry through AWRI's Research to Practice model. Two Research to Practice winemaking modules have been developed this year: *Sustainable Winemaking* and *Winery Wastewater Management and Recycling;* in collaboration with AWRI's Commercial Service and Peter R Day Consulting. These will be rolled out to industry over the next year.

The team also offers information in publications throughout the year (Appendix 5). The article entitled *Post-bottling 'Brett' spoilage* was published in the August issue of *Technical Review* (#187).

The delivery of the Advanced Wine Assessment Course (AWAC) continues to be an important career development opportunity for those who wish to strengthen their knowledge in wine show judging and improve their sensory skills. Around 900 participants have completed the program and this year we completed two AWAC events, both held at Penfold's Magill Estate and also celebrated the 30th AWAC in June 2011. Since the first course in 1992, and in response to feedback from previous participants, the course has been subject to a process of continuous improvement and refinement. The current program is offered in a four day format with more than 40 hours of content. As part of the intensive program; participants have the opportunity to evaluate a diverse range of more than 300 wines under simulated wine show conditions. Lectures are also presented by AWRI staff and also with the participation of leading wine show judges, journalists and winemakers.

Feedback from AWAC graduates suggests that it is very difficult to obtain judging positions at Australia's premier wine show events. In order to fast track opportunities, and to facilitate the development of talented professionals, the top performing participant from each course now has the opportunity to participate as an associate judge at a national wine show level. This is now the fourth and fifth course where we have announced a Dux of the course: Peter Kelly, Winemaker from Peter Lehmann Wines for AWAC29 and Han Tao Lau from Long Gully Estate for AWAC30.

Each AWAC event includes a wine flavour and a wine taint and fault tasting clinic at the beginning of the course. The aims of the tastings are to refresh participants' ability to identify typical wine flavours and taints and faults that can sometimes occur in wine, and to also highlight new taints that have only been observed in wines over the last few years. For the last eight courses we have monitored participants' sensitivity or anosmia to some of these newer compounds in order to gain a better understanding of their behavior in wine, which is presented in Table 4.

L to R: Sarah Ballantine, Emma Kennedy, Con Simos, Francesca Blefari, Virginia Phillips

The_AWRI twitter account, initially developed to communicate awareness of The Advanced Wine Assessment Course, in line with Wine Australia's Landmark tutorials and A+ wine campaigns used to promote Australian wine to the domestic and international market, has proved quite successful increasing its membership from 200 to over 600 followers over the last year. The capability of twitter as an effective communication medium has been rolled out this year to highlight the activities of other AWRI events within the organisation.

The AWRI and the *Institute of Masters of Wine* (IMW) continued the second year of the three year cooperation agreement. As part of the arrangement, the AWRI hosts the Institute of Masters of Wine each year for the Australasian education program and additionally contributes to the selected delivery of each organisation's education programs. As a part of this collaboration, two presentations were delivered to both the Australasian and European residential seminars: *The impact of closure choice on wine development-sulfide development and shelf life*; and *Controlling the highs and lows of alcohol*. A *wine faults and flavours tasting clinic* was also held during the European event.

The Winemaking and extension services team facilitated four workshops at the 14th Australian Wine Industry Technical Conference, including: *Test your limits! Determine your own threshold for important wine flavour compounds* (W01, W53); *Understanding and managing smoke taint* (W02); and *A guide to troublefree packaging for winemakers* (W51). The Winemaking team also gave presentations in the three other workshops: *Wine colloids and protein stability* (W35); *Stinky sulfurs and other stories – Origin and control of reductive off-flavours in wine* (W40); and *Salty Vines and Wines* (W50).

Table 4. Percentage of AWAC participant sensitivity or anosmia to some important wine taints and faults.

			Number of participants who did not observe wine taint/fault			
AWAC Number	**Number participants**		**2,6 dichlorophenol**	**6 chloro-o-cresol**	**Indole**	**Mousy**
		Threshold	**32 ng/L**	**70 ng/L**	**23 µg/L**	**–[1]**
		Sensory descriptor	**Plastic, paint-like, medicinal,**	**Chemical, plastic, chlorine, hot burning aftertaste**	**Chemical, plastic, jasmine**	**Caged mice, cracker biscuit**
21	30		4	6	2	4
22	30		5	10	1	10
25	29		10	13	3	11
26	29		5	7	1	8
27	30		8	7	1	12
28	30		6	14	1	8
29	30		3	11	4	1
30	30		7	9	3	6
Total	**238**		**48**	**77**	**16**	**60**
Average per cent 'anosmia'			**20**	**32**	**7**	**25**

[1] It is not possible to quantitate the concentration of 'Mousy' at this point in time due to no satisfactory analysis method available

The Industry Development and Support group is also responsible for the organisation and delivery of the workshop program for the 14th Australian Wine Industry Technical Conference. A program of 52 workshops (see Table 5 for breakdown of the themes) was staged, and the total number of places available in workshops was 2,212.

Table 5. Workshop themes at the 14th Australian Wine Industry Technical Conference.

Theme	Number of workshops
Analytical & Quality Assurance	3
Engineering	2
Environmental	3
Legal & Regulatory	2
Sensory & Consumer	2
Technology & Innovation	2
Viticulture	20
Winemaking	18
Total	**52**

Of the 12 workshops that sold out, nine were presented by AWRI staff. The most popular workshops also included a high percentage of tasting and sensory evaluation. Thirty-two of the 52 workshops (61.5%) also included a tasting component—over the whole period 17,315 glasses of wine or tasting samples were served. Despite the added 'complication' of organising tastings, workshop participants perceive tastings as increasing interaction and enhancing the overall educational experience.

Feedback from the 13th AWITC indicated that participants wanted to see more viticulture content and a concerted effort was made to proportionally increase the number of topics relating to viticulture. A number of new areas were included to provide a program with diversity and wide ranging appeal, including: W06 *Organic Viticulture*, W25 *Collaborative innovation*, and W44 *Genetically modified vines and yeast and their potential applications in the wine industry*.

» *"excellent range of topics, wish I could have attended more of them"* [1]

» *"too many great subjects not enough time"* [1]

As with previous AWITCs, the AWRI makes a significant resource commitment to the overall program leading 23 of the 52 workshops. Other organisations which also made significant contributions include CSIRO and The New Zealand Institute for Plant and Food Research Ltd, each organising four workshops. The University of Melbourne delivered three workshops with various grape and wine industry suppliers organising 10 workshops.

It is not the role of workshop coordinators to manage content or regulate the development of workshops; we provide advice, a forum and resources to ensure the efficient delivery of each workshop.

A very large amount of positive feedback has been received regarding the content and delivery of the workshop program.

L to R: Lindsay Smith, Sue Milnes, Kate Beames, Shiralee Dodd, Leanne Curtin

» *"audience involvement, the best workshops were those that encouraged participation, rather than being a series of lectures/ presentations"* [1]

Three venues were used: the Adelaide Convention Centre, the WIC sensory labs and the UNISA West Terrace Campus. The consolidation of venues simplified the logistics and organisation (Six different venues were used at the 13th AWITC).

1 Quotations from 14th AWITC attendee post-conference survey

Special thanks must go to Sarah Ballantine, Virginia Phillips, Francesca Blefari, Emma Kennedy and the very large team of volunteers who made the efficient delivery of the workshop program possible. The delivery of such a large event requires significant resourcing by many people over a period of 18 months. Special mention must also be made to the workshop convenors and presenters who also generously volunteered their time to produce and deliver presentations.

WIC Winemaking Services

Staff

Gemma West, Con Simos

WIC Winemaking Services completed its first successful year of operations in December 2010. In 2010, winemaking trials were focused on viticultural and oenological treatments for research, predominately through WIC partners.

The Winemaker presented a seminar in November, entitled *Trial design for optimum winemaking results*, which was delivered to research and academic staff at Waite campus. The Winemaker then worked closely with clients to design trials to ensure effective fruit selection and volumes for vintage 2011, resulting in good quality fruit being delivered for research.

WIC Winemaking Services also provides industry with the opportunity to trial new varietals, and in 2011, there was an increase in the number of small- and pilot-scale commercial wines made from alternative varieties.

In addition to provision of small- and pilot-scale winemaking, vintage 2011 saw the development of a new capability in 5 kg micro-scale fermentations, with both red and white wines delivered. This capability will be expanded in 2012.

Transfer of knowledge relating to viticulture

Staff

Dr Sally Bell (until 28 February 2011), Dr Peter Dry, Marcel Essling

During the year, the viticulture team responded to 335 viticulture-related enquiries. The majority (245) were 'agrochemical-related'. The remaining 90 calls related to various general viticulture enquiries. On average, the Viticulturist and Viticulture Consultant fielded 82% and 18% of the enquiries respectively.

Other issues of note that were dealt with include strategies for managing disease pressure in a very wet year. The viticulture team participated in the AWRI Roadshows throughout the year (Appendix 1).

The Senior Viticulturist facilitated the 'Salty vines and wines' workshop (W50) for the 14th AWITC and gave a presentation entitled *Salt in grapes and wine*. The Senior Viticulturist contributed comments on the wine quality aspect of salt in grapes and wine for the updated version of the PIRSA SA Factsheet on salt in vineyards.

The Viticulturist issued ten e-bulletins or agrochemical updates, predominantly focused on providing information to the grape sector related to disease mitigation. The challenging weather and chemical shortfalls was a catalyst for action. Fact sheets were compiled through collaboration with other researchers, consultants, extension providers and funding bodies. Chemical companies were consulted to identify products that could be used in viticulture and emergency use permits were sought and two granted through the Australian Pesticides and Veterinary Medicines Authority. Stakeholders were engaged and informed to evaluate the potential use of phosphorous acid. The Hunter Valley (NSW) and Riverland (SA) regions were visited by the Group Manager – Industry Development and Support and the Viticulturist to provide winemaking and viticulture support and better understand the issues being faced around disease pressure. Strategies for botrytis control in the vineyard and laccase in the winery were delivered in presentations held in Mudgee, Orange and Canberra.

The Viticulturist engaged with national and state bodies in the lead up to the season when the control of novel insect pests including species of locust and fruit fly was forecast. Agreement between grape and wine producers about appropriate control measures was forged. An Australian Plague Locust control strategy was formulated and disseminated. A method for Queensland Fruit Fly baiting that satisfies export requirements was determined and approved by stakeholders.

To identify the disease susceptibility of less common varieties, the Viticulturist recorded disease levels at the Nuriootpa Research Centre. A preliminary investigation into leaf area, crop load and the impact on carbohydrate accumulation was investigated in the Waite vineyard by the Viticulturist and Viticulture Consultant. A presentation was prepared and delivered on the topic of *Growing grapes for corporate wineries* at the VitiLink Agronomy Forum and a presentation on changes to chemical registrations was delivered at the GWRDC Disease and Pest Debrief sessions held in Adelaide, Melbourne, Mildura, Renmark and Griffith.

The Viticulture Consultant designed and prepared content for Research to Practice training on Alternative varieties; delivered fourteen hours of guest lectures and practicals to University of Adelaide viticulture students; supervised three PhD candidates at University of Adelaide; and co-organised and presented a workshop on 'Emerging varieties from the Mediterranean' at the 14th Australian Wine Industry Technical Conference. The Viticulture Consultant was an invited speaker at the Australian Society of Viticulture and Oenology Australian Alternative Varieties Wine Show joint seminar on 'Alternative Varieties', Mildura, 5-6 Nov. and keynote speaker at the New Zealand Syrah workshop, Chateau Tongariro, Mt Ruapehu, 10-12 Feb. 2011. The Viticulture Consultant co-authored three papers in the *Australian Journal of Grape and Wine Research* and a chapter on 'Controlling the highs and lows of alcohol in wine' in 'Wine: Types, Production and Health' (Nova Publishers), two articles in technical/trade journals and also organised new AWRI columns in trade journals: Alternative Variety column in *Wine and Viticulture Journal* (bi-monthly) and 'Ask the AWRI' in the *Australian New Zealand Grapegrower and Winemaker* (monthly).

Seminars and workshops attended by the AWRI viticulture team during the year are shown in Table 6.

Table 6. Seminars/workshops attended by Viticulture team members during 2010/2011.

Seminar/workshop	Date	Senior Viticulturist	Viticulturist	Viticulture Consultant
Organic Viticuture - 14th AWITC	03/07/2010		*	
Vineyard management for a changing climate – 14th AWITC	05/07/2010	*		
How to determine vine response to irrigation and the environment – 14th AWITC	08/07/2010		*	
Future Challenges – Grower strategies for success – Barossa Conference	12/07/2010		*	
Alternative Varieties – ASVO 5th Australian Wine Industry Environment Conference	05/11/2010		*	*
Disease and Pest debrief workshop - GWRDC	15/06/2011			*

Communication & Information Services

Staff

Con Simos, Rae Blair, Linda Bevin, Sean Boden, Anne Lord, Ingrid Barratt (until 9 March 2011), and Susannah Black (until 31 July 2010).

The Communication and Information Services team (CIS) is a service unit within the AWRI and forms part of the Industry Development and Support group, led by Con Simos. The CIS team is responsible for the strategic sourcing of relevant technical information and, in collaboration with our stakeholders, for its effective delivery to Australian grape and wine producers of all sizes. All of our activities are benchmarked against our team's vision and mission[2], the AWRI's Business Plan[3] and the AWRI's 7 year Research, Development and Extension Plan[4]. The operations of the CIS team also complement and support the knowledge management and communication activities of all of the AWRI staff.

Highlights and activity

Our specific activities include the following:

» Corporate communication and brand management (facilitating effective communication between the AWRI and its stakeholders);

» Information and knowledge management;

» Maintaining the collection held within the John Fornachon Memorial Library;

» Management of the AWRI website, and web-accessible information databases;

» Production of corporate publications, including *Technical Review* and the Annual Report;

» Provision of an editorial service for the staff of the AWRI; and

» Managing requests from media.

2 See www.awri.com.au/information_services/
3 See www.awri.com.au/about_us/business_plan/
4 See www.awri.com.au/about_us/seven-year-rdec-plan/

Progress reports on our GWRDC-funded activities are shown below. However, some of the highlights for the 2010/2011 financial year include:

» The CIS Team showcased our library and information products and services at WineTech 2010.

» Since going 'live' with WiSE (the AWRI's Intranet and collaboration system) in 2009/2010, we have developed electronic workflows to automate a number of business processes. These include leave request and approval, development and approval of corporate documents such as Board reports and factsheets, and development, approval and review of employee Personal Development Plans.

» Twenty-six *eBulletins* were issued, which proved a particularly effective way of distributing crucial information about downy mildew and locusts.

» The AWRI's electronic newsletter *eNews* was distributed six times throughout the year.

» Eighteen new Fact Sheets were uploaded to the AWRI website.

» The AWRI website is undergoing re-development using WordPress, an open-sourced content management system. A benefit of using a content management system is the ease of content update but the key driver for the project is to provide a user-friendly system containing relevant, useful and up-to-date content. It is expected the website will go live in early 2011/2012 financial year.

» Increased usage and improved management of Information Resources: A 43% increase was recorded for information requests from the Australian grape and wine sector in particular, along with overall positive gains in other services provisioned by the John Fornachon Memorial Library.

» A number of new resources were added to the AWRI website this year, including an extensive series of full-colour resources on viticulture topics in PDF format, an electronic registration system for the Advanced Wine Assessment Course and streaming video recordings of presentations from the 14th Australian Wine Industry Technical Conference.

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

Staff

Rae Blair, Linda Bevin, Sean Boden

The AWRI utilises several strategic and effective mechanisms to disseminate knowledge and information to Australian grape and wine producers. Reported above are the physical extension activities – the body contact sport – undertaken by the other members of the Industry Development and Support group. Below are details of the less direct, or personal, extension/communication mechanisms, but nonetheless deliver information to the vast majority of our stakeholders.

Annual report

For the past 56 years, the AWRI has produced a printed annual report such as this one, as its formal report to Australian winemakers and grapegrowers. Since 1999, the annual reports have been made available also for downloading on the AWRI's website. In an endeavour to improve the circulation across Australia of the AWRI's annual activities, we also publish a four-page supplement in the November issue of the *Australian and New Zealand Grapegrower and Winemaker*, and we approach all the major State-based winemaking bodies and offer an annual presentation to their members. This formal activity complements the vast range of presentations and publications undertaken by AWRI staff members throughout the year (Appendix 1).

AWRI website

We recognise that the effectiveness and true value of the AWRI website, as an information resource, comes if the information is relevant, easy to find and current. An increase in our in-house capability to produce new and exciting ways to engage our stakeholders online has seen a number of new initiatives take place over the last year. This has included a further update of the existing viticulture information with full-colour illustrated information in PDF format on topics including pest and disease, irrigation, nutrition and grapevine phenology; the development and implementation of a streamlined Advanced Wine Assessment Course electronic registration and applicant management system; and integration of the video presentations from the 14th Australian Wine Industry Technical Conference into the website and having them accessible to delegates and the Australian grape and wine sector.

The website has seen an overall increase (+12.56%) in usage over the last 12 months (Table 7 and Figure 28). The increase can be attributed to better search engine traffic; increased traffic from referring sites (such as AusTrade, Australian Department of Foreign Affairs and Trade, Wine Australia and Wikipedia); access to videos from the 14th Australian Wine Industry technical Conference; and successful eNews and eBulletin campaigns.

During this year we have also noticed positive increases in general information consumption on the AWRI website (Table 7 and Figure 28). More pages are being accessed per visit (+1%) and visitors are spending more time accessing information on the website during a single session (+9%), with fewer people leaving the website without consuming more than one page of information. These overall increases point to better search engine optimisation (thereby making our site more accessible via common searching tools) and the continued relevance of information resources hosted on the AWRI website.

Table 7. Website statistics 1 July to 30 June.

	2010	2011	% change
Website pageviews comparison	316,358	356,088	+12.56%

Technical Review

The AWRI's *Technical Review* continued to be produced and distributed throughout the year. In the financial year of 2010/2011, more than 20,000 copies of *Technical Review* were distributed to Australian grapegrowers and winemakers who pay the *Grape Research Levy* or *Winegrapes Levy* and subscribers in Australia and overseas. Over 620 articles featured in *Technical* Review were requested and forwarded to readers.

On 28 April 2011, 2,544 people received an invitation to complete a readership survey of *Technical Review*. Based on the survey results, and to accommodate the drastically reduced budget for the production of *Technical Review* for the 2011/2012 financial year, a change in the delivery of the publication will commence from the August 2011 issue. We intend to continue to produce six issues of *Technical Review* next year and will expand the information contained within it. However, a printed copy of *Technical Review* will only be distributed to those levy payers who request it in writing.

Technical Review will continue to be available via the AWRI website for levy payers. However, we have been developing improvements to the electronic version to facilitate more valuable searching; increasing and improving the databases for the new information to be contained within *Technical Review*; and improving electronic acquisition of Current Literature articles.

Editorial services

The Australian Wine Research Institute contributes a regular column and alternative varieties column in the *Wine and Viticulture Journal* and an 'Ask the AWRI' column in the *Australian and New Zealand Grapegrower and Winemaker*. The AWRI also publishes other articles in these journals and also in the Australia's *WBM* amongst other Australian and international industry journals.

Teams across the AWRI continued the development of Fact Sheets relevant to their area of expertise. The Fact Sheets are presented in an easy to understand, single topic, format and are all downloadable from the AWRI website. The Communication Manager is responsible for editing these Fact Sheets prior to distribution and uploading to the AWRI website and 18 Fact Sheets were prepared during 2010/2011 and are listed in Table 8.

Table 8. Fact Sheets prepared and uploaded to the AWRI website during 2010/2011.

Fact Sheet title	Group
Methoxypyrazines	Commercial Services
Using BevScan to determine oxidation in white wine	Industry Applications/ Commercial Services
13 information sheets on the effects of alcohol on human health	Industry Development and Support
Downy mildew	
Locust control	
Wine flavours, mouth-feel, taints and faults tasting	

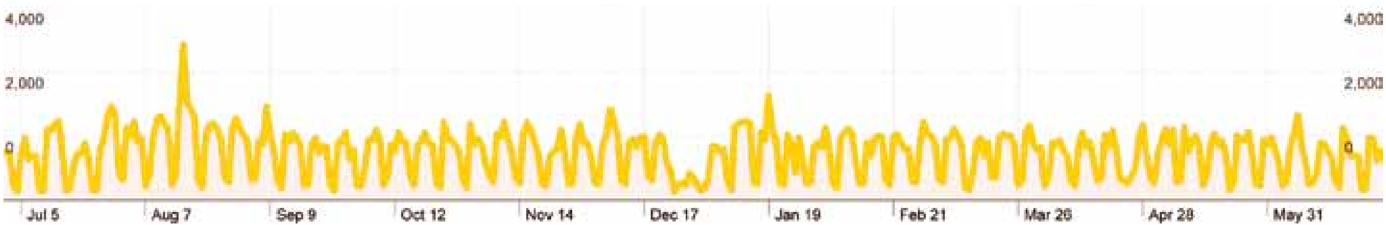


Figure 28. Website pageviews for 1 July 2010 – 30 June 2011.

Provision of scientific, technical and regulatory information

Staff

Linda Bevin, Sean Boden, Anne Lord, Ingrid Barratt (until 9 March 2011), and Susannah Black (until 31 July 2010).

Georg Meissner – Hochschule RheinMain, Geisenheim Research Centre (Germany)

The John Fornachon Memorial Library

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

The AWRI has an ever-growing knowledge base, and technology is providing opportunities for the John Fornachon Memorial Library to evolve beyond the traditional concept of libraries and focus on the expansion of electronic information access and delivery. While printed material still forms a solid core of the Library's offerings, the proliferation of digital content and the highly accessible nature of electronic documents are such that most requests are ultimately fulfilled via digital document delivery via e-mail, regardless of whether the initial query was received in person, over the phone or via the AWRI website.

As part of an ongoing commitment to ensure its service and holdings remain accessible and in line with technological trends, the John Fornachon Memorial Library has been actively working to emphasise electronic document delivery as a fast and cost-effective method of information dissemination to the Australian grape and wine sector. The past 12 months has seen the library continuing to improve the speed and quality of digitised materials in fulfilling requests for critical information to our stakeholders, with the library team experiencing an increase in its information services delivery to the grape and wine sector by 43% (see Table 10). Looking forwards, the team is excited to continue investigating streamlined and innovative ways to increase the availability of information resources and will be implementing more proactive online solutions in the next 12 months that should prove beneficial for its constituents.

Online information databases

Three information databases, available via the AWRI website, can be accessed by all grape and wine producers who pay the *Grape Research Levy* or *Winegrapes Levy*. The databases are a valuable information resource comprising records of books, journal articles, conference proceedings, reports, standards and legislation held in the AWRI collection, and users of the databases can also request items online (Table 9).

There continues to be strong demand for information access via the web, either directly via the online information databases, through the reference lists on common topics (such as botrytis and general taints and faults) or by getting in touch directly with the library over e-mail, telephone or in person. Looking forward, the library staff members have begun to consider more convenient ways to offer information on common topics that are easily accessible and relevant to the needs of the Australian grape and wine sector. It is hoped some of these initiatives will be implemented in the next financial year following maintenance to existing systems to accommodate the changes. Figure 29 provides a summary of database usage during 2010/2011.

Table 9. Description and number of records of online information databases and library catalogues.

Web accessible information databases	
Industry (with searchable abstracts)	65,035
Environment	2,218
AWRI Online Image Collection	2,338
Library catalogues databases	
AWRI_database (library catalogue)	68,499
Journals (journals, theses, statistics and annual reports)	503
New items and maintenance to the information databases	
New monographs	167
Theses	0
Record maintenance	26,428
Reprint Collection to date (see below for details)	30,585
– Reprints	20,971
– AWRI publications	1,288
– Articles indexed via Technical Review.	8,326

John Fornachon Memorial Library catalogue databases

The Library holds over 68,000 records of books, conference proceedings, theses and scientific, technical and medical reprint articles. They are indexed in the Library's database catalogue which is accessible via the John Fornachon Memorial Library in the Wine Innovation Central building and online via the AWRI website. Details of the library's journal holdings including newsletters, statistics and annual reports are held in the *Journals* database. A summary of the library catalogue's holdings and information databases is given in Table 9.

Specialised information services

While the usage of the AWRI's *Industry* online information database is available to all Australian grapegrowers and winemakers who pay the *Grape Research Levy* or *Winegrapes Levy* within the physical library or via the AWRI website, customers are continuing to request the library to perform literature searches across in-house databases and other external resources in order to meet their information requirements.

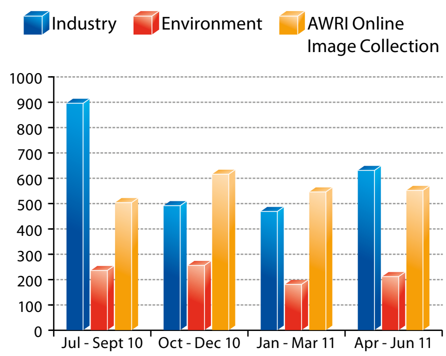


Figure 29. Summary of database usage during 2010/2011.

Document delivery services

'Document delivery' services entails the supply of journal articles, books, DVDs or other library items to customers upon request via post, fax or electronically via e-mail in PDF format where applicable. This also includes sourcing items held by other Australian and overseas libraries if the requested content is not available in-house. The ability to order items online means that the majority of document requests are able to be completed within 48 hours.

Library collection

A total of 167 monographs were added to the collection in the financial year of 2010/2011. The Library continues to subscribe to 72 journals and receives over 70 annual reports, newsletters, journals through exchange and donation. The collection also holds over 30,000 reprints that consist of AWRI staff publications, articles featured in *Technical Review* and articles obtained from other suppliers (Table 9).

Donations to the Library collection

The AWRI wishes to thank all individuals and companies who contribute to the collection through donations or exchange agreements.

Improvement of knowledge management and stakeholder communication The Australian Wine Research Institute

Staff
Rae Blair, Linda Bevin

In its 56 years of operation, the AWRI has generated (and continues to generate) substantial amounts of unique information on the technical aspects of wine production. A key aim of our activities is to ensure our existing knowledge becomes a catalyst to create new knowledge more freely. This can only be achieved if the information and knowledge is managed to become more useful and 'user friendly' not only to Australian grape and wine producers, but also for the staff of the AWRI. We continue to investigate and utilise new technology to fulfill our objectives. Our project activities complement the other activities of the CIS team (as reported above) and the communication aims of all staff members at the AWRI. Our aim is to ensure greater penetration of information to our stakeholders; whilst supporting the positive perception of Brand Australia to the ultimate benefit of the Australian grape and wine sector.

Information and knowledge management

Since going 'live' with WiSE (the AWRI's Intranet and collaboration system) in 2009/2010, we have developed electronic workflows to automate a number of business processes. These include leave request and approval, development and approval of corporate documents such as Board reports and factsheets, and development, approval and review of employee Personal Development Plans.

The AWRI website holds a vast amount of information and smart tools to assist the member of the Australian grape and wine sector. We have selected WordPress, an open-sourced content management system, to redevelop the website. A benefit of using a content management system is the ease of content update but the key driver for the project is provide a user-friendly system containing relevant, useful and up-to-date content. It is expected the website will go live in the early 2011/2012 financial year. The focus of the project over the next twelve to twenty-four months will be delivering 'packaged' information to targeted audience.

The Australian grape and wine sector has embraced the use of social media for communication and marketing with Wine Australia and a large number of producers using Twitter and Facebook to connect with consumers, media and other producers. The AWRI developed a Social Media Strategy utilising Twitter as the primary platform and used the account to promote and communicate with followers leading up to and during AWAC in September 2010. Our Twitter account (www.twitter.com/The_AWRI) hit 600 followers during AWAC 2011. Once again, we were able to share the AWAC experience with our Twitter followers. Some of our AWAC judges and participants are using Twitter and it was encouraging to see conversations between the AWRI, judges, participants and followers.

Due to the success of Twitter, we have expanded the use of the account to communicate other AWRI news and activities. The AWRI also has a Facebook page (www.facebook.com/The.AWRI).

Improved communication with stakeholders

The AWRI continued its focus of connecting with stakeholders throughout the year. Specific evidence of this can be found under the Appendices, which detail the number of Roadshow/workshop presentations and other presentations given, and papers published, by staff at the AWRI. In this project, we collaborate across the entire AWRI staff to facilitate the effective delivery of information to stakeholders via various mechanisms. Electronic delivery of information to stakeholders' desktops has continued to be a priority. We have three email address lists we use to communicate with our stakeholders. Users can automatically subscribe, or unsubscribe from the list at any time, thus ensuring that only those who want the information receive it. With a continued emphasis on agrochemical updates, particularly for the management of locusts and downy mildew, 26 email bulletins were delivered during the year and are shown in Table 11.

The AWRI's electronic newsletter, launched in 2010, continued to be distributed bi-monthly and appears to be well received. This initiative effectively doubles our communication with stakeholders and means information is received by them from the AWRI at least monthly: either in the form of *Technical Review*, *eNews* or through our *eBulletins*. Six *eNews* were distributed throughout the year (Table 12).

Media liaison

The AWRI is often approached for comment on wine technical matters from national and international media. We take this opportunity to ensure accurate information is published about wine made in Australia and to generate further communication opportunities with our stakeholders. Many requests from the media were handled during the year, and specific details can be found in Appendix 4. Media releases prepared and distributed during the year are shown in Table 13.

Table 10. Summary of information requests during 2010/2011.

	Wine industry		Staff		Other[5]		Total		% Change
	2011	2010	2011	2010	2011	2010	2011	2010	2010
Information requests[1]	2257	1575	1372	1485	1197	757	4826	3817	26%
Technical Review requests[2]							161	179	-10%
Technical Review articles forwarded[3]							629	658	-4%
Articles forwarded[4]							2147	1935	11%
Number of AWRI publications forwarded[5]							700	552	27%

1. Includes overall article, book and general requests, copyright advice, literature searches and website account enquiries.
2. Number of requests received for articles published in Technical Review.
3. Number of articles forwarded from Technical Review (usually more than one article is requested).
4. Number of articles forwarded from the library collection, excluding staff publications.
5. Requests from students, Government agencies, private companies and overseas customers for publications authored by AWRI staff.

Table 11. eBulletins issued during 2010/2011.

Date	*eBulletin*	Authored by	Delivered to number of addresses
2/7/10	Visit us at WineTech 2010	Commercial Services team & R.J. Blair	2,618
12/7/10	AWRI raises the profile on closure performance benchmarking	N. Scrimgour	2,608
29/7/10	Agrochemical update: Locust permits	M. Essling	2,601
30/7/10	Wine consumers benefit with new Grigio/Gris wine label	R.J. Blair	2,583
4/8/10	Get to know your closure	N. Scrimgour	2,576
18/8/10	Agrochemical update (expanded): Locust permits	M. Essling	2,571
27/9/10	AWRI eBulletin: Follow the AWRI on Twitter	R.J. Blair	2,562
12/10/10	AWRI Agrochemical Update	M. Essling	2,557
11/11/10	Downy mildew update	M. Essling	2,550
17/11/10	Kelly takes top AWAC honours	R.J. Blair	2,537
19/11/10	Alternative varieties information exclusively through AWRI's Research to Practice	R.J. Blair	2,530
2/12/10	Downy mildew update	M. Essling	2,525
6/12/10	Downy mildew – essential questions and answers	M. Essling/R.J. Blair (links to document prepared by P. Magarey)	2,518
8/12/10	AWRI Agrochemical update Downy Mildew Permits	M. Essling	2,512
9/12/10	Beyond ideas: our year in review.	R.J. Blair	2,511
16/12/10	Commercial Services Investigations pre-vintage bulletin	M. Nutt	2,274
17/12/10	2011 Pre-vintage warning about fungal diseases - winemaking strategies	Winemaking & Extension Service	2,590
28/2/11	Pasteuriser urgently needed – can you help AWRI's research?	E.M.C. Robinson	2,557
7/4/11	Botrytis and laccase winemaking strategies	Winemaking & Extension Service	2,609
19/4/11	Fruit Fly baiting and release of Pest and Disease survey	M. Essling	2,595
20/4/11	Imminent new requirement for wine exported to Canada – labels to require allergen information	C.S. Stockley	2,586
28/4/11	Your opinion helps to improve our information delivery	R.J. Blair	2,580
4/5/11	Using wastewater to create greater business sustainability	R.J. Blair	2,463
17/5/11	Wine quality the winner in research funding boost	R.J. Blair	2,586
7/6/11	2011/2012 agrochemicals book now available	M. Essling	2,581
8/6/11	Winemaking consultancy included in your levy investment	M.G. Holdstock and R.J. Blair	2,822

Table 12. eNews produced and distributed during 2010/2011.

Date	No. of email addresses
1/7/10	2,700
7/7/10	2,641
1/11/10	2,631
19/1/11	2,619
1/3/11	2,582
6/5/11	2,541

Table 13. Media releases prepared and distributed 2010/2011.

Announcement	Date distributed	Author
Launching the PinotG Style Spectrum	29/7/10	R.J. Blair and P.W. Godden
Dux of AWAC announced	17/11/10	R.J. Blair
The AWRI announces three new Board members	8/12/10	R.J. Blair
19 ways to take the heat out of refrigeration costs for wineries	16/2/11	R.J. Blair
Wine quality the winner in research funding boost	17/5/11	R.J. Blair

Commercial Services

Staff:
Vince O'Brien, Leanne Hoxey, Randell Taylor, Melissa Nutt, Alana Williams, Heather Tosen, Slavko Bekavac, Tim Reilly, Bryan Newell, Pamela Stepancich, Daniel Tynan, Warren Roget, Tina Tran, Karl Forsyth, Neil Scrimgeour, Simon Nordestgaard, Robyn Gleeson, Alana Williams and Kerry Pinchbeck

Times are tough for the Australian wine industry so the AWRI Commercial Services are doing what we can to help. Our goal is to provide services that help Australian wineries make the correct decisions and stay competitive in increasingly challenging economic and environmental conditions. A brief overview of some of our initiatives launched this financial year is outlined below.

- Support for cutting costs:
  - Launch of cheap analytical services;
  - Process streamlining support
- Assisting competitive winemaking operations
  - A forum to help wineries improve their operations
  - Benchmarking of supplier technologies
- Reducing environmental impact
  - It is easy being green
  - Reducing your carbon footprint and power bills

Support for cutting costs

Launch of cheap analytical services

The AWRI Commercial Services has been focused on streamlining our analytical workflows. Our goal has been to reduce costs and turn around times, while maintaining our strict quality assurance regimes. We have now implemented substantially cheaper analyses prices particularly for export certification testing (less than half price for some tests). Our revised pricelist available on our website provides the details.

This initiative has been extremely well received by our customers:

"Its heartening to see that AWRI is aware of the hardships faced by Australian Wine Exporters and actually doing something about it."
Joe Ceravolo – Ceravolo Wines

Karl Forsyth

Process streamlining support

Most wineries have the opportunity to improve operations efficiency. Our team of technically qualified experts is actively helping wineries and wine industry suppliers stay competitive. Our customers are benefitting from our process streamlining experience across a range of industry sectors. We use process streamlining tools and techniques based on lean manufacturing philosophies and engineering theory.

We have proven our skills in our own laboratory and we now offer these skills for the benefit of our customers.

"At Enartis Vinquiry we strive to offer the best possible Technical Services, Enological Products, and Service to our customers. In an effort to provide unparalleled service and enhance our customer's experience with us, we engaged AWRI Commercial Services to undertake a strategic review of our Laboratory Operations.

Throughout the process the AWRI was very proficient in their evaluation of our Laboratory and Business Initiatives. They performed an initial evaluation of our business model and interviewed key associates within the company. This evaluation was followed by a visit to our Laboratories in the United States. During their time at Enartis Vinquiry, the AWRI evaluated our business structure and worked with our staff to exchange ideas and share key points around an efficient operating model. Finally the AWRI provided us with detailed reporting and made several follow-up calls to ensure that the changes and improvements made had been successful.

As a result, Enartis Vinquiry has had improved outcomes and efficiencies throughout the Laboratory. We have realized even faster turnaround times for analysis, while maintaining a high level of accurate results and service to our customers.

AWRI Commercial Services was very efficient, honest, and open to a full non-partial evaluation of our company's Laboratory Operations. They were able to work within our guidelines, and respected the values of our company by enhancing and making high quality recommendations. This entire process has helped develop a strong relationship between our two companies. Furthermore, based on the quality of work provided, Enartis Vinquiry has plans for further engagement in future projects and strategic initiatives with the AWRI."

Assisting competitive winemaking operations

Successful implementation of technology in the winemaking process has been an essential part of the Australian wine industry's success. Technology has provided the tools for Australian winemakers not only to craft high quality wines reliably and reproducibly, but also to do it in an economical manner with minimal environmental impact. However, significant opportunities still exist for the Australian wine industry to make the most of advanced manufacturing approaches that are commonplace in highly engineered industry sectors, such as the automotive and mining industries. Australia's ongoing success in the wine sector will depend on our ability to harness technology as part of our value proposition in the market place.

We are doing what we can to facilitate the development and uptake of the next generation of winemaking technology. We have built an accurate understanding of available process improvement opportunities, utilising robust techniques to calculate the true cost and true environmental impact and what is required to enable wineries to harness their benefits.

L to R: Melissa Nutt, Leanne Hoxey, Warren Roget, Karl Forsyth, Vince O'Brien

Forum to help wineries improve their operations

The AWRI Commercial Services have established a Winery Operations Improvement Forum to help wineries benchmark operating practices, gain technical insight to the key performance requirements, learn opportunities to implement improvement strategies and highlight key areas that require research. We have now run three workshops attended by over 15 South Australian wineries covering the following subjects:

» Alternative cold stabilisation techniques; and

» Effective ullage management.

Our effective ullage management workshop highlighted the significant opportunity for wineries to reduce cost in their operations. Benchmarking showed that finished wines often undergo transfer operations a staggering eight times leading to unnecessary costs associated with:

» Wine losses

» Labour requirements

» Cleaning requirements; and

» Potentially also wine quality loss

Inert gas usage also varies dramatically (over tenfold) highlighting the potential of substantial cost savings. The solution lies in building an ullage management technology that enables storage of wine in ullaged tanks. Preliminary findings have identified:

» Dry ice addition to wine ullages only provides very short term protection – typical management regimes of 2-8 kg three times a week is substantially inadequate.

» Over 4 L of oxygen ingress per day occurs through the seals of a typical tank lid.

» Thermal contraction draws in enough oxygen to increase dissolved oxygen values to 0.15 mg/L every refrigeration event.

» 28 L of oxygen gets in every time the lid is opened.

Within the near future we expect to engineer a solution that eliminates the need to pack down tanks altogether.

Benchmarking of supplier technologies

The AWRI Commercial Services is now screening the proficiency of supplier technologies using consortium style trials. These trials quantify the key performance criterion of supplier technologies in a technically robust fashion benchmarked against their competitors. Reliable, accurate and impartial assessments are now affordable to all wineries because costs are shared across a large number of participants.

Our first consortium trial, a red wine closure trial, was bottled November 2010. A list of the Australian wine industry's 10 most popular closure technologies are being evaluated against their impact on wine flavour, aroma and shelf-life of a premium red wine. Trial participants are learning how one of the most important performance criterion of a closure, the oxygen transmission rate (OTR), drives wine style evolution. They will also benefit from an insight into consumer preferences for the variations that result from different closures.

This red wine closure trial is one example of how the Australian wine industry can start to influence suppliers in the development of pull technologies. For example, communicating to a supplier what OTRs are acceptable for any closure to meet their needs.

Environmental impact

It is easy being green

The current political debate in Australia over the implementation of a carbon tax has reignited wineries' concerns regarding environmental performance and in particular managing their greenhouse gas emissions. We are helping wineries keen to develop broader environmental credentials through providing the following:

» Quantifying environmental footprints throughout supply chains.

» Identifying high environmental impact areas.

» Development and implementation of reduction strategies maximising benefit to cost ratios.

» Developing strategies maximise leverage of business environmental initiatives.

Implementing reduction strategies help the wine industry to improve its environmental credentials, but will it help sell more wine? This is of course a critical question. Some recent studies have shown care must be taken with the communication strategy. In our experience the most important factor is to be rigorous in your approach. If you want to promote your environmental credentials, make sure you are genuinely taking action to improve your impact on our precious resources.

Reducing your power bill and your carbon footprint

Refrigeration in Australian wineries accounts for 50-70% of the total electricity consumption. Cooling, critical to the production of quality wines, not only impacts on profitability, it also enlarges the carbon footprint of wine producers. With the focus on reducing environmental harms and improving profitability, we have prepared a handbook which helps wine producers understand and improve winery refrigeration efficiencies.

The handbook summarised 19 improvement opportunities, presented in terms of both low-cost and high-cost solutions. This publication is vital reading for everyone in the industry who relies on cooling and refrigeration and is available to download from the AWRI website.

"The refrigeration manual is one of AWRI best publications as it actually can help producers reduce costs."

Keith Pekin, Industry Sustainability Coordinator
Wine Industry Association of Western Australia

Corporate Services

Staff

Hans Muhlack, Catherine Borneman (maternity leave), Mark Braybrook, Alfons Cuijvers, Chris Day, Anne Hayworth, Adam Holland, Pauline Jorgensen, Linda Halse, Jan O'Donnell, Deborah Thornton-Wakeford, Jeanette Tooley

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

The Group has had to adapt to a contraction in staff numbers through funding pressure which necessitated changing the mix of skills and attributes that could now be accommodated. Accordingly, a number of staff have left the Group. Notwithstanding the contraction in overall staff numbers, the level of service provided by the Group has been maintained. This is in no small part due to the quality and enthusiasm of the new staff that have joined the Group at various stages during the year. Adam Holland is our new IT Coordinator and is now the sole IT specialist. Alfons Cuijvers is our new Payroll/OH&S officer who also provides para-legal support to the General Manager: Business Development. Chris Day is our new Finance Manager who has stepped in to fill the specialist accounting role usually undertaken by Catherine Borneman, whilst she is on maternity leave, but also recruited to provide higher level financial and commercial support pending the retirement next year of the Group Manager: Corporate Services, Hans Muhlack.

The larger than usual level of scientific staff recruitment this year was challenging for HR Manager, Linda Halse, given that the majority were recruited from overseas, necessitating employer sponsored visa nominations as well the greater complexity that international recruiting necessarily involves. The HR manager has developed and managed a series of staff workshops dealing with the evolution of the AWRI's 'culture'. The HR Manager was also an invited speaker at the 'Employer Branding' summit in Auckland, New Zealand and spoke on how the AWRI attracts international talent through their collaborations and networks.

The Operations Manager, Mark Braybrook, continues to manage and attend to the AWRI's infrastructure needs including representing the AWRI on the 'WIC Management Committee'. A major power outage early in 2011 caused serious disruption to a number of AWRI facilities and services which necessitated replacement of the batteries in the AWRI's 100kva UPS system. The Operations Manager successfully negotiated compensation with the University of Adelaide without harm to the otherwise harmonious working relationship with the University in relation to the management of the WIC Central Building infrastructure. The Operations Manager has also taken over the management of the AWRI's telephone systems, which requires regular liaison with both the University given the AWRI's land lines and internet connection are part of the University's infrastructure, and an outside provider for mobile telephone services.

The newly appointed IT Coordinator, Adam Holland has been immediately involved in coordinating, with specialist outside IT support, the completion of the virtualisation of the AWRI's server network and updating the VPN and firewall infrastructure.

The new Payroll/OH&S officer, Alfons Cuijvers, who has formal legal qualifications from Belgium has utilised his prior management experience to quickly orientate himself to the AWRI's payroll, HR and OH&S policies and procedures. He is also now applying his legal expertise to reviewing and drafting new funding and contract research agreements, in supporting the AWRI's Business Development activities.

The new Finance Manager, Chris Day, who had previously worked at the AWRI as a winemaker, settled in very quickly and has taken a proactive part in the continuing enhancement of the AWRI's management financial reports and a prime role in the preparation of the financial reports in this Annual Report.

Financial statements – Directors' report

The Directors present their financial statements for the year ended 30 June 2011.

Review of operations

The long-term objectives of The Australian Wine Research Institute Ltd (AWRI) are embedded in its Constitution and deal with the undertaking of research and other scientific work in connection with the winemaking, viticulture and other allied or ancillary industries. The Objects include the preparation of publications and encouraging the discovery and investigation of inventions, improvements, processes, materials and designs which are capable of use in the winemaking and viticultural industries. This work has been on-going since 1955 and its success is measured by the significance of the AWRI's scientific publications, its research and development outcomes and the extent to which those outcomes have been adopted by industry practitioners, improved the quality and consistency of wine produced in Australia and the extent to which that new knowledge has enabled Australian wine to be successful in new and emerging markets. The research, development, extension and commercial outcomes achieved this year are described in detail in the 'Highlights of the year' and the 'Team reports' sections of the 2011 Annual Report of which this report forms an integral part. A detailed list of this year's publications is also included. The manner in which the objectives are undertaken is encapsulated in the AWRI's mission, vision and values which are shown on the inside front cover.

The AWRI's long-term objectives are articulated in its 10-year business plan which is subject to periodic review. This plan highlights the following objectives as critical in delivering the AWRI's vision:

» Advance the competitive edge of the Australian wine industry through the delivery of **world class research and development** activities;

» Provide **integrated solutions** to proactively manage industry problems;

» Delivery of high **value** information and outcomes to the Australian wine industry; and

» The AWRI being **'top of mind'** in wine innovation knowledge for all stakeholders of the Australian wine industry.

These objectives are underpinned by a broad range of specific strategies and initiatives, implemented in response to the changing environment and requirements of the Australian wine industry and the AWRI.

The financial year began with many AWRI staff being involved actively in supporting the staging of the 14th Australian Wine Industry Technical Conference. It is worthy of note that the Conference workshops with the greatest demand involved sensory analysis of taints and other off-flavours in wines.

The AWRI's activities following the Conference continued to be focused on utility to industry and potential for adaptation. Whilst many of these activities have been very strategic with short-term time horizons, they have increasingly involved the application of 'new science' and new 'systems-based' approaches utilising specialised genomic, transcriptomic, metabolomic, proteomic and bioinformatic expertise. A good example is the AWRI's continuing work in the development of optimal yeast strains to enhance the reliable and efficient production of wine styles, to satisfy an increasingly discerning and diverse market place. A new commercial yeast strain emanating from this research is likely to be available during the next year. A further example is the AWRI's current work with Chardonnay comparing the compositional data of juice sourced from different regions with fermentation performance to inter alia facilitate the evolution of Chardonnay styles. It was the process engineering staff within the Commercial Services Group that investigated and published their findings on 'Improving Winery Refrigeration Efficiency', as a GWRDC-funded project. The 'Pinot G Style Spectrum' has continued to be adopted by an increasing number of producers of these styles whilst the Tannin Portal has now been accepted as a 'fee for service' analytical tool by a growing number of producers in Australia and Europe. The Industry Applications Group is now investigating a potentially exciting alternative to bentonite fining as well as continuing their work on developing practical and cost effective spectral solutions for in-winery application. However, perhaps the best example this year of interaction with, and working for, industry has been the work undertaken by the Industry Development and Support Group regarding the management of issues such as locusts, downy mildew and advances in the understanding of smoke taint, both on the ground and communicated via AWRI's 'eNews' and 'eBulletins'.

The above examples are great illustrations of both the effectiveness of AWRI's RDE&C business model and the alignment of AWRI activities to industry issues encompassing both technical and market related solutions. Furthermore, these examples are indicative of the breadth of expertise and experience that AWRI possesses that have come about as the AWRI has acquired critical mass in sync with its business plan, much of which has been financed by successful application for specific, contestable Australian/State Government funding outside of the industry R&D levy system. The AWRI does not have access to 'block funding' as do universities and some other RD&E providers. However, the success that the AWRI has enjoyed thus far in attracting other funding has been critically dependent upon the quality of the AWRI's scientific output, which has largely come as the AWRI has been able to attract and retain staff with 'new science' expertise and experience capable of adaptation to wine science. Often such staff members have been funded by those same non-levy funds and as such add great leverage and impetus to the AWRI's R&D activities at no additional cost to industry. The Commercial Services Group (the 'C' in AWRI's business model) is also not funded from industry levies.

As the Australian wine industry adapts to a new exchange rate paradigm and increasing global competition, the GWRDC develops its new 5 year strategic plan and the AWRI enters the 6th year of its 7-year Investment Agreement, it has never been more important for the AWRI to effectively communicate its value to industry and to its major stakeholders. If the AWRI is to maintain its position as the industry's preferred supplier of RDE&C services, it must continue to demonstrate to its stakeholders that an industry-owned specialist provider represents the best value proposition and the greatest accountability for industry funded RD&E.

Results of operations

The higher level of comprehensive income achieved compared to last year is pleasing and significantly better than budget. Notwithstanding the overall fall in revenue, operating expenses were also less due mainly to staff vacancies taking longer to fill than anticipated. New non-GWRDC funding awarded to the AWRI this year was $300k, under the Australian Government's 'Education Investment Fund' (EIF) initiative, to form a Bioinformatics capability to support the EIF-funded Metabolomics facility housed at the AWRI and run by the AWRI staff, as well as other Adelaide-based Proteomics & Genomics platforms. Revenue earned by the Commercial Services Group rose marginally in an extremely tough operating environment. Whilst the Commercial Services division is covering its overhead costs, a modest surplus remains a difficult target given the current industry scenario. The fall in contract research revenue compared to last year reflects the conclusion of a large multi-year contract during the year. Further contract research opportunities, which generally come from overseas clients, have been limited in line with a generally flat global wine market.

Robyn Williams AM – The Science Show

The AWRI's operating costs were less than last year reflecting in the main salary and other payroll associated expenses not incurred. Consumable expenses benefited from the reduced cost of liquid nitrogen stemming from new facilities installed last year. Whilst project outcomes necessitated a much greater amount of small-lot winemaking being undertaken this year, other project expenses were generally less stemming from delays in replacing staff. However, infrastructure and general service costs have increased this year reflecting the full impact of car parking and other WIC Central Building outgoings imposed by the University of Adelaide.

Unspent GRWDC project funds from this year's funding allocation amounted to $278k. Future disposition of these funds will be discussed by the Joint Agreement Committee in accordance with the provisions of the Investment Agreement between the AWRI and the GWRDC.

The increase in finance income this year has principally arisen from an opportunistic reinvestment of AWRI funds in term deposits.

As stated last year, the Results of Operating Activities has to be seen in the context of an organisation whose main operational activities are not profit driven. This is why the finance income AWRI derives is critically important to provide the organisation with some flexibility should a funding hiatus or other anomaly occur that halts the flow of regular funding at critical levels.

Significant changes in state of affairs

There are no significant changes in the state of affairs of the AWRI.

Principal activities

The principal activities of the AWRI have not changed significantly and are best described as:

» **Research** activities which strive for scientific excellence and industry relevance;

» **Development** activities which seek to bridge the gap between scientific discovery and value adding technology or processes;

» **Extension and Education** activities which seek to disseminate research and development outcomes to facilitate rapid uptake by the viticultural and winemaking sectors. In addition, problem solving services and an on-line search capacity across a range of technical websites are also provided; and

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

Information on directors

The names and particulars of the directors of The Australian Wine Research Institute in office at any time during or since the end of the year are:

Name and Qualifications and Experience	Special responsibilities	No. of Directors' meetings attended	No. of Audit meetings attended	No. of N & R meetings attended
John Carlyon Angove, BSc, Chairman and Managing Director of Angove Family Winemakers, Founding member of WFA in 1988. Chairman of WFA/AWBC Wine Industry Technical Advisory Committee, member WFA medium winemakers Membership Committee & alternate member of WFA Executive.	Member of N & R Committee	5		1
James Frederick Brayne, BAppSc(Wine Science), Production Director/Chief Winemaker McWilliam's Wines Pty Ltd, National wine show judge, 37 years technical and winemaking experience in the Australian wine industry.		3		
Paul Conroy, LLB (Hons), BComm, Chief Legal Officer and Company Secretary, Treasury Wine Estates Ltd, Admitted as solicitor in the Supreme Courts of NSW, Victoria and the High Court of Australia, over 20 years legal and management experience working in Australia, Asia, United Kingdom and United States.	Member of Audit Committee	5	1	
Peter James Dawson, BSc, BAppSc(Wine Science), Principal Peter Dawson Consulting, Chairman and Managing Director of Taransaud Australasia, Tasmanian wine producer, formerly Senior Vice President Group Operations and Technical, Constellation Wines, Adjunct Professor, Faculty of Science and Technology, Deakin University, National wine show judge, 33 years technical and winemaking experience in the Australian wine industry.	Chairman Member of N & R Committee	5		1
Geoffrey Raymond Linton, BAppSc (App Chem), Grad Dip (Systems Analysis), Manager, Technical and Research, Yalumba Wine Company, member of the Wine Industry Technical Advisory Committee (AWBC, WFA), 37 years experience in the Australian wine industry (to 31/12/2010).		0		
James Anthony Lumbers , BSc, Lit B (public policy) ANU Principal Lumbers Consulting and Chairman Lerida Estate. Associate Principal of Partners in Performance, member of Canberra and District Wine Industry Association, Canberra and District Vignerons Association, ASVO and AIAS.	Member of Audit Committee	4	1	
Brett Malcolm McKinnon, BAgSc (Oenology) (Hons), Managing Director, Orlando Wines, ASVO Professional Member, Graduate Leadership in Innovation Program INSEAD France, 23 years technical, winemaking, viticulture and commercial experience.		3		
Jan Sheree O'Connor, BEd (P E), MAICD, Managing Director, O'Connor Harvesting, Committee Member, Robinvale and District Wine Grape Growers Association, Committee Member, Murray Valley Winegrowers Inc, and the Murray Valley Industry Development Committee, 24 years experience in the Australian wine industry.		4		
Isak Stephanus Pretorius, BSc Agric (Hons) PhD, Managing Director, The Australian Wine Research Institute Ltd, Affiliate Professor in Oenology, University of Adelaide, Committee Member: Wine Industry Technical Advisory Committee (WFA/Wine Australia), Wine Committee Royal Agricultural and Horticultural Society (South Australia), Member, International Commission of Yeasts, Scientific Board of L'Institutdes Sciences de la Vinge et du vin (ISVV) Bordeaux, France, Scientific Committee, Institut Catalá de Recerca en Enologia i Viticultura (ICREV) Tarragona Spain, Editorial Board Member, *American Journal of Enology and Viticulture, Annals of Microbiology,* FEMS Yeast Research,Yeast, and Chair of the Australian Wine Industry Technical Conference, 33 years experience in microbiology and biotechnology.	Managing Director	7		
Louisa Elizabeth Rose, BAppSc (Oenology) BSc, Head of Winemaking The Yalumba Wine Company and Hill Smith Family Vineyards, Co-Chair of the South Australian Wine Industry Council, Chairman of Wine Barossa, Former Director of the Barossa Grape and Wine Association, National Wine Show judge (from 1/1/2011).	Member of N & R Committee	3		1
Mark Richard Watson, BEc, MBA , ACA ,IPAA, AICD Partner KPMG, previously CFO Wirra Wirra and Manager, Corporate Strategy and Development, FH Faulding & Co Ltd.	Chair of Audit Committee	4	1	

Name and Qualifications and Experience	Special responsibilities	No. of Directors' meetings attended	No. of Audit meetings attended	No. of N & R meetings attended
ALTERNATE DIRECTORS				
Nigel Peter Blieschke, BAppSc, GradCertVit, Viticultural Manager, Peter Lehman Wines (to 31/12/2010).		1		
Michael Robert DeGaris, BAppSc (Oenology) FACBS ,Wine Consultant, previously held winemaking positions at Tyrells and Cellarmaster Wines, previously general manager of Cardmember Wines and Rothbury Wines; National and international wine judge. Over 30 years experience in the wine industry (from 22/3/2011).		1		
Neil Anthony McGuigan, BAppSc (Oenology), CEO Australian Vintage Ltd, Chairman of Judges Queensland Wine Show. Over 33 years technical, winemaking and management experience (from 22/3/2011).				
Corey Brett Ryan, BSc, Masters of Oenology, Grad Dip Wine Bus, Group Chief Winemaker McWilliam's Wines Group Ltd and Echelon Wine Partners, former Chief Winemaker Villa Maria Estates NZ, national and international wine judge, 22 years technical winemaking viticulture and commercial experience.		2		
Alexander Nikolai Sas, BSc Agric (Hons), Regional Viticulturist, Constellation Wines, 20 years experience in viticultural R&D and grape supply management.				
COMPANY SECRETARY				
Hans Engelbert Muhlack, BEc CPA, 36 years experience in finance and administration in the wine industry.		5	1	

Five Board meetings, one Audit Committee meeting and one Nomination and Remuneration (N & R) Committee meeting were convened during the year.

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 (named above), all members of the Company's Executive Management Group and members of the Bio Safety Committee against a liability incurred as such a director, 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.

Auditor's independence declaration

The auditor's independence declaration under section 307C of the Corporations Act 2001 is attached.

Dated at Urrbrae on this the 20th day of September 2011.

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

P.J. Dawson
Chairman

I.S. Pretorius
Managing Director

The Australian Wine Research Institute Limited

A Company limited by guarantee

Statement of comprehensive income

For the year ended 30 June 2011

	Note	2011	2010
Revenue from operating activities			
Grape and Wine Research and Development Corporation			
Investment agreement project funding		9,544,316	9,807,673
Other project funding		462,376	650,700
Other capital funding		44,230	245,806
Other grant funding		889,933	519,776
Commercial services analytical and consulting income		2,259,302	2,248,981
Contract research and other commercial income		910,403	1,137,587
Other revenue		222,729	102,779
Total revenue		14,333,289	14,713,302
Other income	2	67,266	(654)
Expenses from operating activities			
Personnel expenses	3	9,839,750	10,003,691
Analytical and project operating expenses		2,100,877	2,408,029
Infrastructure and general services expenses		901,719	863,163
Depreciation and amortisation expense	8, 9	1,143,866	1,207,482
Travel expenses		359,965	405,759
Total expenses		14,346,177	14,888,124
Results from operating activities		54,378	(175,476)
Finance income		416,054	237,299
Profit for the period		470,432	61,823
Other comprehensive income		-	-
Total comprehensive income for the period		**470,432**	**61,823**

The notes on pages 64 to 69 are an integral part of these financial statements

The Australian Wine Research Institute Limited

A Company limited by guarantee

Statement of changes in equity

For the year ended 30 June 2011

	Retained Earnings	Total Equity
Balance at 1 July 2009	11,666,458	11,666,458
Total comprehensive income for the period		
Profit or loss	61,823	61,823
Other comprehensive income	-	-
Total comprehensive income for the period	61,823	61,823
Balance at 30 June 2010	11,728,281	11,728,281
Balance at 1 July 2010	11,728,281	11,728,281
Total comprehensive income for the period		
Profit or loss	470,432	470,432
Other comprehensive income	-	-
Total comprehensive income for the period	470,432	470,432
Balance at 30 June 2011	12,198,713	12,198,713

The notes on pages 64 to 69 are an integral part of these financial statements

The Australian Wine Research Institute Limited

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Statement of financial position

As at 30 June 2011

	Note	2011	2010
Assets			
Cash and cash equivalents	4	4,592,218	6,688,352
Other investments	5	5,000,000	-
Trade and other receivables	6	747,977	2,098,363
Inventories	7	31,855	47,142
Prepayments		186,248	108,412
Total current assets		10,558,298	8,942,269
Property, plant and equipment	8	2,512,061	3,198,564
Interest in WIC Building	9	5,572,641	5,775,979
Total non current assets		8,084,702	8,974,543
Total assets		18,643,000	17,916,812
Liabilities			
Payables and accruals	10	4,192,256	4,115,082
Project funds not expended and repayable	11	321,412	47,904
Provisions	12	1,584,019	1,701,451
Total current liabilities		6,097,687	5,864,437
Payables and accruals	10	61,001	41,000
Provisions	12	285,599	283,094
Total non-current liabilities		346,600	324,094
Total liabilities		6,444,287	6,188,531
Net assets		12,198,713	11,728,281
Equity			
Retained earnings		12,198,713	11,728,281
Total equity		12,198,713	11,728,281

The notes on pages 64 to 69 are an integral part of these financial statements

The Australian Wine Research Institute Limited

A Company limited by guarantee

Statement of cash flows

For the year ended 30 June 2011

	Note	2011	2010
Cash flows from operating activities			
Cash receipts from grants and other income		16,122,884	14,711,873
Cash paid to suppliers and employees		(13,095,122)	(13,201,322)
Net cash from operating activities		3,027,762	1,510,552
Cash flows from investing activities			
Interest received		131,811	253,688
Proceeds from sale of property, plant and equipment		949	14,145
Acquisition of property, plant and equipment		(236,316)	(568,770)
Acquisition of other investments		(5,000,000)	-
Net cash used in investing activities		(5,103,556)	(300,937)
Cash flows from financing activities			
Payment of finance lease liabilities		(20,340)	(11,673)
Net cash used in financing activities		(20,340)	(11,673)
Net increase (decrease) in cash and cash equivalents		(2,096,134)	1,197,941
Cash and cash equivalents at 1 July		6,688,352	5,490,411
Cash and cash equivalents at 30 June	4	4,592,218	6,688,352

The notes on pages 64 to 69 are an integral part of these financial statements

Notes to and forming part of the financial statements

1 SIGNIFICANT ACCOUNTING POLICIES

The Australian Wine Research Institute Limited (the 'Company') is a company 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 20th day of September 2011.

The accounting policies set out below 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 early adopted AASB 1053 *Application of Tiers of Australian Accounting Standards* and AASB 2010-02 *Amendments to Australian Standards arising from Reduced Disclosure Requirements* for the financial year beginning on 1 July 2010 to prepare Tier 2 general purpose financial statements.

The financial statements of the Company are Tier 2 general purpose financial statements which have been prepared in accordance with Australian Accounting Standards - Reduced Disclosure Requirements (AASB-RDRs) (including Australian Interpretations) adopted by the Australian Accounting Standards Board (AASB) and the Corporations Act 2001.

(ii) Basis of measurement

The financial statements have been prepared on the basis of historical costs and do not take into account changing money values.

(iii) Functional and presentation currency

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

The Company is of a kind referred to in ASIC Class Order 98/100 dated 10 July 1988 and in accordance with that Class Order, all financial information presented has been rounded to the nearest dollar unless otherwise stated.

(iv) Use of estimates and judgements

The preparation of financial statements in conformity with AASBs requires management to make judgements, estimates and assumptions that affect the application of accounting policies and the reported amount of assets, liabilities, income and expenses. Actual results may differ from these estimates.

Estimates and underlying assumptions are reviewed on an ongoing basis. Revisions to accounting estimates are recognised in the period in which the estimates are revised and in any future periods affected.

(v) Changes in accounting policies

Starting as of 1 July 2010, the Company has changed its accounting policies in the following area:

» Application of reduced disclosure requirements

(b) Financial instruments

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

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

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

The Company has the following financial assets: held to maturity financial assets and loans and receivables.

Held to maturity financial assets

If the Company has the positive intent and ability to hold debt securities to maturity, then such financial assets are classified as held to maturity. Held to maturity financial assets are recognised initially at fair value plus any directly attributable transaction costs. Subsequent to initial recognition held to maturity financial assets are measured at amortised cost using the effective interest method, less any impairment losses.

Loans and receivables

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

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

(c) Property, plant and equipment

(i) Recognition and measurement

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

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

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

(ii) Subsequent costs

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

(iii) Depreciation

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

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

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

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

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

(d) Intangible assets

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

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

(e) Leased assets

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

Other leases are operating leases and the leased assets are not recognised in the Company's statement of financial position. The Company's commitments at reporting date in regards to operating leases are disclosed in note 13.

(f) Inventories

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

(g) Impairment

(i) Financial assets (including receivables)

Financial assets are assessed at each reporting date to determine whether there is objective evidence that it is 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 amount of the Company's non-financial assets is 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.

(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.

(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.

(m) Presentation of financial statements and reduced disclosure

The Company applies revised AASB 101 *Presentation of Financial Statements* (2007), which became effective as of 1 January 2009. As a result, the Company presents in the statement of changes in equity all owner changes in equity, whereas all non-owner changes in equity are presented in the statement of comprehensive income.

The Company early adopted AASB 1053 *Application of Tiers of Australian Accounting Standards* and AASB 2010-02 *Amendments to Australian Standards arising from Reduced Disclosure Requirements*. This has resulted in a reduction of disclosures for items such as financial instruments, auditor's remuneration and operating segments. Comparative information has been re-presented or removed so that it also conforms to the new disclosure requirements. Since the change in accounting policy only impacts presentation aspects, there is no impact on comprehensive income.

2 OTHER INCOME

	2011	2010
Net gain / (loss) on sale of property, plant and equipment	189	(654)
Forgiveness of liabilities	67,077	-
	67,266	(654)

3 PERSONNEL EXPENSES

	2011	2010
Wages and salaries	8,057,111	8,242,409
Other associated personnel expenses	1,069,288	1,025,655
Contributions to defined contribution plans	713,351	735,627
	9,839,750	10,003,691

4 CASH AND CASH EQUIVALENTS

	2011	2010
Cash on hand	500	500
Bank deposits at-call	4,591,718	6,687,852
Cash and cash equivalents in the statement of cash flows	4,592,218	6,688,352

5 OTHER INVESTMENTS

	2011	2010
Held-to-maturity investments	5,000,000	-
	5,000,000	-

Held-to-maturity investments consist of term deposits with interest rates between 6.00 and 6.26 per cent (2010: not applicable) and mature within three months of balance date.

6 TRADE AND OTHER RECEIVABLES

	2011	2010
Trade receivables due from those other than related parties	409,658	1,610,283
Trade receivables due from related parties	8,977	31,665
Other receivables	329,342	456,415
	747,977	2,098,363

Trade receivables are shown net of impairment losses amounting to $6,463 (2010: $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:

	2011	2010
Balance at 1 July	-	-
Impairment loss recognised	6,463	-
Balance at 30 June	6,463	-

7 INVENTORIES

	2011	2010
Course materials on hand – wine	31,855	47,142
	31,855	47,142

8 PROPERTY, PLANT AND EQUIPMENT

	Plant & machinery	Office furniture & IT	Laboratory equipment	Capital WIP	Total
Cost					
Balance at 1 July 2010	326,379	1,116,571	7,172,902	31,800	8,647,652
Additions	40,197	89,207	125,381	-	254,785
Transfers	1,800	-	30,000	(31,800)	-
Disposals	-	(157,080)	(148,787)	-	(305,867)
Balance at 30 June 2011	368,376	1,048,698	7,179,496	-	8,596,570
Depreciation and impairment losses					
Balance at 1 July 2010	126,680	689,590	4,632,818	-	5,449,088
Depreciation charge for the year	51,892	151,822	736,814	-	940,528
Disposals	-	(156,970)	(148,137)	-	(305,107)
Balance at 30 June 2011	178,572	684,442	5,221,495	-	6,084,509
Carrying amounts					
at 1 July 2010	199,699	426,981	2,540,084	31,800	3,198,564
at 30 June 2011	189,804	364,256	1,958,001	-	2,512,061

9 INTEREST IN WIC BUILDING

AWRI has a 50 year nominal occupancy right to approximately 53% of the space in the WIC Central building owned by the University of Adelaide. The other occupants are the University of Adelaide and SARDI. The term of occupancy is reviewable after 30 years based on the remaining economic life of the building. The value assigned to AWRI's interest in the building is net of amounts contributed by the GWRDC.

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

Cost	
Balance at 1 July 2010	6,100,140
Balance at 30 June 2011	6,100,140
Amortisation and impairment losses	
Balance at 1 July 2010	324,161
Amortisation charge for the year	203,338
Balance at 30 June 2011	527,499
Carrying amounts	
at 1 July 2010	5,775,979
at 30 June 2011	5,572,641

10 TRADE AND OTHER PAYABLES

	2011	2010
Current		
Trade payables due to those other than related parties	452,259	550,737
Trade payables due to related parties	35	43,115
Income received in advance	2,035,301	2,218,234
PAYG and GST	506,776	319,876
Non-trade payables and accrued expenses	1,197,885	962,780
Lease Liability	-	20,340
	4,192,256	4,115,082
Non current		
Other payables and accrued expenses	61,001	41,000
	61,001	41,000

11 PROJECT FUNDS NOT EXPENDED

Any unexpended GWRDC funding other than core equipment funding is reimbursable to the GWRDC, except where the Joint Agreement Committee agrees that amounts can be retained by AWRI for purposes approved by the Joint Agreement Committee.

The unspent investment agreement funds for the current year were $278,857 (2010: none). The unspent funds from other GWRDC contracts for the current year were $5,740 (2010: $47,904).

During the year unspent prior years' funds totalling $47,904 relating to other GWRDC contracts were utilised in the course of those projects' current year activities, in accordance with the applicable project agreements.

Expenditure on a project previously approved by the Joint Agreement Committee to be funded through prior year unspent funds was concluded in the current year with total expenditure $36,815 below the approved amount. As a result, $36,815 has been rerecognised as unexpended GWRDC funding in the current year (2010: none).

	2011	2010
GWRDC 2011 investment agreement funding unexpended	278,857	-
GWRDC 2011 other contract funding unexpended	5,740	47,904
GWRDC prior years' investment agreement funding unexpended	36,815	-
	321,412	47,904

12 PROVISIONS

	2011	2010
Current		
Employee entitlements	1,584,019	1,701,451
Non current		
Employee entitlements	285,599	283,094
Number of Employees (FTE's)	99.8	109.9

13 OPERATING LEASES

There were no operating lease commitments at reporting date (2010: none).

14 CAPITAL COMMITMENTS

There were no capital commitments at reporting date (2010: none).

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:

	2011	2010
Total remuneration	1,755,613	1,719,502

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

» Lerida Estate

» O'Connor Harvesting

» Peter Dawson Consulting

» Arrivo Wine

Other related party transactions

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

Other related parties:

» The Australian Wine Industry Technical Conference Incorporated

Transactions with related parties

	Transactions value for the year ended 30 June		Balance outstanding as at 30 June	
	2011	2010	2011	2010
Services received from related parties	6,176	44,530	35	43,115
Services provided to related parties	201,907	49,875	8,977	31,665

16 CONTINGENCIES

In the opinion of the Directors, there were no material or significant contingent liabilities at 30 June 2011 (2010: none).

17 SUBSEQUENT EVENTS

On 26 July 2011 the resignation of the Company's Managing Director, Professor Isak Pretorius, was announced. Professor Pretorius has been appointed Deputy Vice Chancellor and Vice President: Research and Innovation at the University of South Australia, with his last day at the Company to be 30 November 2011. The Company has commenced an international recruitment search for Professor Pretorius' replacement.

On 10 July 2011 the Australian Federal Government announced *Securing a Clean Energy Future - The Australian Government's Climate Change Plan*. This plan encompasses a fixed carbon price period of three years commencing on 1 July 2012, with transition to an emissions trading scheme in July 2015. The Company has considered the impact of this plan on the carrying value of its assets shown in the Statement of Financial Position, and determined that this announcement has not materially affected their recoverable amount and has not caused them to become impaired. The Company has yet to determine the likely impact of the plan on its future operations or performance.

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

18 LIMITED LIABILITY

The company is limited by guarantee. In the event of the company being wound up, the liability of each member (both during the time he or she is a member and within one year afterwards) is limited to two dollars. There are currently ten members.

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 64 to 69 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 2011 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.

P.J. Dawson
Chairman

I.S. Pretorius
Managing Director

Dated at Urrbrae on this the 20th day of September 2011.

AUDITOR'S INDEPENDENCE DECLARATION

As lead auditor for the audit of The Australian Wine Research Institute Limited for the year ended 30 June 2011, I declare that to the best of my knowledge and belief, there have been:

(a) no contraventions of the auditor independence requirements of the Corporations Act 2001 in relation to the audit; and

(b) no contraventions of any applicable code of professional conduct in relation to the audit.

This declaration is in respect of The Australian Wine Research Institute Limited.

I.J. Painter
Partner

Signed in Adelaide on 20th September 2011

INDEPENDENT AUDITOR'S REPORT TO THE MEMBERS OF THE AUSTRALIAN WINE RESEARCH INSTITUTE

Report on the Financial Report

We have audited the accompanying financial report of the Australian Wine Research Institute Limited, which comprises the statement of financial position as at 30 June 2011, the statement of 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 controls as the directors determine is necessary to enable the preparation of the financial report that 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 controls relevant to the entity'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 entity's internal controls. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by the directors, as well as evaluating the overall presentation of the financial report.

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

Independence

In conducting our audit, we have complied with the independence requirements of the *Corporations Act 2001*.

Opinion

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

(i) giving a true and fair view of the company's financial position as at 30 June 2011 and of its performance for the year ended on that date; and

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

I.J. Painter
Partner

Dated this 20th day of September 2011

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. HASSELGROVE MEMORIAL TRUST FUND

THE STEPHEN HICKINBOTHAM
RESEARCH MEMORIAL TRUST

STATEMENT BY DIRECTORS OF THE TRUSTEE COMPANY

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:

(a) (i) The Statements of comprehensive income give a true and fair view of each Trust's surplus for the year ended 30 June 2011; and

(ii) The Statements of financial position give a true and fair view of each Trust's state of affairs as at 30 June 2011.

(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:

P.J. Dawson
Chairman

Dated at Urrbrae on this the 20th day of September 2011.

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 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 2011	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**
Income								
Interest	4,741	3,878	3,894	3,566	3,321	2,659	4,236	3,793
Donations	-	-	-	-	-	-	-	-
Total income	4,741	3,878	3,894	3,566	3,321	2,659	4,236	3,793
Expenses								
Advertising	-	-	-	-	-	-	-	-
Audit fees	550	550	550	550	550	550	550	550
Bank charges	-	-	-	-	-	-	-	-
Technical Review contributions	-	-	-	-	-	-	-	-
Sponsorship	-	-	10,000	-	-	-	5,000	-
Total expenses	550	550	10,550	550	550	550	5,550	550
Profit / (loss) from ordinary activities	4,191	3,328	(6,656)	3,016	2,771	2,109	(1,314)	3,243
Other comprehensive income	-	-	-	-	-	-	-	-
Total comprehensive income for the period	**4,191**	**3,328**	**(6,656)**	**3,016**	**2,771**	**2,109**	**(1,314)**	**3,243**

STATEMENTS OF FINANCIAL POSITION								
As at 30 June 2011	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**
Assets								
Cash at bank	2	2	1,010	10	-	-	500	-
Investments	115,171	-	94,493	-	75,679	-	102,013	-
Receivables	1,221	1,078	1,002	991	556	-	1,082	-
Total current assets	116,394	1,080	96,505	1,001	76,235	-	103,595	-
Investments	-	111,123	-	102,160	-	73,464	-	104,909
Total non-current assets	-	111,123	-	102,160	-	73,464	-	104,909
Total assets	116,394	112,203	96,505	103,161	76,235	73,464	103,595	104,909
Liabilities								
Sundry creditors	550	550	550	550	550	550	550	550
Total current liabilities	550	550	550	550	550	550	550	550
Net assets	115,844	111,653	95,955	102,611	75,685	72,914	103,045	104,359
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	98,868	95,540	77,561	74,545	52,914	50,805	104,309	101,066
Surplus for the year	4,191	3,328	(6,656)	3,016	2,771	2,109	(1,314)	3,243
Closing balance	103,059	98,868	70,905	77,561	55,685	52,914	102,995	104,309
Total trust funds	**115,844**	**111,653**	**95,955**	**102,611**	**75,685**	**72,914**	**103,045**	**104,359**

INDEPENDENT AUDITOR'S REPORT TO THE TRUSTEE OF:

THE JOHN FORNACHON
MEMORIAL LIBRARY ENDOWMENT FUND

THE THOMAS WALTER HARDY
MEMORIAL TRUST FUND

THE H. R. HASSELGROVE MEMORIAL TRUST FUND

THE STEPHEN HICKINBOTHAM
RESEARCH MEMORIAL TRUST

Report on the Financial Reports

We have audited the accompanying financial reports, being special purpose financial reports of The John Fornachon Memorial Library Endowment Fund, The Thomas Walter Hardy Memorial Trust Fund, The H.R. Hasselgrove Memorial Trust Fund and The Stephen Hickinbotham Research Memorial Trust, which comprise the statements of financial position as at 30 June 2011 and the statements of comprehensive income, notes comprising a summary of significant accounting policies and other explanatory information, and the statement by directors of the trustee company.

Trustee's Responsibility for the Financial Report

The directors of the trustee company are responsible for the preparation of the financial reports and have determined that the basis of preparation described in Note 2 to the financial report is appropriate to meet the requirements of the trustee company.

The directors of the trustee company's responsibility also includes such internal controls as the directors determine is necessary to enable the preparation of financial reports that are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on the financial reports based on our audits. We have conducted our audits 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 audits to obtain reasonable assurance whether the financial reports are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial reports. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial reports, whether due to fraud or error. In making those risk assessments, the auditor considers internal controls relevant to the funds' preparation and fair presentation of financial reports 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 funds' internal controls. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by the directors of the trustee company, as well as evaluating the overall presentation of the financial reports.

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

Opinion

In our opinion the financial reports of The John Fornachon Memorial Library Endowment Fund, The Thomas Walter Hardy Memorial Trust Fund, The H.R. Hasselgrove Memorial Trust Fund and The Stephen Hickinbotham Research Memorial Trust:

(i) presenting fairly the memorial funds' financial positions as at 30 June 2011 and of their performance for the year ended on that date; and

(ii) complying with Australian Accounting Standards to the extent described in Note 2.

Basis of Accounting

Without modifying our opinion, we draw attention to Note 2 to the financial report, which describes the basis of accounting. The financial report has been prepared for the purpose of fulfilling the directors' financial reporting responsibilities for the memorial funds. As a result, the financial report may not be suitable for another purpose.

I.J. Painter
Partner

Signed in Adelaide on 20th September 2011

Appendix 1 – External presentations and talks

Staff	Title of talk	Presented to and where	Date
V.T. O'Brien	Oxygen management at bottling	Inter Winery Analysis Group, Adelaide, SA	2 Jul 10
N. Scrimgeour	AWRI Tannin Portal		
P.A. Smith	An introduction to the AWRI Tannin Web Portal	14th Australian Wine Industry Technical Conference, Workshop Program, Adelaide, SA	3 and 6 Jul 10
G.D. Cowey, I.L. Francis	Introduction to threshold testing		3 Jul 10
I.L. Francis	Topical flavours		
I.L. Francis, G.D. Cowey	Threshold testing results and conclusion		
G.D. Cowey	Sulfides and musty compounds		
P.R. Dry	Emerging varieties from the Mediterranean		
M.P. Day	Oxygen pickup during grape processing		
M. Ugliano	Aroma development during bottle ageing, the role of oxygen exposure before and after bottling		
K. Bindon	Grape maturity		
S. Nordestgaard	White grape draining and pressing: opportunities to maximise value		
P.C. Osidacz	Oxygen and wine style: what do consumers prefer?		
E.J. Waters	Aroma development during bottle ageing, the role of oxygen exposure before and after bottling		4 Jul 10
E.S. King[1]	Thiols and tropical fruit flavour		
T.E. Siebert	Rotundone and pepper flavour		
D.L. Capone	The origin of eucalyptol in Australian wine		
	Monoterpenes in wine		
I.L. Francis	Introduction to understanding wine flavour		
	Norisoprenoids		
	Consumer responses to wine flavours		
J. Geue	Oak derived and bottle aged flavours		
D.W. Jeffery	Green flavour		
	Conclusion to understanding wine flavour		
P.A. Henschke	Introduction to Next Gen Chardonnay		
C.D. Curtin	Style creation session – fermentation focus		
P.R. Dry	Vineyard management for a changing climate		5 Jul 10
C.S. Stockley	Where is allergen labelling at?		
	Health warning labeling for alcoholic beverages – international perspectives and positions		
K.K. Forsyth	Doing it right – right from the start. Cleaner ways to produce wine.		
J.C. Hack, M.D. Mercurio, P. Mercurio	Are your wine analysis data good to the last drop or are they hard to swallow?		
P.C. Osidacz	Sensory properties of Australian Shiraz		
I.L. Francis	Chemical composition of wines in the US market		
J.R. Bellon	Hybrid wine yeast and flavour diversity		
P.A. Henschke	The nature and use of non-conventional yeasts: Potential for increasing flavour complexity		
P.C. Osidacz, I.L. Francis	Tasting results		
H.E. Holt	Yeast and wine tannin: how do they interact?		

Staff	Title of talk	Presented to and where	Date
J.A. Kennedy	Interactions between aroma, flavour and mouth-feel	14th Australian Wine Industry Technical Conference, Main Program, Adelaide, SA	5 Jul 10
E.J. Waters	Oxygen management: wine making in the bottle		
P.W. Godden	Shining some light on wine innovation – developing decision support tools that aid creative winemaking		
I.L Francis, P.C. Osidacz, B.R. Bramley, E.S. King[1], V.T. O'Brien, C.D. Curtin, E.J. Waters, D.W. Jeffery Francis	Linking wine flavour components, sensory properties and consumer quality perceptions		
K.K. Forsyth	Winery efficiency: strategies and examples for long term sustainability		
I.L. Francis	Introduction to understanding wine flavour	14th Australian Wine Industry Technical Conference, Workshop Program, Adelaide, SA	6 Jul 10
	Norisoprenoids		
	Consumer responses to wine flavours		
E.S. King[1]	Thiols and tropical fruit flavour		
T.E. Siebert	Rotundone and pepper flavour		
D.L. Capone	The origin of eucalyptol in Australian wine		
	Monoterpenes in wine		
J. Geue	Oak derived and bottle aged flavours		
D.W. Jeffery	Green flavour		
	Conclusion to understanding wine flavour		
G.D. Cowey	Current best practice to ensure protein stability with bentonite		
	Sulfides in the wine industry – An overview.		
R.A. Muhlack	Process improvement opportunities		
	Energy efficiency strategies		
	Energy, sustainability and costs of protein stabilisation		
T.E. Siebert	Phew! What is that stench?? (Volatile sulfur compounds involved in reductive off-flavours in wine)		
P.A. Henschke, M. Ugliano, R. Kalouchova	Management of fermentation S-stinks - yeast selection and nitrogen addition		
M. Marangon	Factors involved in thermal aggregation of grape PR-proteins		
	Zirconia dioxide as alternative to bentonite for protein removal in white wines		
P.C. Osidacz, I.L. Francis, M. Stevens[2]	Effect of repeated wine exposure on consumer preferences	14th Australian Wine Industry Technical Conference, Main Program, Adelaide, SA	7 Jul 10
T.G. Cordente, A. Heinrich[6], I.S. Pretorius, J.H. Swiegers[7]	Isolation of sulfite reductase variants of a commercial wine yeast with significantly reduced hydrogen sulfide production.		
C.A. Varela, D. Kutyna, P.A. Henschke, P.J. Chambers	Generating wine yeasts for the production of low alcohol wines		
W.K. Roget	In-bottle measurement of closure oxygen transmission rates		
P.J. Costello	Influence of MLF on the fruity characters of red wine	14th Australian Wine Industry Technical Conference, Workshop Program, Adelaide, SA	8 Jul 10
G.D. Cowey, I.L. Francis	Introduction to threshold testing		

Staff	Title of talk	Presented to and where	Date
I.L. Francis, G.D. Cowey	Threshold testing results and conclusion	14th Australian Wine Industry Technical Conference, Workshop Program, Adelaide, SA	8 Jul 10
I.L. Francis	Topical flavours		
G.D. Cowey	Sulfides and musty compounds		
M.G. Holdstock	Cold stability		
	Packaging preparation		
	Line sanitation and filtration		
	Post-bottling transport		
A.D. Coulter	Sulfide treatment and wine fining practical		
	Controlling microbiological activity		
	Heat stability		
	Packaging operation		
	Closure choice and post-bottling storage		
G.D. Cowey	Real wine tasting		
	Salt management in the winery		
I.L. Francis, G.D. Cowey	Sensory perception of salt, a guided tasting		
S. Van Sluyter	The taste of white wine phenolics		
S.J. Bell	Salty vines and wines		
M.P. Day	Relating phenolic taste in white wine to winemaking practices		
R. Gawel	White wine phenolics – an overview.		
	Effect of alcohol and pH on phenolic taste		
P.W. Godden	Objectively defining the Pinot Grigio/Gris Style Spectrum: development of a tool to help communicate wine style differences to the wine trade and to consumers		
M. Essling	Growing grapes for corporate wineries	VitiLink Agronomy Forum, Adelaide, SA	9 Jul 10
P.W. Godden	Objectively defining the Pinot Grigio/Gris Style Spectrum: development of a tool to help communicate wine style differences to the wine trade and to consumers	Australian Sommeliers Association, Sydney chapter meeting, Est Restaurant, Sydney, NSW	30 Jul 10
S.A. Schmidt	Systems Biology: a new approach to industrial yeast strain development	Yeast Genetics and Molecular Biology Conference, Vancouver, Canada	1 Aug 10
D. Cozzolino	Rapid analytical methods to evaluate grape and wine composition: limitations and realities	Gallo Winery, Modesto, USA	23 Aug 10
M.J. Herderich, T.E. Siebert, M. Parker, D.L Capone, D.W. Jeffery	Spice up your life: analysis of key aroma compounds in Shiraz	240th American Chemical Society (ACS) National Meeting, Boston, USA	24 Aug 10
D. L. Capone, M.A. Sefton[1], D.W. Jeffery	Analytical investigations to relate important wine odorant 3-mercaptohexan-1-ol to its precursors		
M. Ugliano, P.A. Henschke, E.J. Waters, M.J. Herderich	Fermentation and post-fermentation factors affecting accumulation and degradation of odour-active sulfur compounds during wine bottle storage		25 Aug 10
A.D. Coulter	Tasting of wines spiked with smoke taint compound	Constellation Wines Australia Winemakers Technical Meeting, Tintara, McLaren Vale, SA	15 Sep 10
M. Ugliano, S-J. Bell, I.L. Francis, E.J. Waters, P.A. Henschke	Origin and control of reductive off-flavours in wine		
M. Parker	Smoke taint: New research findings		

Staff	Title of talk	Presented to and where	Date
P.J. Chambers	Systems Biology: a new approach to industrial yeast strain development	9th Annual World Congress of the Human Proteome Organisation, Sydney, NSW	19-24 Sept 10
D.L. Capone	The origin of eucalyptol in Australian wines	University of Adelaide, School of Agriculture, Food and Wine Postgraduate Symposium, Adelaide, SA	21 Sept 2010
A.D. Coulter	Simulated tainted/faulty wine	29th Advanced Wine Assessment Course, Penfolds Magill Estate, SA	28 Sept 10
P.C. Osidacz	Descriptive terminology		
E.J. Bartowsky	Construction of a Wine Yeast Genome Deletion Library (WYGDL)	12th International Culture Collection Conference, Florianopolis, Brazil	27 Sept 10
	Management of wine microorganisms for the Australian wine industry		30 Sept 10
P.W. Godden	Objectively defining the Pinot Grigio/Gris Style Spectrum:	Judges of the Royal Adelaide Wine Show, Wayville, SA	28 Sept 2010
	Development of a tool to help communicate wine style differences to the wine trade and to consumers	Winemaking staff at Lindemans Wines, Karadoc, Vic	1 Oct 10
M.J. Herderich	Metabolomics and the quest for quality in flavour chemistry and wine research	2nd Australasian Symposium on Metabolomics, Melbourne, Vic	5 Oct 10
C.S. Stockley	Healthful or harmful? The public perception of wine versus the reality	WineHealth 2010, Friuli, Italy	6 Oct 10
I.L. Francis, P.C. Osidacz	Cat pee, coconut and capsicum: the chemistry of wine flavour	RI Aus, Adelaide, SA	12 Oct 10
C.A. Varela	Biosciences Research at the AWRI	Universitat Rovira i Virgili, Tarragona, Spain	18 Oct 10
G.D. Cowey	Topical flavours – the latest AWRI research of important wine flavour compounds	Summer School, Advances in Viticulture and Enology, Dipartimento di Biotecnologie Agarie, Universitá degli Studi di Padova, Conegliano, Italy	19 Oct 10
	The impact of closure choice on wine development		
	Brettanomyces research and practical management strategies		21 Oct 10
	Overview of the Australian wine industry and The Australian Wine Research Institute		22 Oct 10
	Australian red and white wine; winemaking and master class tasting		
C.A.Varela	Biosciences Research at the AWRI	IATA Institute, Valencia, Spain	21 Oct 10
C.S. Stockley	Wine – its bioactive compounds and health	Lecture series: Food for a healthy planet - Bioactive phenolic compounds, University of Melbourne, Vic	25 Oct 10
M.J. Herderich	Opportunities and synergies in wine science	Review Meeting for the NZ Sauvignon Blanc research program, Matakana, NZ	27 Oct 10
D.L. Capone	Origin of Eucalyptol in Australian Wine	University of Adelaide Research Day, Morphettville, SA	29 Oct 10
P.J. Chambers	Systems Biology: a new paradigm for wine yeast strain development	Bio21 Systems Biology Symposium, Bio21, Melbourne University, Melbourne	4 Nov 10
G.D. Cowey	Heat stability	AWRI Roadshow Workshop (A guide to trouble free packaging for winemakers) Dromana Estate, Tuerong, Mornington Peninsula	9 Nov 10
G.A. West	Cold stability		
A.D. Coulter	Sulfide treatment and wine fining practical		
G.D. Cowey	Packaging preparation		
A.D. Coulter	Controlling microbiological activity		
G.A. West	Line sanitation and filtration		
G.D. Cowey	Packaging operation		
	Real wine tasting		
A.D. Coulter	Closure choice and post-bottling storage		
G.A. West	Post bottling transport		
M. Essling	Salt: from grapes to wine and what your grapes go through	Barossa Salinity Workshop Yalumba Nursery	10 Nov 10
I.L. Francis	Salt and wine flavour	Managing Saline Irrigation Water SA North Roadshow #2: Salinity, Angaston, SA	

Staff	Title of talk	Presented to and where	Date
G.D. Cowey	Heat stability	AWRI Roadshow Workshop (A guide to trouble free packaging for winemakers) Swinburne University, Lilydale, Yarra Valley, Vic	11 Nov 10
G.A. West	Cold stability		
A.D. Coulter	Sulfide treatment and wine fining practical		
G.D. Cowey	Packaging preparation		
A.D. Coulter	Controlling microbiological activity		
G.A. West	Line sanitation and filtration		
G.D. Cowey	Packaging operation		
	Real wine tasting		
A.D. Coulter	Closure choice and post-bottling storage		
G.A. West	Post bottling transport		
Y. Hayasaka	Smoke-taint research	Dipartimento di Biotecnologie Agarie, Padova University, Italy	12 Nov 10
E.J. Bartowsky	Strategies for successful MLF	AWRI Roadshow: Wines of Gippsland Incorporated; Traralgon, Vic	16 Nov 10
P.R. Dry	Vine balance – how does it affect yield and quality?		
P.A. Henschke, M. Ugliano, S.-J. Bell, R. Kalouchova	Managing H_2S during fermentation – latest research		
R. Gawel	Putting the texture back into white wine – the role of white wine phenolics		
	Wine development in bottle – the role of oxygen		
P.A. Henschke, M. Ugliano, I.L. Francis, S.-J. Bell, R. Kalouchova	Did you know that DAP can strongly affect the flavour profile and style of wine?		
E.J. Bartowsky	Using the timing of MLF inoculation to optimize your winemaking		
P.W. Godden	Which new AWRI technologies can add value to your business?		
P.R. Dry	How can cultural practices be used to improve fruit set?	AWRI Roadshow: Mornington Peninsular Vignerons Assocation, Mantons Creek Vineyard, Main Ridge, Vic	17 Nov 10
P.W. Godden	Which new AWRI technologies can add value to your business?		
P.A. Henschke, M. Ugliano, S.-J. Bell, R. Kalouchova	Managing H_2S during fermentation – latest research		
R. Gawel	Wine development in bottle – the role of oxygen		
E.J. Bartowsky	Using the timing of MLF inoculation to optimise your winemaking		
C. Varela, D. Kutyna, P.J. Chambers, P.A Henschke	Strategies for reducing alcohol levels in wine		
R. Gawel	Putting the texture back into white wine – the role of white wine phenolics		
P.R. Dry	Great wine from grafted vines		
P.W. Godden	Practical management of Brett in the winery	AWRI Roadshow: Wine Growers' Assocation, Swinburn University, Lillydale, Yarra Valley, Vic	18 Nov 10
E.J. Bartowsky	Using MLF to accentuate wine aroma and flavour		
	Using the timing of MLF inoculation to optimise your winemaking		
P.A. Henschke, M. Ugliano, S.-J. Bell, R. Kalouchova	Managing H_2S during fermentation – latest research		
R. Gawel	Putting the texture back into white wine – the role of white wine phenolics		
P.A. Henschke	Wild ferments – what are the alternatives?		

Staff	Title of talk	Presented to and where	Date
P.W. Godden	Which new AWRI technologies can add value to your business?	AWRI Roadshow: Wine Growers' Assocation, Swinburn University, Lillydale, Yarra Valley, Vic	18 Nov 10
R. Gawel	Wine development in bottle – the role of oxygen		
M. Nygaard[3], E.J. Waters, P.C. Osidacz, M. Ugliano, H. van der Merwe[4], O. Aagaard[3]	The influence of oxygen management during bottling and post-bottling on final wine sensory characteristics and shelf-life		
R.G. Dambergs	Pinot Noir and sparkling wine research	Wine Tasmania Field Day	19 Nov 10
J.R. Bellon	Newly generated hybrid wine yeast impart aroma and flavour diversity	IWAG (Interwinery Analysis Group) AGM, Mildura, Vic	
I.L. Francis	Sensory evaluation of Pinot Noir wines	Victorian Pinot Noir Workshop 2010, Lancefield, Vic	29 Nov 10
R.G. Dambergs	Understanding Pinot Noir phenolics: Part 1. Grape phenolics and vinification effects Part 2. 'Wine-omics' Spectral fingerprinting of Victorian Pinot		
A.D. Coulter	The impact of closure choice on wine development; sulfide development and wine shelf-life Controlling the highs and lows of alcohol	The Institute of Masters of Wines, AWRI, Urrbrae, SA	
I.S. Pretorius	Sparkling! The art of wine and the science of yeast	The 2010 Conference of New Zealand Microbiological Society and New Zealand Biochemistry and Molecular Biology Society, Auckland, New Zealand	30 Nov 10
R.A. Muhlack	Introducing the AWRI Riverina Node	Riverina Wine and Food Technology Centre, Griffith, NSW	1 Dec 10
I.L. Francis	The chemistry of wine aroma	RACI Chemical Education Group Annual conference, Adelaide, SA	3 Dec 10
G.D. Cowey	Heat stability	AWRI Roadshow Workshop (A guide to trouble free packaging for winemakers) Carilley Estate Winery, Herne Hill, Swan Valley, WA	6 Dec 10
G.A. West	Cold stability		
A.D. Coulter	Sulfide treatment and wine fining practical		
G.D. Cowey	Packaging preparation		
A.D. Coulter	Controlling microbiological activity		
G.A. West	Line sanitation and filtration		
G.D. Cowey	Packaging operation		
	Real wine tasting		
A.D. Coulter	Closure choice and post-bottling storage		
G.A. West	Post-bottling transport		
P.J. Costello	Strategies for successful MLF	AWRI Roadshow: Great Southern Wine Producers Association, Mt Barker, WA	
P.A. Smith	Practical management of 'Brett' in the winery		
	Which new AWRI technologies can add value to your business?		
P.A. Henschke, M. Ugliano, S.-J. Bell, R. Kalouchova	Managing H_2S during fermentation – latest research		
P.A. Henschke, M. Ugliano, I.L. Francis, S.-J. Bell, R. Kalouchova	Did you know that DAP can strongly affect the flavour profile and style of wine?		
P.R. Dry	Why do bunches get hot – and what does this mean for wine quality?		
	It's getting hotter – what does this mean for our vineyard management?		

Staff	Title of talk	Presented to and where	Date
I.L. Francis	Important wine aroma compounds	The Yalumba Wine Company, Angaston, SA	7 Dec 10
P.C. Osidacz	The complexity of wine flavour	Future Materials/Australian Nanotechnology Alliance Adelaide Executive Technology Update and Networking Event, Adelaide, SA	
W.K. Roget	Which new AWRI technologies can add value to your business?		
P.J. Costello	Using the timing of MLF inoculation to optimise your winemaking	AWRI Roadshow: Gloucester Motel, Pemberton Wine Region Association, Pemberton, WA	
P.A. Smith	Which new AWRI technologies can add value to your business?		
P.R. Dry	Why do bunches get hot – and what does this mean for wine quality?		
	Why do we need new varieties for the future?		
	How can cultural practices be used to improve fruit set?		
W.K. Roget	How to significantly reduce your carbon footprint without spending any money		
	Becoming carbon neutral		
P.A. Smith	Which new AWRI technologies can add value to your business?		
G.D. Cowey	Heat stability	AWRI Roadshow Workshop (A guide to trouble free packaging for winemakers) West Cape Howe Winery, Mount Barker, WA	8 Dec 10
G.A. West	Cold stability		
A.D. Coulter	Sulfide treatment and wine fining practical		
G.D. Cowey	Packaging preparation		
A.D. Coulter	Controlling microbiological activity		
G.A. West	Line sanitation and filtration		
G.D. Cowey	Packaging operation		
	Real wine tasting		
A.D. Coulter	Closure choice and post-bottling storage		
G.A. West	Post-bottling transport		
P.J. Costello	Bacterial spoilage of wine	AWRI Roadshow: Swan Valley and Regional Winemakers Association, Swan Valley, WA	9 Dec 10
	Using MLF to accentuate wine aroma and flavour		
P.A. Smith	Which new AWRI technologies can add value to your business?		
P.A Henschke	Mousy off-flavour in wine – causes and prevention		
	Wild ferments – what are the alternatives?		
P.R. Dry	Why do bunches get hot – and what does this mean for wine quality?		
	How can irrigation management strategies be used to manipulate wine?		
G.D. Cowey	Heat stability	AWRI Roadshow Workshop (A guide to trouble free packaging for winemakers) Gloucester Motel, Pemberton, WA	
G.A. West	Cold stability		
A.D Coulter	Sulfide treatment and wine fining practical		
G.D. Cowey	Packaging preparation		
A.D. Coulter	Controlling microbiological activity		
G.A. West	Line sanitation and filtration		
G.D. Cowey	Packaging operation		
	Real wine tasting		
A.D. Coulter	Closure choice and post-bottling storage		
G.A. West	Post bottling transport		
G.D. Cowey	Heat stability	AWRI Roadshow Workshop (A guide to trouble free packaging for winemakers) Watershed Wines, Margaret River, WA	10 Dec 10

Staff	Title of talk	Presented to and where	Date
G.A. West	Cold stability	AWRI Roadshow Workshop (A guide to trouble free packaging for winemakers) Watershed Wines, Margaret River, WA	10 Dec 10
A.D. Coulter	Sulfide treatment and wine fining practical		
G.D. Cowey	Packaging preparation		
A.D. Coulter	Controlling microbiological activity		
G.A. West	Line sanitation and filtration		
G.D. Cowey	Packaging operation		
	Real wine tasting		
A.D. Coulter	Closure choice and post-bottling storage		
G.A. West	Post bottling transport		
A.D. Coulter	Simulated tainted/faulty wine tasting	Fosters Wine Group, Bilyara, Barossa Valley, SA	14 Dec 10
	Are my grapes smoke tainted and what are my options?		
	Tasting of wines spiked with smoke taint compounds		
	Reduced sulfur-type off-flavours and musty-type taints		
Y. Hayasaka	Knowledge-based wine industry research at AWRI (Closures, tannins and bushfires)	The Institute of Enology and Viticulture, Yamanashi University, Japan	14 Dec 10
D.L. Capone	Flavour precursors in Sauvignon Blanc grape juice: The effect of fruit processing on thiol conjugate concentration	International Chemical Congress of Pacific Basin Societies (Pacifichem), Honolulu, Hawaii, USA	15-20 Dec 10
G.D. Cowey	The impact of closure choice on wine development – sulfide development – SO_2 levels and shelf life	The Institute of Masters of Wine, Chateau Pey La Tour, Salleбœuf, France	9 Feb 11
	Controlling the highs and lows of alcohol		
	Wine faults, taints and flavours		10 Feb 11
P.R. Dry	Vine balance effects on Syrah yield and quality; Growing premium cool climate Shiraz in Australia; What's new in Shiraz research at the AWRI	NZ Syrah workshop, Chateau Tongariro, Mt Ruapehu	10–12 Feb 11
M.J. Herderich	Smoke taint: current and future research	VWIA smoke research workshop; Melbourne, Vic	11 Feb 11
K.K. Forsyth	Helping growers measure, compare and improve	HAL Horticulture Forum – CCRSPI Conference 2011, Melbourne Cricket Ground, Melbourne, Vic	14 Feb 11
I.L. Francis	Leather, lime and lychee: describing wine flavour	SA Wine Guild, North Adelaide Primary School, Adelaide	14 Feb 11
P.R. Dry	Australian viticulture	University of Adelaide – CalPoly Students	17 Feb 11
C.A. Simos	Winemaking management strategies for Botrytis and Powdery Mildew.	AWRI Seminar series Mudgee, Orange, NSW and Canberra, ACT	2-3 Mar 11
P.W. Godden	New technologies developed by the AWRI	Visiting OIV students, Urrbrae SA	3 Mar 11
P.R. Dry	Red wine varieties	University of Adelaide - Vineyard and Winery Operations II	10 Mar 11
C.S. Stockley	Resveratrol evaluation – evaluation of safety or an additive approved for food and for oral use, but not approved for vine products	OIV Food Safety Expert Group meeting, Paris, France	11 Mar 11
	Australian requirements for registration of GM organisms and products		
M.J. Herderich	Understanding wine quality: linking wine composition, sensory properties and consumer quality perceptions	General Assembly of the Lien de la Vigne (Vinelink) group; Paris, France	
C.S. Stockley	Wine in our society	Premium Wine Brands, Barossa Valley, SA	24 Mar 11
G.D. Cowey	Sensory evaluation. Wine aromas, flavours, faults and taints and Australian Wine Show Judging		
E.J. Bartowsky, P.J. Costello, S. Krieger-Weber[5], A. Markides[5], I.L. Francis, B. Travis	Using malolactic fermentation to enhance fruity characters in red wine – sensory and chemistry	2nd International Wine Active Compounds Conference held in Beaune, France	
I.S. Pretorius	Wine Innovation: Bridging the gap between research and practice	E&J Gallo Winery, Modesto, USA	29 March 11

Staff	Title of talk	Presented to and where	Date
I.S. Pretorius	Wine Innovation: Bridging the gap between research and practice	Bronco Winery, Modesto, USA	29 March 11
	The winemaker's bug: From ancient wisdom to opening new vistas with frontier yeast science	Second International Wine Microbiology Symposium, Yosemite, USA	30 March 11
	Wine Innovation: Bridging the gap between research and practice	The Wine Group, Fresno, USA	31 March 11
	Wine Innovation: Bridging the gap between research and practice	O'Neil's Winery, Modesto, USA	
E.J. Bartowsky	Influence of malolactic fermentation on the fruity characters of red wine – bringing wine chemistry and sensory together	Lallemand's Annual Technical meeting (XXIIth Entretiens Scientifiques), Dubrovnik, Croatia	27 April 11
P.R. Dry	Vine balance – how does it affect yield and quality?	AWRI Roadshow seminar, Hunter Valley, NSW	18 May 11
P.W. Godden	Which new AWRI technologies can add value to your business?		
C.A. Varela, M. Ugliano, I.L. Francis, S.-J. Bell, R. Kalouchova, P.A Henschke	Did you know that DAP can strongly affect the flavour profile and style of wine?		
P.R. Dry	Why do we need new clones?		
C.A. Simos	What options do you have in cold stabilising your wines?		
C.A. Varela, P.A. Henschke	Wild ferments – what are the alternatives		
P.W. Godden	Does repeated exposure to red wines change consumer preferences?		
P.R. Dry	How can cultural practices be used to improve fruitset?		
D. Cozzolino	NIR monitoring of wine	15th NIR International Conference, Cape Town, South Africa	18 May 11
C.S. Stockley	Drinking and driving? The A-Z of why you shouldn't drink and drive.	Pernod Ricard Australia, Sydney NSW	23 May 11
I.S. Pretorius	Wine Innovation: Bridging the gap between research and practice	University of Stellenbosch, Stellenbosch, South Africa	24 May 11
	The art of wine and the science of yeast		
P.R. Dry	Vine balance – how does it affect yield and quality?	AWRI Roadshow: Langhorne Creek and Adelaide Hills Seminar	25 May 11
C.A. Simos	Winemaking management strategies for Botrytis and powdery mildew.		
I.L. Francis	What sensory properties of red wines drive consumer preferences?		
C.S. Stockley	Health, nutrition and other warning labels		
D.L. Capone	The origin of eucalyptol and minty flavour in red wines		
P.W. Godden	Which new AWRI technologies can add value to your business?		
P.R. Dry	How can irrigation management strategies be used to manipulate wine quality?		
M. Essling	I have *Botrytis* bunch rot – what can I do about it?		
C.A. Simos	Features of the AWRI website		
P.W. Godden	What style of PinotG are you? Helping consumers understand the styles of wine made from Pinot Grigio and Pinot Gris	Public lecture, Mildura Campus of La Trobe University, Vic	29 May 11
P.J. Chambers	Tailoring wine yeast	Melbourne Festival of Ideas: The Pursuit of Identity (Landscape, History and Genetics)	14 June 11
M. Essling	Changes to the 2011/2012 'Dogbook'	Grape and Wine producers – Adelaide, SA	15 June 11
M.J. Herderich	Metabolomics and the quest for understanding wine quality	OENO 2011, 9th International Symposium of Oenology, Bordeaux, France	16 June 11

Staff	Title of talk	Presented to and where	Date
M. Marangon	Is Proctase the right enzyme for protein stabilisation of white wines?	OENO 2011, 9^{th} International Symposium of Oenology, Bordeaux, France	17 June 11
P.J. Costello	Influence of malolactic fermentation on the fruity characters of red wine	IXth International Symposium of Oenology 'Oeno 2011', Bordeaux, France	
	Impacts of MLF on the chemical and sensory properties of wine	Lallemand training seminar, Toulouse, France	21 June 11
		Lallemand Malolactic School, Aurillac, France	23 June 11
P.T. Hayes[8], T. Battaglene[9], I.S. Pretorius, K. Anderson[1]	Where art and science meet – Constructing a better future for the wine sector	Thirty-fourth World Congress of Vine and Wine, Porto, Portugal.	20 June 11
G. Cordero-Bueso[10], A.G. Cordente, I.S. Pretorius, T. Arroyo[10], C. Curtin	Characterisation of low-acetic acid-producing yeast		
I.S. Pretorius, D.L. Johnson	Bridging the gap between research and practice	INRA, Montpellier, France	21 June 11
M. Essling	Changes to the 2011/2012 'Dogbook'	Grape and Wine producers – Melbourne, Vic	
K. Bindon	Ripening-induced changes in grape cell walls modify their interaction with tannins	ASEV Conference, Monterey, California	22 June 11
S. Nordestgaard	Improving winery refrigeration efficiency and opportunities for cleaner production	Winery Engineers Association Conference 2011, Nuriootpa, SA	
M. Essling	Changes to the 2011/2012 'Dogbook'	Grape and Wine producers – Mildura, Vic	
I.S. Pretorius, D.L. Johnson	Bridging the gap between research and practice	Institut Universitaire de la Vigne et du Vin Jules Guyot, Université de Bourgogne, Dijon, France	23 June 11
M. Essling	Changes to the 2011/2012 'Dogbook'	Grape and Wine producers – Renmark, SA	
K.K. Forsyth	A golden example of green wine – the world's first ISO14044 compliant carbon neutral wine brand	American Association of Wine Economics, Free University Bozen-Bolzano, South Tyrol, Italy	
I.S. Pretorius	Magic! The art of wine and the science of yeast	Katholieke Universiteit Leuven, Leuven, Belgium	27 June 11
M. Essling	Changes to the 2011/2012 'Dogbook'	Grape and Wine producers – Griffith, NSW	28 June 11
I.S. Pretorius	Magic! The art of wine and the science of yeast	Forschungsanstalt Geisenheim, Germany	29 June 11
I.S. Pretorius, D.L. Johnson	Current and future strategies of the Australian wine industry		
P.W. Godden	What style of PinotG are you? Helping consumers understand the styles of wine made from Pinot Grigio and Pinot Gris	Winemaking and marketing staff and present and former CEOs of Brown Brothers, Brown Brothers winery, Milawa, Victoria	
R.G. Dambergs	Using vineyard profiling to predict red grape quality	Riverina Winemakers Technical Meeting, Griffith	30 June 11
P.W. Godden	Introduction to the AWRI	Riverina Winemakers Technical Development Group, Riverina TAFE, Griffith, NSW	
	Proctase – a potential enzymatic alternative to bentonite for removing heat-unstable protein from wine		
	The PinotG Style Spectrum – a practical application of wine fingerprinting technology		
R.A. Muhlack	Update on 2011 Griffith YAN Project		
	Fermentation modeling and control		
	Energy strategies		
N. Scrimgeour	Commercial Services Overview.		

1. The University of Adelaide, 2. SensoMetrics, 3. Nomacorc, 4. Cork Supply S. Africa, Stellenbosch, South Africa, 5. Lallemand, 6. A.B. Mauri, 7. Christian Hansen, 8. International Organisation of Vine and Wine, 9. Winemakers' Federation of Australia, 10. Instituto Madrileño de Investigación y Desarrollo Rural, Agrario y Alimentario

Workshops organised by AWRI staff

Conducted by	Title of workshop	Held	Date
G.D. Cowey, I.L. Francis, P.C. Osidacz, B.R Bramley, J. Geue, M. Parker, J. O'Mahony, N. Lloyd	Test your limits! Determine your own threshold for important wine flavour compounds (Workshop 1 and 53)	14th Australian Wine Industry Technical Conference, Adelaide, SA	3 and 8 Jul 10
A.D. Coulter, Y. Hayasaka, G. Ward[1], K. Kennison[1], K. Wilkinson[2], D. Haswell[3]	Understanding smoke taint (Workshop 2)		3 Jul 10
P.R. Dry, N. Dry[4]	Emerging varieties from the Mediterranean and their potential for Australia (Workshop 3)		
D. Cozzolino, W.U. Cynkar, N.K. Shah	Hands on rapid methods to measure grape, juice and wine composition (Workshop 4)		
I.L. Francis, D. Jeffery, D.L. Capone, T.E. Siebert, E.S. King[2], B.R. Bramley, J. Geue, P.C. Osidacz, N. Lloyd, M. Solomon, C. Black, K.H. Pardon	Understanding wine flavour: grape and wine components important to wine quality (Workshop 21 and 42)		4 and 6 Jul 10
R. G. Dambergs, F. Kerslake[7]	Pinot Noir – 'The heartbreak grape' – mending it in the vineyard and winery (Workshop 10 and 52)		4 and 8 Jul 10
V.T. O'Brien, W.K. Roget, R.A. Muhlack	Winemaking process improvement opportunities (Workshop 5)		4 Jul 10
J.A. Kennedy, M. Walker[5], M. Downey[6]	Managing tannins in the vineyard and winery (Workshop 9)		
V.T. O'Brien	Effective packaging (Workshop 14)		
G. James[8a], T. Newton[8b], C.D. Curtin, P.A. Henschke	Next gen Chardonnay (Workshop 15)		
D. Pearce[9], R. Kerrison[10], K.K. Forsyth	Carbon footprinting: implementation as part of a business development and marketing strategy (Workshop 22)		
C.S. Stockley, S. Guy[11], J. Pater[11]	A-Z of rules and regulations for labeling for the domestic and export marketplace (Workshop 24)		5 Jul 10
L. Lockshin[12], S. Mueller[12], I.L. Francis, P.C. Osidacz	What most influences consumers' wine choices: the wine, the package, or external information? (Workshop 31)		
J.R. Bellon, P.A. Henschke	Winemaking with non-conventional yeast (Workshop 32)		
D. Cozzolino, R.G. Dambergs, M. Gishen[13]	Data mining and multi-variate analysis in grape and wine (Workshop 34)		6 Jul 10
E.J. Waters	Wine colloids and protein stability (Workshop 35)		
M. Ugliano, P.A. Henschke	Stinky sulfurs and other stories – origins and control of reductive off-flavours in wine		
P.J. Chambers, M. Walker[5]	Genetically modified vines and yeast and their potential applications in the wine industry (Workshop 44)		8 Jul 10
E.J. Bartowsky, P. Costello	Malolactic fermentation – tailoring to your wine style		
R. Gawel, P. Leske[15], M. Day, S. Van Sluyter, H. Heymann[16]	White wine phenolics (Workshop 48)		

Conducted by	Title of workshop	Held	Date
S-J. Bell, T. Biswass[14]	Salty vines and wines (Workshop 50)	14th Australian Wine Industry Technical Conference, Adelaide, SA	8 Jul 10
G. D. Cowey, A.D. Coulter, M.G. Holdstock	A guide to trouble free packaging (Workshop 51)		
P.R. Dry, M. Essling	Preparations for the RtP module *Alternative Varieties: emerging options for a changing environment*	Griffith, NSW	16 Nov 10
G.D. Cowey, A.D. Coulter, G.A. West	A guide to trouble-free packaging for winemakers	Dromana Estate, Tuerong, Mornington Peninsula, Vic	9 Nov 10
		Swinburne University, Lilydale, Yarra Valley, Vic	11 Nov 10
		Carilley Estate Winery, Herne Hill, Swan Valley, WA	6 Dec 10
		West Cape Howe Winery, Mount Barker, WA	8 Dec 10
		Gloucester Motel, Pemberton, WA	9 Dec 10
		Watershed Wines, Margaret River, WA	10 Dec 10
M.G. Holdstock	Fault clinic tasting	SA Ministerial delegation including SA Minister of Agriculture, Minister Michael O'Brien, AWRI , Urrbrae, SA	15 Dec 10
G.D. Cowey	The avoidance of taints and contaminations during winemaking	The Wine & Spirit Education Trust, London	2 Feb 11

1. Department of Agriculture and Food WA, 2. The University of Adelaide, School of Agriculture, Food and Wine, 3. Department of Environment and Conservation, 4. The Yalumba Nursery, 5. CSIRO Plant Industry, 6. Department of Primary Industries, Victoria, 7. Tasmanian Institute of Agricultural Research, 8.a. Treasury Wines, 8.b. Constellation Wines, 9. Grove Mill Wines, 10. Aura Sustainability, 11. AWBC, 12. University of South Australia, Ehrenberg Bass Institute of Marketing Science, 13. Gishen Consulting, 14. Murray Darling Basin Authority, 15. Vina La Linea, 16. University of California, Davis

Posters

Author(s)	Title of poster	Presented at	Date
R.G. Dambergs, T. Ravech[1], P. Steer[2], A. Sparrow[3], R.E. Smart[4], M.J. Herderich	A comparison of oak and alternative storage vessels for maturation of Pinot Noir	14th Australian Wine Industry Technical Conference, Adelaide, SA	4-8 Jul 10
P. Majewski[5], E.J. Waters	Surface Engineered Silica (SES) for wine fining		
K. Forsyth, W. Roget	Maximising refrigeration efficiency		
R.A. Muhlack, P.A. Smith, P.W. Godden	Energy efficiency in the Australian wine sector: immediate strategies and emerging technologies		
H.E. Holt, J.M. McCarthy, R. Kievit, C.E. Abrahamse, R. Kolouchova, M.R. Solomon, P.A. Smith, A.R. Borneman, D. Cozzolino, P.J. Chambers, C. Curtin	Influence of yeast strain on Shiraz wine composition – a multivariate approach		
P.J. Ashman[6], P.J. van Eyk[6], R.A. Muhlack	Reducing the carbon footprint of Australian wine: renewable energy from winery biomass waste		
R.L. Kievit, A.G. Cordente, J.H. Swiegers[7], C.D. Curtin	*Saccharomyces cerevisiae* genes involved in membrane stability modulate accumulation of flavour compounds during fermentation		
C.E. Abrahamse, E.J. Bartowsky	Timing of malolactic fermentation inoculation in Shiraz grape must and wine: influence on chemical composition		
H.E. Holt, J.M. McCarthy, R.L. Kievit, C.E. Abrahamse, R. Kolouchova, M.R. Solomon, P.A. Smith, A.R. Borneman, D. Cozzolino, P.J. Chambers, C.D. Curtin	Influence of yeast strain on Shiraz wine composition – a multivariate approach		
D. Cozzolino, N.K. Shah, W. Cynkar, P.A. Smith	Real time measurement of yeast assimilable nitrogen		
G. Winter, M. Ugliano, C.D. Curtin, T. van der Westhuizen[8], P.K. Bowyer[8], P.A. Henschke, V.J. Higgins[9]	Regulation of sulfur metabolism during wine fermentation by nutrient supplements		
D. Torrea[10], C.A. Varela, M. Ugliano, T.E. Siebert, C. Ancin-Azpilicueta[10], I.L. Francis, P.A. Henschke	Modulation of Chardonnay aroma profile: effect of nitrogen juice supplementation with amino acids		
E.S. King[11], I.L. Francis, I.S.Pretorius, S.E.P. Bastian, J.H. Swiegers[7], C.D. Curtin	Are yeast-derived flavour differences in young Sauvignon Blanc wines retained after a period of bottle age?		

Author(s)	Title of poster	Presented at	Date
E.S. King[11], C.D. Curtin, I.L. Francis, I.S. Pretorius, S.E.P. Bastian[11], J.H. Swiegers[7]	Choice of yeast influences aroma profile and consumer preference of Sauvignon Blanc wines	14th Australian Wine Industry Technical Conference, Adelaide, SA	4-8 Jul 10
J.M. McCarthy, E.J. Bartowsky	The AWRI Wine Microorganism Culture Collection (WMCC) – a valuable resource for the Australian wine industry		
C.A. Varela, D. Kutnya, P.A. Henschke, P.J. Chambers	Generating wine yeasts for the production of low alcohol wines		
P.J. Costello, E.J. Bartowsky, S.A. Kreiger-Weber[12], A.J. Markides[13], I.L. Francis, B. Travis	Influence of malolactic fermentation on the sensory and chemical properties of Cabernet Sauvignon wine		
T. Liccioli[11], P.J. Chambers, V. Jiranek[11]	Improving fructose utilisation in wine yeast		
C.A. Varela, S.A. Schmidt, A. R. Borneman, P.J. Chambers, Bioplatforms Australia/AWRI Wine Yeast Systems Biology Consortium[14]	Systems Biology: a new approach to industrial yeast strain development.		
N. Lloyd[11], M. Ugliano, D.L. Capone, M.A. Sefton[11], D. Taylor[11], G. Elsey[11]	The role of yeast in the generation and degradation of damascenone in wine		
C.D. Curtin, P.C. Osidacz, R.L. Kievit, B. Travis, B.R. Bramley, P.J. Chambers, I.L. Francis	Yeast influence and Margaret River Chardonnay volatile aroma compounds profiles, sensory attributes, and consumer preferences		
A.R. Borneman, J.P. Affortit[15], I.S. Pretorius, M. Egholm[15], P.J. Chambers	What makes wine yeast special; comparative genomics of industrial of *Saccharomyces cerevisiae*		
M. Ugliano, B. Travis, T.E. Siebert, I.L. Francis, P.A. Henschke	Aroma composition and sensory properties of Shiraz wines as affected by nitrogen		
P.C. Osidacz, P.A. Dimanin, B.R. Bramley, K.A. Lattey[16], E.J. Waters	Consumer acceptance of white wines; association with phenolic-related sensory and chemical attributes		
T.E. Siebert, M.R. Solomon	Rotundone: development in the grape and extraction during fermentation		
M. Ugliano, M. Kwiatkowski, S. Vidal[17], E.J. Waters	Impact of pre- and post-bottling oxygen exposure on the development of Shiraz wines during storage		
P.C. Osidacz, T. Parker, G.A. Baldock, I.L. Francis, Y. Hayasaka, R. Ristic[11], J.P. Geue, C.A. Simos, A.D. Coulter, M.J. Herderich	The contribution of several volatile phenols to bushfire smoke-related sensory properties in red wine		
E.J. Bartowsky, A.R. Borneman, J.M. McCarthy, P.J. Chambers	Genotypic diversity in the malolactic fermentation bacterium *Oenococcus oeni*		
A.G. Cordente, A. Heinrich[18], I.S. Pretorius, J.H. Swiegers[7]	Isolation of sulfite reductase variants of a commercial wine yeast significantly reduced hydrogen sulfide production		
R. Ristic[11], I.L. Francis, P.C. Osidacz, C.A. Simos, K.L. Wilkinson[11]	The effect of winemaking techniques on the chemical composition and sensory properties of smoke tainted wines		
S. Holt, A.G. Cordente, S. Williams[19], W. Jitjaroen, C.D. Curtin, P. Anderson[19]	Identification and characterisation of a novel flavour enhancing gene in *Saccharomyces cerevisiae: STR3*		
W. Roget, O.J. Macintyre	In bottle measurement of closure oxygen transmission rates		
E.S. King[11], P.C. Osidacz, S.E.P Bastian[11], C.D. Curtin, I.S. Pretorius, I.L Francis	Assessing desirable levels of 'passion-fruit', 'cat pee', and 'green' flavours in Sauvignon Blanc – consumer preferences and contribution of key aroma compounds		
D.L. Capone, M.A. Sefton[11], Y. Hayasaka, D.W. Jeffery	Quantification of the precursors to the wine odorant 3-mercaptohexanol		
M. Ugliano, M. Kwiatkowski, S. Vidal[17], D.L. Capone, M.R. Solomon, E.J. Waters	The role of copper and glutathione addition and oxygen exposure in the evolution of key aroma compounds of Sauvignon Blanc		
J.P. Geue, B.R. Bramley, D.W. Jeffrey, I.L. Francis	Aroma constituents of ultra-premium Shiraz wine		
P.C. Osidacz, J. Robichaud[20], I.L. Francis	A cross-cultural study comparing Chinese and Australian red wine preferences		

Author(s)	Title of poster	Presented at	Date
J. Hixson[11], C.D. Curtin, D. Taylor[11]	Stereospecificity of the Decarboxylase Enzyme of *D. Bruxellensis*	14th Australian Wine Industry Technical Conference, Adelaide, SA	4-8 Jul 10
P.C. Osidacz, I.L. Francis, B. Bramley, M. Stevens[21]	The effect of repeated wine exposure on consumer preferences		
D.L. Capone, K.A. van Leeuwen, D. Taylor[11], K.H. Pardon, G.M. Elsey[11], D.W. Jeffrey, M.A. Sefton[11]	The origin of eucalyptol in Australian wines		
C.M. Cox[22, 11], P.R. Dry, M.G. McCarthy[23], C. Collins[11]	Reproductive development changes when Merlot and Cabernet Sauvignon are grafted to rootstocks in a cool climate region		
R. De Bei[11], S. Fuentes[11], W. Sullivan[11], E.J. Edwards[24], C. Wilkinson[24], J. Pech[23], D. Cozzolino, M.G. McCarthy[23], S.D. Tyerman[11]	Carbohydrates reserve dynamics of Chardonnay grapevines as affected by water supply, drought and drought recovering regimes		
S.M. Boden, I.B.M. Barratt, A. Lord, L.M. Bevin	Electronic information from The Australian Wine Research Institute		
M. Marangon, M. Lucchetta[25], E.J. Waters	Protein stabilisation of white wines using zirconium dioxide enclosed in a metallic cage		
G. Langhans[11], P.R. Grbin[11], C.D. Curtin	Impact of Australian *Dekkera (Brettanomyces) bruxellensis* strains upon wine quality		
R.G. Dambergs, M. D. Mercurio, S. Kassara, D. Cozzolino, P.A. Smith	Analysis of tannin in red wine – development of a spectral calibration model for industry use		
	Transfer of a spectral calibration for wine tannin to industry laboratories		
P.A. Smith, M.D. Mercurio, E.M.C. Robinson, C. Congiusta, D. Cozzolino	Rapid phenolic profiling and benchmarking using the AWRI Tannin Portal		
K.A. Bindon, P.A. Smith, J.A. Kennedy	Toward a model of grape skin tannin extraction during vinification		
S. Kassara, D.W. Jeffrey, P.A. Smith, R.G. Dambergs	Phenolic profiling of a 30 year vertical series of Australian Cabernet Sauvignon and Shiraz wines		
J.M. McRae, R.J. Falconer[26], J.A. Kennedy	Effect of wine age on tannin-protein interaction		
R.G. Dambergs, K.M. Dambergs[27]	Spectral discrimination of variety and quality with wines spanning three decades		
R.G. Dambergs, A. Sparrow[28]	The 'Bodum French Press' – a simple, reliable, small-lot red wine fermentation method		
R.G. Dambergs, N. Shah, D. Cozzolino	The relationship between Pinot Noir wine spectral properties and wine show performance		
R.G. Dambergs, S. Kassara, K.M. Dambergs[27], P.A. Smith	The relationship between total phenolics and tannin in red wines of varying maturation		
R.G. Dambergs, A. Sparrow[28], R.E. Smart[4], M.J. Herderich	Vinification effects on Pinot Noir wine phenolic profiles		
S. Kassara, J.A. Kennedy	Colour and tannin compositional variation with wine allocation		
D. Cozzolino, P.A. Smith, N.K. Shah, W.U. Cynkar	In vineyard soil monitoring		
K.A. Dungey[11], Y. Hayasaka, P.R. Grbin[11], K.L. Wilkinson[11]	Smoke taint: impacts on the chemical and microbiological profile of grapes and wine		
L.M. Craddock, S.M. Bekavac	Leaning towards continuous improvement in the laboratory		
D. Cozzolino, W. Cynkar, N. Shah, P.A. Smith, R. Riovanto[29]	Regional differences in Australian Shiraz: the role of spectroscopy		
D. Cozzolino, W. Cynkar, N. Shah, P.A. Smith	Rapid and objective analysis of grape composition		
P. Mercurio, J.C. Hack, M.D. Mercurio	Are your wine analysis data good to the last drop or are they hard to swallow?		
F.L. Kerslake[28], R.E. Smart[4], R.G. Dambergs, J.E. Jones[28], D. Close[28]	The effect of canopy manipulation on Pinot Noir fruit and wine composition in Tasmania, Australia		

Author(s)	Title of poster	Presented at	Date
D. Cozzolino, W. Cynkar, R.G. Dambergs, N. Shah, P.A. Smith	Rapid and objective analysis of wine	14th Australian Wine Industry Technical Conference, Adelaide, SA	4-8 Jul 2010
M.P. Day, O. Aagaard[30], E.J. Waters	Dissolved oxygen measurements during processing in the winery		
M. Marangon, S.C. Van Sluyter, C. Chan[26], E.J. Waters, R.J. Falconer[26]	The different behaviours of thaumatin-like proteins or chitinases during white wine haze formation		
M.D. Mercurio, S. Kassara, R.G. Dambergs, P.A. Smith	Regionality characterisation using tannin concentration profiling		
M. Ugliano, M. Kwiatkowski, E.J. Waters	VIS-NIR spectroscopy to predict selected chemical parameters in unopened bottles of Sauvignon Blanc wines		
M. Ugliano, P.A. Henschke	Rapid and accurate quantification of hydrogen sulfide during fermentation: comparison of methods for winery applications		
S.A. Schmidt, S. Dillon, P.J. Chambers[31]	Chardonnay – grape juice composition and component influence on fermentation outcomes		
J.A. Gill[28], R.G. Dambergs	Predicting wine show medals using chemometrics and multi-wavelength spectroscopy		
F.L. Kerslake[28], R.E. Smart[4], R.G. Dambergs, J.E. Jones[28], D. Close[28]	The effect of crop load manipulation on Pinot Noir fruit and wine composition in Tasmania, Australia		
L.M. Donachie[28], J.E. Jones[28], C.D. Curtin, R.G. Dambergs	An evaluation of the autolysis character of sparkling wines using spectroscopy and multivariate data analysis		
Y. Hayasaka, G.A. Baldock, K.H. Pardon, D.W. Jeffery, M.J. Herderich	Smoke-affected grape and wine research – 1: Formation of guaiacol conjugates in berries and leaves of grapevine *Vitis vinifera* L. cv. Cabernet Sauvignon: investigations using deuterium labelling and HPLC-MS and MS/MS analysis		
Y. Hayasaka, G.A. Baldock, T. Parker, K.H. Pardon, C.A. Black, M.J. Herderich, D.W. Jeffery	Smoke-affected grape and wine research – 2: investigation of the presence of glycoconjugated forms of smoke-derived volatile phenols in smoke-affected grapes and wine using HPLC-MS/MS		
G.A. Baldock, T. Parker, D.W. Jeffery, M.J. Herderich, Y. Hayasaka	Smoke-affected grape and wine research – 3: analysis of smoke derived volatile phenols in grapes and wine		
T. Parker, P.C. Osidacz, J.P. Geue, Y. Hayasaka, G.A. Baldock, D.W. Jeffery, C.A. Black, K.H. Pardon, A.D. Coulter, C.A. Simos, I.L. Francis, J.A. Kennedy, M.J. Herderich	Insight into smoky and medicinal flavour associated with smoke affected wines		
S.A. Schmidt, C.A. Varela, A.R. Borneman, P.J. Chambers, & Bioplatforms Australia/AWRI Wine Yeast Systems Biology Consortium	Systems Biology: a new approach to industrial yeast strain development.	Yeast Genetics and Molecular Biology, Vancouver, Canada	27 Jul – 1 Aug 10
D.L. Capone, M.A. Sefton	Identification and analysis of new taint compounds using GC/MS/ODP and GC/MS/SIM	Separation Science Singapore 2010	5-6 Aug 10
T.E. Siebert	Ultra-trace level determination of rotundone in grapes and wine using SPE-SPME-GC-MS		
P.C. Osidacz, I.L. Francis, B.R. Bramley, M. Stevens[21]	The effect of repeated wine exposure on consumer preferences	Sensiber – VI Simposio Ibero-Americano em Analise Sensorial, São Paulo, Brazil	19-21 Aug 10
J.M. McRae, R.J. Falconer, J.A. Kennedy	Red wine structure and activity variation: Implications for wine astringency	25th International Conference on Polyphenols 2010	24-27 Aug 10
P. Mercurio, M.D. Mercurio, J.C. Hack, M.J. Herderich	Flow injection analysis of volatile and non-volatile metabolites as a tool for non-targeted screening and de-replication	The 2nd Australasian Symposium on Metabolomics in Melbourne, Vic	30 Sept – 2 Oct 10
C.A. Varela, S.A. Schmidt, A.R.Borneman, J. Krömer[32], P.J. Chambers	Systems Biology: a new approach to industrial yeast strain development.	11th International Conference on Systems Biology, Edinburgh, Scotland.	10-16 Oct 10

Author(s)	Title of poster	Presented at	Date
Y. Hayasaka, G.A. Baldock, M. Parker, K.H. Pardon, C. Black, M.J. Herderich, D. Jeffery	Investigation of the presence of glycosides of smoke-derived volatile phenols in smoke-affected grapes and wine using HPLC-MS/MS	2nd Mass Spec Europe conference held in Florence, Italy	9-10 Nov 10
J. Geue, I.L. Francis, B.R. Bramley, D.W. Jeffery	Aroma constituents of ultra-premium Shiraz wine	Australasian Association for Chemosensory Science 12th Annual meeting, Yarra Valley, Vic	2 Dec 10
Seong-Beom Ahn[33], Alamgir Khan[33], S.Schmidt, C.A. Varela, M. Baker[34], P.J. Chambers	Quantitative analysis of growth phase-related changes of proteome of the wine yeast.	The 16th Proteomics Symposium, Lorne, Australia.	3-6 Feb 11
D. Cozzolino, W.U. Cynkar, N. Shah, P.A. Smith	Monitoring electric conductivity and macro elements in *Vitis Vinifera* grapes by near infrared reflectance spectroscopy	15th NIR International Conference, Cape Town, South Africa	18 May 11
R. Riovanto[29], N. Shah, W.U. Cynkar, P. Berzaghi[29], D. Cozzolino	Discrimination between Shiraz wines from different Australian regions: the role of spectroscopy and chemometrics		
M. Marangon, S.C. Van Sluyter[34], N. Warnock[19], S.A. Schmidt, E.M.C. Robinson, P.A. Smith, P. Godden, E.J. Waters	Is Proctase the right enzyme for protein stabilisation of white wines?	OENO 2011, 9th International Symposium of Oenology, Bordeaux, France	15-17 June 11
P.J. Costello	Influence of malolactic fermentation on the fruity characters of red wine	IXth International Symposium of Oenology 'Oeno 2011', Bordeaux, France	15-17 June 11

1. Tamar Ridge Estates, 2. Flextank International Ltd, 3. Tasmanian Institute of Agricultural Research, 4. Smart Viticulture and RuralSmart, 5. University of South Australia, 6. The University of Adelaide, School of Chemical Engineering, 7. Christian Hansen, 8. Laffort Australia, 9. University of Western Sydney, School of Biomedical and Health Sciences, 10. Universidad Publica de Navarra, Department of Applied Chemistry, Spain, 11. The University of Adelaide, School of Agriculture, Food and Wine, 12. Lallemand (Germany), 13. Lallemand Australia Pty Ltd, 14. Genomics Australia, Proteomics Australia, Metabolomics Australia, Australian Bioinformatics Facility and The Australian Wine Research Institute, 15. 454 Life Sciences, A Roche Company, 16. Orlando Wines, 17. Nomacorc SA, Oxygen Management Research Centre, 18. Mauri Yeast Australia, 19. Flinders University, School of Biological Science, Adelaide, SA 5042, Australia, 20. Tragon Corporation, 21. SensoMetrics, 22. Phylloxera and Grape Industry Board of South Australia, 23. South Australian Research and Development Institute, 24. CSIRO Plant Industry, 25. Dipartmento di Biotechnologie agrarie, C.I.R.V.E, Università di Padova, Italy, 26. Australian Institute for Bioengineering and Nanotechnology, 27. Taltarni Vineyards, 28. Tasmanian Institute of Agricultural Research, 29. Animal Science Department, Università di Padova, Italy, 30. Nomacorc SA, Belgium, 31. The Yalumba Wine Company, 32. Bioplatforms Australia/The Australian Wine Research Institute Wine Yeast Systems Biology Consortium, 33. Australian Proteome Analysis Facility (APAF), Macquarie University, Sydney NSW 2109, Australia, 34. Dept. of Chemistry & Biomolecular Sciences, Faculty of Science, Macquarie University, Sydney NSW 2109, Australia

Appendix 2 – Teaching responsibilities (Lectures) of AWRI Staff

Institution	Subject number	Subject name	No of lectures	Staff member
The University of Adelaide	7004WT	Wine packaging and quality management	2	E.J. Waters
	3046WT/7046WT	Fermentation Technology	1	P.A. Henschke
			1	J.R. Bellon
			2	I.L. Francis
	3045WT/7048WT	Advances in Oenology	4	P.A. Henschke
			3	E.J. Bartowsky
			1	C.A. Simos
			1	K.K. Forsyth
	3047/7047	Winemaking at Vintage	2	P.A. Henschke
	Not known	Gene expression and human development	2	A.R. Borneman
	3044	Viticultural methods and procedures III	4	P.R. Dry
	3002WT	Biotechnology in the Food and Wine industries	2	P.J. Chambers
	2001WT	Wine in society	1	C.S. Stockley
	3005WT	Grape industry practice, policy and communication	2 plus approx 50 hours	C.S. Stockley
	3021WT	Viticultural Science II	4	P.R. Dry
Flinders University	MMED 3921 /BTEC 9671	Industrial and Pharmaceutical Microbiology / Bioprocessing and Industrial Biotechnology	2	P.A. Henschke

Appendix 3 – Student supervision responsibilities of AWRI staff for 2010/2011

Student	Supervisors	Source of funds
Hons		
T. White	S.Bastian[2], R. Gawel	
PhD		
A. Carew	D. Close[1], R. Shellie[1], R.G. Dambergs, C.D. Curtin	University of Tasmania, AWRI
C. Cox-Kidman	C. Collins[2], P.R. Dry, M.G. McCarthy[3]	Phylloxera and Grape Industry Board of SA
L. Donachie	J. Jones[1], R.G. Dambergs, C.D. Curtin	University of Tasmania, ICIP, GWRDC
J. Gill	J. Jones[1], R.G. Dambergs	University of Tasmania, Tasmanian Pinot Forum
G. Hill	K. Evans[1], R.G. Dambergs, R. Beresford[4]	UTas, NZ Plant and Food Research
J. Hixson	C.D. Curtin, G. Elsey[2], D. Taylor[2]	University of Adelaide
A. Sparrow	R.G. Dambergs, D. Close[1]	UTas
S. Van Sluyter	E.J. Waters[5], F. Pettolino[6], A. Bacic[6]	Melbourne University/AWRI
N. Warnock	S. Schmidt, E.J. Waters[5], P. Anderson[7]	Flinders University
C. Yonker	C. Ford[2], P.R. Dry, S. Bastian[2], N. Dokoozlian[8]	E.&J. Gallo

1. University of Tasmania, 2. University of Adelaide, 3. South Australian Research and Development Institute (SARDI), 4. NZ Plant and Food Research, 5. now Grape and Wine Research and Development Corporation, 6. University of Melbourne, 7. Flinders University, 8. E&J Gallo, USA

Theses completed

Student	PhD/ MBA/ Hon	Title of Thesis	Supervisors
D. Blythe-Rubenstein	MBA	Identifying effective public relations, marketing and social media practices for medium-scale Californian wineries	R. Gawel, F. Livat-Pécheux[1]
F. Kerslake	PhD	Effect of vineyard management on Pinot Noir fruit and wine	J. Jones[8], R.G. Dambergs, D. Close[8]
E.S. King	PhD	The modulation of Sauvignon Blanc wine aroma through control of primary fermentation	C.D. Curtin, I.L. Francis, H. Swiegers[7], S. Bastian[2], I.S. Pretorius
C. McDonnell	PhD	Effect of crop load and extended ripening on vine balance and wine quality in Cabernet Sauvignon	P.R. Dry, S. Bastian[2], R. Wample[6]
E. Mertes	Hon	The effect of mineral nutrient content and post harvest conditions on phenolic chemistry in sweet cherry	D. Close[8], R.G. Dambergs
S. Nordestgaard	PhD	Phenolic extraction and juice expression during white wine production.	E.J. Waters[5], B.K. O'Neill[2] and G. Jones[2]
J. Parsons	Hon	The detection of sulfite in wine with an amperometric biosensor	P.A. Smith, J. Shapter[3]
K. A Pinchbeck (nee Dungey)	PhD	Smoke taint: Impacts on the chemical and microbiological profile of grapes and wine	Y. Hayasaka, K. Wilkinson[2], D. Taylor[2]
T. Tran	PhD	Identifying genes that confer ethanol tolerance in *Saccharomyces cerevisiae*	P.J. Chambers, G. Stanley[4]
R. Wells	PhD	Vineyard stress and leaf health links to fruit and wine	J. Jones[8], R.G. Dambergs, D. Close[8]

1. Bordeaux Management School, 2. University of Adelaide, 3. Flinders University, 4. formerly Melbourne University, now Central Queensland University, 5. now Grape and Wine Research and Development Corporation, 6. CSUF, USA, 7. Christian Hansen, 8. University of Tasmania

Appendix 4 – Media interviews during 2010/2011

Date	Staff member	Discussed	Media
4 Jul 10	C.S. Stockley	Appropriate wine and health messages	ABC News
12 Jul 10	I.L Francis	Consumer preferences	Tim White, *Australian Financial Review*
11 Aug 10		Wine and food sensory interactions	Brian Heard, KW Tastings
2 Sept 10	P.C. Osidacz	Consumer research	GWRDC *R&D at Work*
8 Sept 10	D.L Capone	Eucalyptol	Patrick Iland Publishing
30 Sept 10	A.D. Coulter	TCA in oak barrels	*Australia and New Zealand Wine Industry Journal*
15 Oct 10	I.L. Francis	Flavour changes when cooking with wine	Francis Percival, *World of Fine Wine*
5 Nov 10	P.R. Dry	Alternative varieties	ABC Country Radio
16 Nov 10		Potential for vineyard expansion in Gippsland	WIN TV Gippsland
13 Dec 10	C.S. Stockley	Women, wine and health	*Reader's Digest*
18 Jan 11	C.A. Simos	Implications of the Queensland flood and how this may affect wine that has been exposed to flood water	Tyson Stelzer, Wine Press
19 Jan 11	G.D. Cowey	Implications of wine bottles exposed to potentially contaminated water during Australian floods	
22 Mar 11	C.S. Stockley	Three good reasons to drink red wine	Oryana Angel, Special Reports Writer, Nationwide News – Body & Soul
20 Jan 11	R.G. Dambergs	Tasmanian wine research update	Mark Smith, *Wine and Viticulture Journal*
3 Mar 11	M. Marangon	Innovation award	ABC radio
4 Mar 11			*Wine and Viticulture Journal*
3 May 11	C.S. Stockley	Alcohol consumption and the incidence of cancer	ABC South West WA
24 May 11		Wine consumption and the incidence of cancer and other diseases	Aimee Meredith, Freelance journalist

Appendix 5 – Papers published by the AWRI staff during 2010/2011

1197 Godden, P.W., Cozzolino, D., Smith, P.A., Dambergs, B.G., Cynkar, W.U., Shah, N., Robinson, E.M.C., Pretorius, I.S. Shining some light on wine innovation: novel applications of spectral analysis developed by The Australian Wine Research Institute. Aust. N.Z. Wine Ind. J. 25(3), 46–50; 2010.

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1200 Arevalo-Villena, M., Bartowsky, E.J., Capone, D., Sefton, M.A. Production of indole by wine-associated microorganisms under oenological conditions. Food Microbiol. 27(5), 685–690; 2010.

1201 Kamffer, Z., Bindon, K.A., Oberholster, A. Optimization of a method for the extraction and quantification of carotenoids and chlorophylls during ripening in grape berries (Vitis vinifera cv. Merlot). J. Agric. Food Chem. 58(11), 6578–6586; 2010.

1202 Evans, D.E., Dambergs, R., Ratkowsky, D., Li, C., Harasymow, S., Roumeliotis, S., Eglinton, J.K. Refining the prediction of potential malt fermentability by including an assessment of limit dextrinase thermostability and additional measures of malt modification, using two different methods for multivariate model development. J. Inst. Brew. 116(1), 86–96; 2010.

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1204 Stockley, C. Does alcohol adversely affect an adolescent's brain? Aust. N.Z. Grapegrower Winemaker 555, 42–45; 2010.

1205 Pretorius, S. Beyond the buzz. WBM (April), 56–58; 2010.

1206 Pretorius, S. Beyond competition. WBM (May), 34–35; 2010.

1207 Kutyna, D.R., Varela, C., Henschke, P.A., Chambers, P.J., Stanley, G.A. Microbiological approaches to lowering ethanol concentration in wine. Trends Food Sci. Tech. 21(6), 293–302; 2010.

1208 Pretorius, S. Investing for gold medal results. Aust. N.Z. Grapegrower Winemaker 557a, p5; 2010.

1209 Smith, P., Dambergs, B., Mercurio, M., Robinson, E. The world is waking up to tannin values. Aust. N.Z. Grapegrower Winemaker 558, 62–64; 2010.

1210 Shah, N., Cynkar, W., Smith, P., Cozzolino, D. Rapid and real-time analysis of compositional parameters in commercial white grape juice. Aust. N.Z. Grapegrower Winemaker 557a, 74–76; 2010.

1211 King, E., Curtin, C., Francis, L., Swiegers, H., Pretorius, S., Bastian, S. Are yeast-derived flavour differences in young Sauvignon Blanc wines retained after a period of bottle age? Aust. N.Z. Grapegrower Winemaker 557a, 60–68; 2010.

1212 Godden, P., Muhlack, R. Trends in the composition of Australian wine, 1984–2008. Aust. N.Z. Grapegrower Winemaker 558, 47–61; 2010.

1213 Bartowsky, E.J., Stockley, C.S. Waiter, is there histamine in my wine? Histamine in Australian wines — a survey over 27 years (1982 to 2009). Aust. N.Z. Grapegrower Winemaker 557a, 69–72; 2010.

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1217 Francis, L. Riesling flavour. In: Helm, K., Burgess, T. Riesling in Australia, pp 40–43; 2010.

1218 Pretorius, S. Beyond collaboration. WBM (July), 38–40; 2010.

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1220 Smyth, H.E., Cozzolino, D., Cynkar, W.U., Dambergs, R.G., Sefton, M., Gishen, M. Near infrared spectroscopy as a rapid tool to measure volatile aroma compounds in Riesling wine: possibilities and limits. Anal. Bioanal. Chem. 390(7), 1911–1916; 2008.

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1227 Coulter, A. Post-bottling spoilage – who invited Brett? Aust. N.Z. Grapegrower Winemaker 559, 78–86; 2010.

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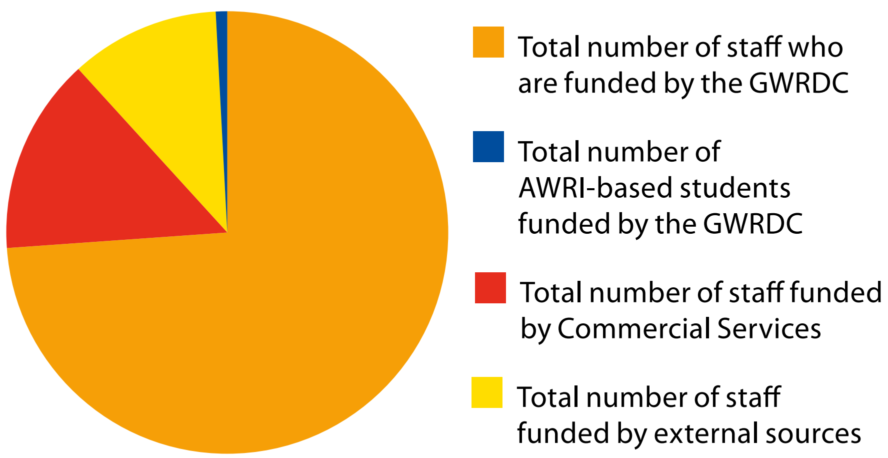

Figure 30. Funding of the AWRI staff, excluding overseas students and visiting researchers.

Staff of The Australian Wine Research Institute

1 Rae Blair
2 Leanne Hoxey
3 Ian Francis
4 Markus Herderich
5 Cory Black
6 Kevin Pardon
7 Christopher Curtin
8 Matthew Holdstock
9 Peter Godden
10 Daniel Johnson
11 Kate Beames
12 Hans Muhlack
13 Linda Halse
14 Sakkie Pretorius
15 Angus Forgan
16 Timothy Reilly
17 Neil Scrimgeour
18 Bryan Newell
19 Mark Braybrook
20 Dimitra Capone
21 Linda Bevin
22 Tracey Siebert
23 Jeanette Tooley
24 Daniel Tynan
25 Yoji Hayasaka
26 Paul Henschke
27 Meagan Mercurio
28 Christopher Day
29 Pauline Jorgensen
30 Helen Holt
31 Pamela Stepancich
32 Gayle Baldock
33 Janice O'Donnell
34 Kerry Pinchbeck
35 Heather Donnell
36 Paul Chambers
37 Alexander Schulkin
38 Eveline Bartowsky
39 Jane McCarthy
40 Virginia Phillips
41 Creina Stockley
42 Karl Forsyth
43 Radka Kolouchova
44 Tina Tran
45 Adam Holland
46 Wade Hines
47 Amy Hill
48 Mardi Longbottom
49 Jacqui McRae
50 Warren Roget
51 Marlize Viviers
52 June Robinson
53 Toni Cordente
54 Alfons Cuijvers
55 Mark Solomon
56 Paul Smith
57 Francesca Blefari
58 Gal Winter
59 Robyn Kievit
60 Wies Cynkar
61 Jelena Jovanovic
62 Alana Williams
63 Heather Tosen
64 Estibaliz Matteo
65 Matteo Marangon
66 Simon Nordestgaard
67 Samantha Anderson
68 Christine Mayr
69 Richard Gawel
70 Eric Wilkes
71 Mark Smith
72 Anne Haworth
73 Ignacio Nevares
74 Claudio Hidalgo
75 Nathan Watson-Haigh
76 Slavko Bekavac
77 Geoffrey Cowey
78 Gemma West
79 Andrea Anesi
80 Martin Day
81 Randell Taylor
82 Daniel Cozzolino
83 Melissa Nutt

Absent

Adrian Coulter
Anne Lord
Anthony Borneman
Belinda Bramley
Brian Beggs
Con Simos
Cristian Varela
Dariusz Kutyna
Deborah Thornton-Wakeford
Ella Robinson
Emma Kennedy
Felicity Harding
Fiona Brooks
Fiona Woodcock
Gurinder Khera
Heather Smith
Jaqueline Gould
Jennifer O'Mahony
Jennifer Bellon
Jeremy Hack
Keren Bindon
Lynn Alabaster
Marcel Essling
Mark Werner
Martin Day
Mary Likos
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Patricia Osidacz
Peter Baldwinson
Peter Costello
Peter Dry
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Ralph Osborne
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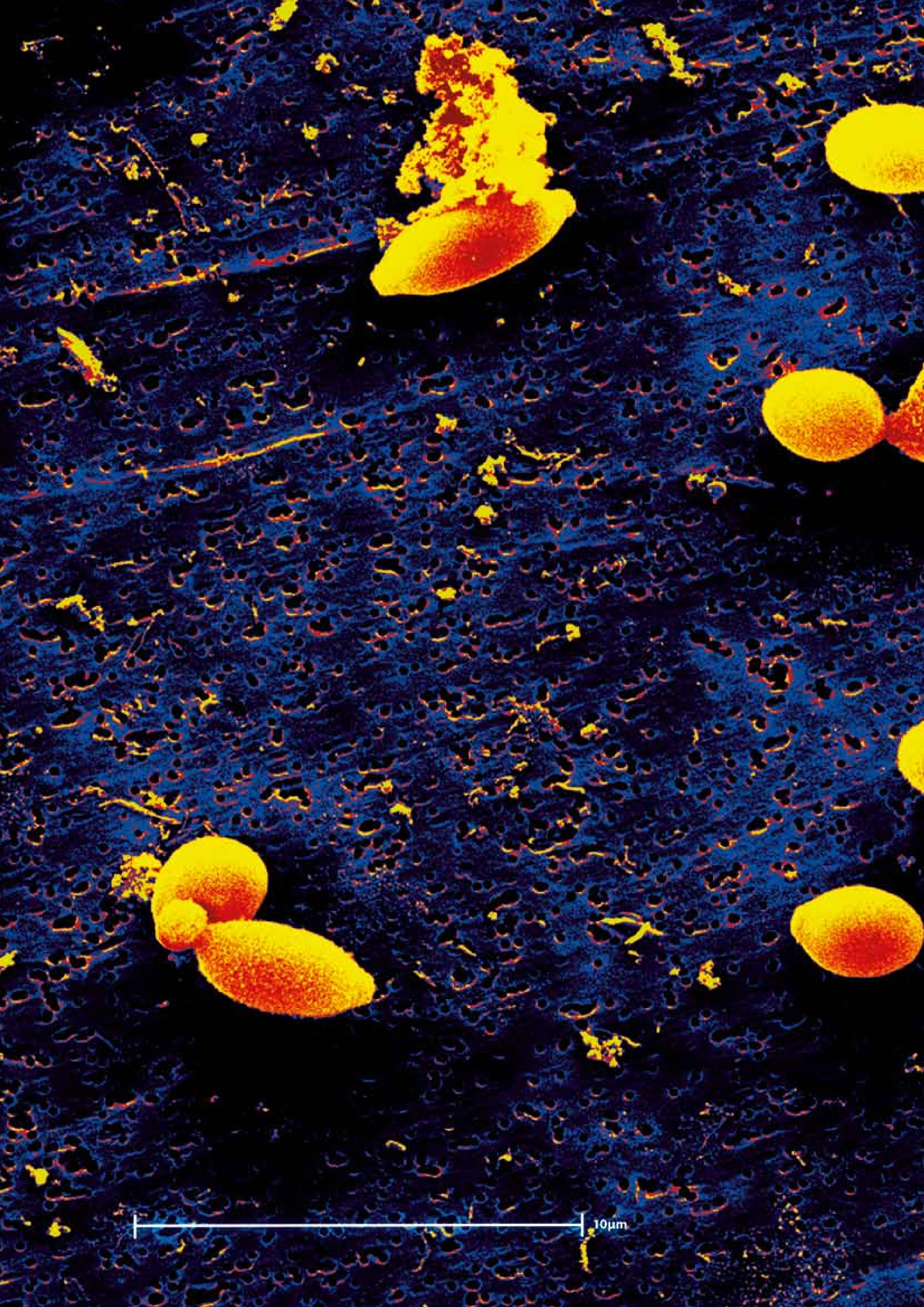
Robyn Gleeson
Russell Gardiner
Sean Boden
Sibylla Morey
Simon Schmidt
Sonya Henderson
Stefania Mercorella
Stella Kassara
Tangerine Parker
Vincent O'Brien
Vivianne Rees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