AWRI

The Australian Wine
Research Institute

Seven-Year Research, Development and Extension Plan

Executive Summary
2006 - 2013

The Australian Wine
Research Institute

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Increasing innovation and success for the Australian wine industry to 2013

The activities of the AWRI are primarily funded by Australian winemakers and grapegrowers through their investment body, the Grape and Wine Research and Development Corporation, with matching funding from the Australian government.

Apart from the AWRI Board and staff members and suppliers, the critical stakeholders in AWRI are:

> members of the Australian grape and wine industries, including their peak bodies: the Winemakers' Federation of Australia (WFA) and the Wine Grape Growers Australia (WGGA)

> the Australian government

> the Grape and Wine Research and Development Corporation (GWRDC)

> our national and international collaborators, including other industry and government bodies and research providers

> the South Australian government through their contribution to the central building of the Wine Innovation Cluster: the new home of the AWRI

To create maximum return on investment in AWRI's activities and to respond to the requirements of AWRI's stakeholders, the activities detailed in this Seven-Year Research, Development and Extension Plan have been aligned with:

> National Research Priorities established by the Australian government

> GWRDC program areas

> Strategic Directions Group (SDG) priority areas established by WFA, WGGA and GWRDC

Our previous highlights

The Australian Wine Research Institute (AWRI) has a 50-year history of providing world-class, industry-relevant science, and facilitating the adoption and application of science in the Australian wine industry. We have been instrumental in building a culture of experimentation and innovation which is directly linked to the industry's market success.

We have helped keep this dynamic industry at the leading edge by building the capacity for rapid adoption of new science and technology.
This industry is flexible and able to modify its products according to changing market demands. The entrenchment of scientific and technological adoption at the core of the industry's culture, confers an important market advantage in an increasingly competitive global environment.

The AWRI remains responsive to the demands of its many stakeholders, particularly the grapegrowers and winemakers of Australia, and increasingly the consumers of Australian wine. The AWRI can demonstrate that its activities are of continued benefit to those stakeholders.

Selected highlights include the following outcomes and benefits:

For the consumer

> Improved wine quality by facilitating continual enhancements in wine composition

> Sensory studies that identify the drivers of wine quality and style

> Lower incidence of quality loss conferred by bottle closures

> Improved wine quality due to continual enhancements in the winemaking process

> Reduction of the lead level in Australian wine

> Supporting and fostering a culture of product integrity in the Australian wine industry

For the grapegrower

> Elucidating colour / quality relationships in grapes

> Annual publication of *Agrochemicals registered for use in Australian wine*

> Providing easily accessible information on maximum residue limits in export markets

> The application of near infrared spectroscopy for the analysis of grape composition

> Provision of targeted technical and information services to grapegrowers

For the winemaker

> Fermentation management including the development of novel yeast and the supply of pure microbial cultures

> Practical understanding of the sherry flor and spoilage of fortified wine

> Early recognition of the importance of pH in the microbiological stability of exported wines

> Understanding of, and development of management strategies related to temperature and oxidation; red wine colour and phenolics; wine instabilities

> Identification of wine taints, and development of strategies to eliminate them

> Allowed industry to optimise wine flavour through the identification of key components of grape, wine and oak flavour

> Provision of targeted technical and information services to winemakers

> Fostering positive trends in the key measurements of wine composition (e.g. free to total SO_2 ratios; volatile acidity; and 4-ethylphenol)

The Australian Wine Research Institute Directory

Registered Office	Waite Road, Urrbrae (Adelaide), SA 5064
Board Members	Mr R.E. Day, BAgSc, BAppSc (Chairman) Mr J.F. Brayne, BAppSc (Oen) Mr P.D. Conroy, LLB(Hons), BCom Mr P.J. Dawson, BSc, BAppSc (Wine Science) Mr T.W.B. James, AssDip(WineProd) Mr G.R. Linton, BAppSc(AppChem), GradDip (SysAnal) Mr S.B. Millar, CPA Professor I.S. Pretorius, BSc(Hons), MSc, PhD Professor S.D. Tyerman, BSc(Hons), PhD
Managing Director	Professor I.S. Pretorius, BSc(Hons), MSc, PhD
Bankers	The Commonwealth Bank of Australia, Adelaide
Solicitors	Finlaysons Lawyers, Adelaide
Auditors	PKF, Adelaide
Key funding agency	The Grape and Wine Research and Development Corporation

(L to R) Members of the AWRI Board: Steve Tyerman, Peter Dawson, Sakkie Pretorius, Robin Day (Chairman), Tim James, Paul Conroy, Steve Millar (absent: Jim Brayne and Geoff Linton)

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Executive Summary

Purpose of this research, development and extension (RD&E) plan

At the beginning of 2006, the AWRI adopted and started to implement a ten-year business plan *Towards 2015* (Figure 1), which identified where the AWRI finds itself after 50 years of operation; where the AWRI wants to be in ten years time; the opportunities facing the AWRI; what might prevent the AWRI from realising these opportunities; and how the AWRI might overcome these 'roadblocks' to achieve our goals.

Its purpose is to act as a roadmap for the next ten years and reveal the well-considered and agreed route developed from management and other stakeholders' discussions and planning.

The Business Plan identified ten key initiatives for the AWRI to deliver on its vision (and industry expectations) against the internal and external environment identified and to overcome the roadblocks. They are:

1. Take a key role in the establishment and operation of the proposed Wine Innovation Cluster (WIC) at the Waite Precinct.
2. Expand its presence and visibility in the winemaking and grapegrowing regions through the establishment of satellite RD&E nodes in New South Wales, Victoria, Western Australia, Queensland and Tasmania.
3. Seek to expand its share of Grape and Wine Research and Development Corporation (GWRDC) funding from an estimated 32% in 2006 to levels that will allow the AWRI to achieve its objectives by 2013 and beyond.
4. Seek to reduce its total reliance on GWRDC funding to less than 75% of total revenue during the planning period 2006 - 2015.
5. Secure long-term funding from GWRDC and move from a totally project funded relationship to a core and project theme funding arrangement. This will create a more certain environment and allow for longer range planning.
6. Expand the size of the AWRI Analytical Service by, amongst other things, re-investing surpluses earned in that area.
7. Seek to exploit the commercial research that might be available to it and exploit intellectual property (IP) opportunities as they arise.
8. Create a culture of conscious governance and move from the existing Council arrangement to a corporate Board. Special Qualification Directors will be appointed to supplement the skills of the industry representatives.
9. Implement an 'Employer of Choice' program.
10. Implement a new measurement and control system to monitor the AWRI's intangible assets that address the AWRI's longer-term health, and assess the efficiency of short term operations via the performance against key performance indicators.

Implementation of these initiatives will enable the AWRI to:

> enhance its value delivery to the Australian wine industry;
> help stakeholders meet their needs;
> exploit its internal strengths and the opportunities presented by the market place;
> overcome its weaknesses and protect itself from market place threats; and
> maintain its position as one of the world's leading grape and wine RD&E organisations.

This seven-year RD&E plan was developed to align with the above key initiatives and builds on current research programs with the AWRI's proven track record of innovative science and delivery. The programs are based on projects identified by the wine industry (including those from the priorities and topics identified in the 2006-2008 research prospectus *Investing in Innovation* of the Strategic Directions Group [SDG]), the GWRDC, the Winemakers' Federation of Australia, the Wine Grape Growers Australia (WGGA) or by the AWRI Board and staff members. In doing so, the AWRI continues to focus itself on ways to improve the Australian industry domestically and for export purposes.

Figure 1a. To commemorate the AWRI's 50th anniversary, a book was published in 2005 containing reviews of topical aspects of wine science and other related AWRI activities. To ensure effective delivery of the papers within this book, AWRI staff gave presentations around Australia in 17 different seminars.

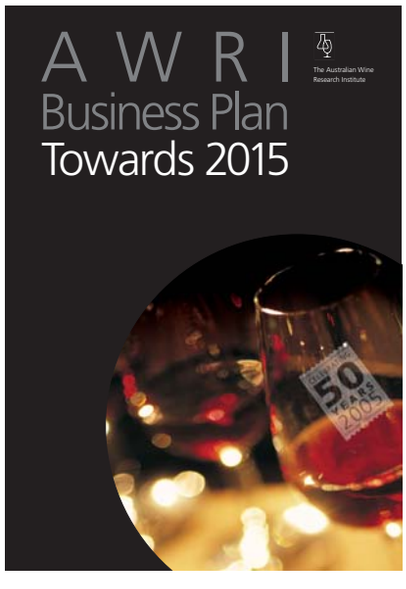

Figure 1b. Following strategic input from the AWRI Board and staff members and stakeholders over a twelve month period, a ten-year Business Plan was published for the AWRI. An Executive Summary of the Business Plan was distributed to all levy-payers in 2006.

The AWRI's role in the wine industry

Acceptance of Australian wine by the world's consumers has not evolved through centuries of tradition, but has been earned by the industry's capacity to deliver approachable wine with exceptional value at various price points. The Australian wine industry's method has been to listen to the desires of consumers and strive to meet those through innovation - while respecting the cultural roots of wine. A few decades ago, inventive hard work in vineyards, wineries and laboratories started paying off: wine quality reached new heights; exports grew at spectacular speed; and consumers around the world embraced our wines.

Particularly since the 1980s, the AWRI has become an integral player in the technical and business development of the modern Australian wine industry. This has happened through the AWRI's ground-breaking work in scientific research, technology development, information sharing and regulatory support, for which it is recognised domestically and internationally.

In 2005, the AWRI celebrated 50 years of operation and in those years direct benefits to the industry have been many and varied. The AWRI has become one of the world's leading knowledge developers and disseminators of wine research and the benefits of this flow directly to the Australian industry. The AWRI model of an industry-owned body delivering world-class research with integrated solutions is acknowledged as able to successfully bring high value to the industry and much of this is due to the kind of forward planning and teamwork evident in the RD&E Plan.

The AWRI recognises the need to extend the scale and reach of its research, extension and industry development services. It fully intends to make its integrative model even better in its value to the industry and to customers on a broad, national basis. It is committed to the further advancement of the industry's competitive edge through the delivery of innovative grape-to-wine-to-consumer research driven by multi-disciplinary strengths, national outreach, state-of-the-art infrastructure and effective creation and dissemination of knowledge and technology that will inform and drive development and direction (Figures 2 and 3).

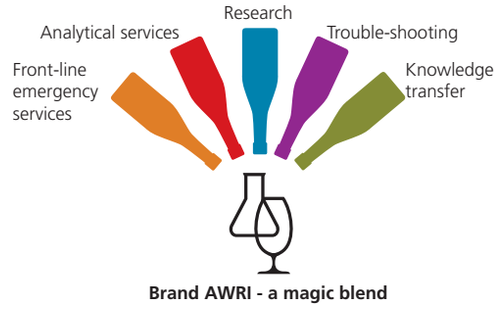

Figure 2. The AWRI's RD&E model

The AWRI intends to continue to work in partnership with the industry and promote oenological and viticultural innovation that will help Australian winemakers and grapegrowers to meet the challenges of an ever-more multi-faceted and volatile global market while continuing to improve the product in the consumer's glass. The AWRI will remain market driven with its mind firmly set on the needs of its primary customers - Australia's winemakers and grapegrowers.

The AWRI's role - and the *raison d'être* for this RD&E plan - is to continue to enable the Australian wine industry to grow and make the wine the consumer wants to drink. In other words, its role is principally market-driven rather than exclusively science-driven.

The AWRI's purpose, mission, vision and values

The AWRI's *purpose* is to contribute substantially in a measurable way to the ongoing success of the Australian wine industry.

The AWRI is resolute in its *vision* to deliver high value to the Australian wine industry through world-class research and integrated solutions and to provide thought leadership to the research activities of the Australian wine industry.

The *mission* is to underpin that 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.

The 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 industry and industry driven.

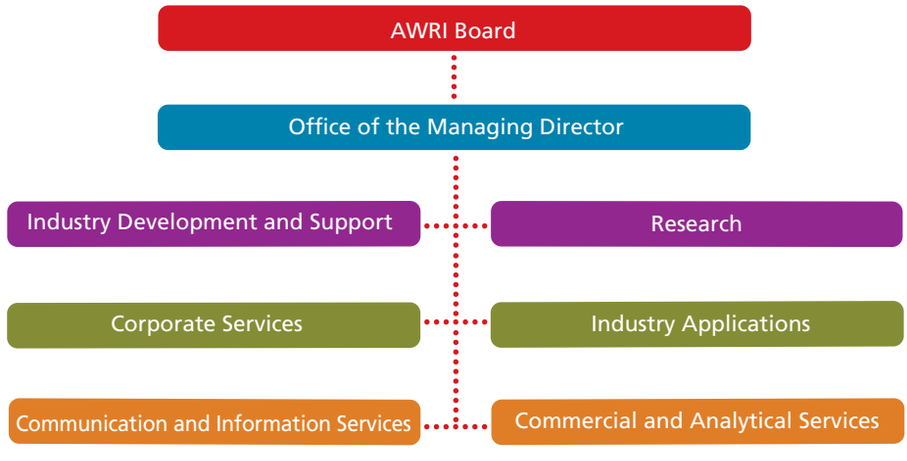

Figure 3. Proposed organisation structure of the AWRI

The AWRI faces many challenges in delivering on its purpose, vision and mission. The global wine industry is in a state of change and the research support the Australian wine industry receives is fragmented. As an 'industry-owned' RD&E organisation, the AWRI intends to take the lead in promoting an industry-focussed collaborative, multi-disciplinary RD&E program with a *whole-of-chain* capability (i.e., RD&E that is adequately integrated across the whole supply chain of the wine industry).

In summary, the AWRI will, in a measurable way, substantially contribute to the ongoing success of the Australian wine industry and it is resolute in delivering high value to the Australian wine and grape industry through world-class research and integrated solutions.

To maximise its potential contribution, the AWRI is the key driving force behind establishing the Wine Innovation Cluster (WIC) at the Waite Precinct in Adelaide. Whilst there are financial and political challenges to overcome, the WIC's establishment is crucial if the AWRI is to blossom and achieve its potential position in the global market place against strongly funded competitors in other countries.

The WIC's development is a central tenet of this plan. The Australian wine industry places high expectations on the AWRI's performance - the WIC is a key platform for the AWRI to deliver on those expectations (Figure 4).

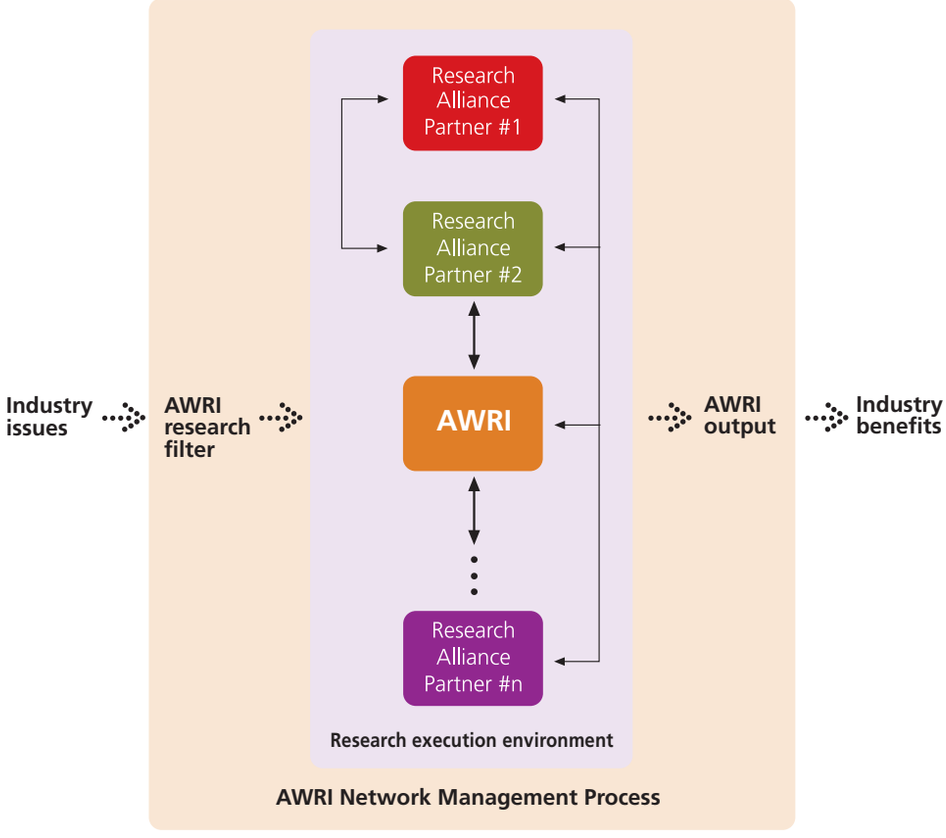

Figure 4. A new paradigm in collaborative research. The AWRI will seek to establish an expanded collaborative network involving other research organisations, nationally and internationally. The *Wine Innovation Cluster* (WIC), the new home of the AWRI, will facilitate enhanced collaboration with the other WIC occupants: CSIRO Plant Industry, the University of Adelaide, South Australian Research and Development Institute and Provisor.

World-class research and integrated solutions for industry success

Introduction

In introducing the AWRI's RD&E plan for the coming seven years, it is important to consider the underlying reason for the AWRI's existence - scientific research and integrated solutions to increase fundamental understanding in a context responsive to the applied needs of the wine industry.

The Australian wine industry is characterised by its innovation and technical capability to respond to consumer preferences. Much of this has been driven by the AWRI, especially in the past 25 years where the industry has become one of the world's most successful and profitable exporters of distinct, consistent and marketable table wine.

Combining scientific rigour with market-led research initiatives, along with targeted information provision and knowledge transfer, development and problem-solving activities, will bring long-term benefits to the Australian wine industry. This seven-year plan has been designed to enable the AWRI to contribute in a quantifiable way to the continuing success of the industry through high-quality, cross-disciplinary research and integrated solutions.

Plan structure and alignment to industry and government priorities

The plan is constructed in four *Themes*, each of which has a number of *Streams* within which planned RD&E *Projects* have been itemised.

The activities of the staff within the research, development and extension *Themes* are supported by the Office of the Managing Director and the Corporate Services group (support functions). The Office of the Managing Director will provide insightful scientific, commercial and strategic leadership to ensure the achievement of the objectives of the AWRI's Business Plan *Towards 2015*. Similarly, it will have the ability to recognise and assist in the delivery of rapid uptake opportunities for Australian producers, and to assess the extent to which they might require appropriate and timely protection and commercialisation of intellectual property. The Corporate Services group provides an amalgam of essential service units that both underpin and enable the research, development and extension staff to focus on their core activities with minimal involvement in administrative and commercial issues.

To meet the conditions of the new seven-year GWRDC Funding Agreement, the AWRI has aimed to build Streams and Projects of critical mass to achieve flexibility with regard to management of resources within Themes and Streams while retaining the current team structure.

As a guiding principle, the proposed Theme/Stream/Project structure has been designed to further foster integration between disciplines, i.e. Chemistry and Biosciences (Themes 1 and 2), AWRI's research and development groups (Themes 2 and 3) and information and knowledge management and delivery, and communication activities (Theme 4, linking with Themes 1, 2 and 3).

The AWRI plans to 'fast-track' progress in competitive areas through identification of project champions and appointment of additional staff. To strengthen the AWRI's effectiveness extra attention is proposed for projects that focus on novel winemaking processes, process engineering, industry applications, technical problem solving, sensory sciences, and environmental and sustainability aspects.

In this plan, all research projects have been matched to, and are fully aligned with, SDG, GWRDC and National Research Priorities.

Focus on outcomes for the Australian wine industry

In realising its mission, the AWRI strives to be the leading provider in Australia of outcome-driven research services, knowledge and innovation by pursuing new knowledge, scientific excellence, meeting industry needs, actively managing and validating existing knowledge and building and promoting a culture of innovation and delivery of change to the wine industry.

The AWRI's goals are to contribute through cutting-edge science to the success of Australian winemakers and grapegrowers in competitive markets, to build the AWRI's position as the benchmark provider of knowledge and solutions to the industry, and to provide the industry with innovative and effective tools and technology to meet the demands of customers and stakeholders.

The AWRI will build on the work it has already done and the RD&E Plan is designed to enable it to become still more outcome-focussed and business-like in its future direction to maximise its value to industry in the most effective and efficient ways. Successful future development will require discipline, focus, strategic positioning and change, embracing a new paradigm of enhanced collaboration.

As the need for research to enhance industry's technical capability to respond to consumer preferences and profitably deliver products at superior quality and price ratios becomes more essential, the AWRI realises that it also becomes more difficult to accomplish all its goals in house. In providing leadership in thought, it also seeks to lead the way in developing a new proposition for research effectiveness.

The AWRI will remain lean, nimble and responsive to the industry's needs. To achieve this, the AWRI is already working to develop further a collaborative network of research organisations through construction of the Wine Innovation Cluster at the Waite Precinct and through establishing nodes in other States (Figure 5).

Figure 5. The AWRI collaborative network driven by the Australian wine industry

Rather than using these external parties as a mechanism to compensate for capabilities not yet mastered, the AWRI will develop strategic collaborations with them to expand all the parties' competencies and thus benefit the Australian wine industry further.

This RD&E Plan will enable the AWRI to deliver research outcomes to the furthest corners of the Australian industry, both established and emerging, and build on the domestic and international advantage Australia enjoys in an increasingly-competitive world.

In other words, the AWRI is committed to the further advancement of the industry's competitive edge through delivery of innovative wine and grape research and integrated solutions.

Approach to achieve our objectives

With major advances in research delivered or being delivered to the Australian wine industry in such areas as controlling spoilage by *Brettanomyces/Dekkera*, reduction of volatile acidity and measuring bottle closure performance, the focus of attention for research is shifting to enhancement of product attributes and value.

Winemakers are seeking to respond to market preferences and, despite the popular myth that technical input creates wine lacking in character, it is technology that creates diversity to enable grapegrowers and winemakers to respond to those preferences. Technology - produced by the research results achieved in the past and embodied in this plan for the future - ensures that the wonderful diversity nature provides within grapes grown under different conditions can be adapted by winemakers to make wine to satisfy identified consumers.

Thus in recent years, the focus of attention has shifted from eliminating faults towards tailoring enhancements of product attributes and value (Figure 6). While this might sound straightforward, it has necessitated the AWRI to lead the way with multi-disciplinary research teams, extensive field and laboratory work, close interaction with grapegrowers and winemakers, collaboration with research partners, and an RD&E Plan solidly designed on scientific principles.

Among the many challenges facing winemakers and grapegrowers is the aspiration for development of objective ways to measure quality in grapes and wines. It is an elusive goal because not only is the composition of grapes and wine challenging to unravel, but consumer preferences constantly evolve, altering the type of measurements required. In addition to these changing preferences, quality is very much an individual feeling - not until the wine reaches the consumer's lips is the real judgement made of the quality in the bottle that in turn resulted from the quality in the grape.

In a globalised economy in which quality can be defined only loosely as 'sustainable customer and consumer satisfaction', it is a challenge for the industry to create and deliver wines that meet consumer expectations of quality while being price competitive in a range of markets. Success in such a demand-chain environment requires keeping abreast of how the application of new technologies can assist the wine industry to meet the challenges presented to it by consumers and competitors.

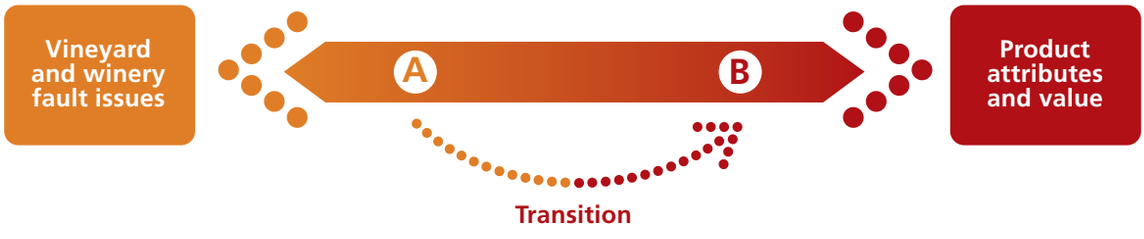

Figure 6. Transition of research focus

The challenge for the AWRI in its RD&E plan is to set clear goals from the variable messages on quality and other areas of consumer preference so that the outcomes delivered to winemakers and grapegrowers give them the management options and capabilities to deliver answers.

The AWRI's approach is a mix of strategic, applied *and* frontier *research leading to the transfer of knowledge to the industry while safeguarding it from external risks. It is an approach directed towards increasing fundamental understanding in a context responsive to applied needs of producers and consumers at the stages of both problem selection and experiment design (Figure 7).*

Innovation and knowledge generation will be pursued through the AWRI's strategic research projects, which form the main focus of activity. The potential to transform the Australian wine industry stemming from these long-term, multi-disciplinary and resource-intensive research efforts is critical to raise the bar. For the AWRI to support the industry through a *whole-of-chain* approach to wine production, it is essential for AWRI's *strategic* research to develop the required capabilities in new, emerging or additional disciplines and through collaborative alliances with other research bodies.

The second key element in the AWRI's research mix is *applied* research, whereby projects require

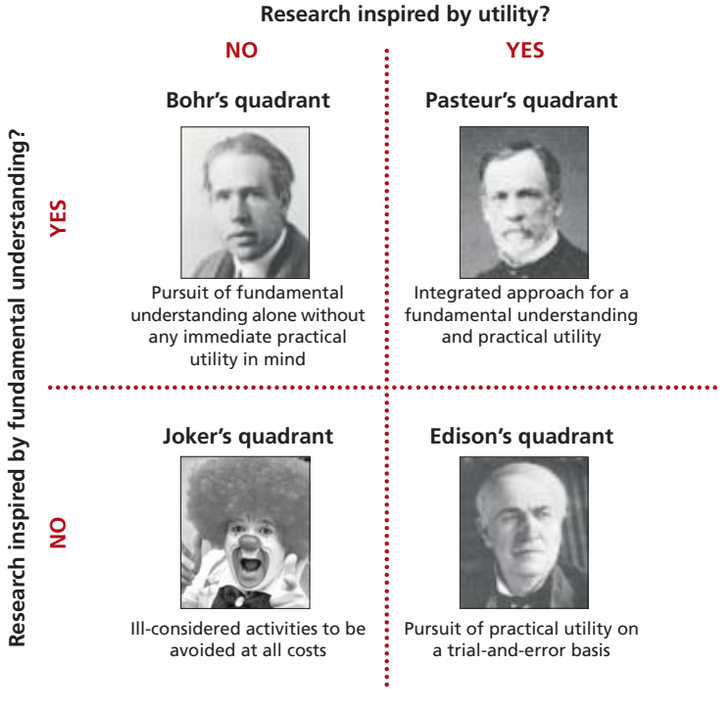

Figure 7. A schematic representation of the quadrant model for classifying research. Pasteur's quadrant shows graphically that grape and wine research need not be either fundamental or applied, but could be both simultaneously. The AWRI's research philosophy is directed towards increasing fundamental understanding in a context responsive to applied needs at levels of both problem selection and experimental design (Pasteur's quadrant). In this context, the AWRI aims to achieve the optimum mix of *Frontier*, *Strategic* and *Applied* research.

in-depth and practical knowledge of industry processes and the targeted application, and usually close interaction with industry partners. This applied research is essential to address industry needs efficiently by delivering robust knowledge critical for incremental improvements in quality and production efficiency.

Frontier research has the potential to move the goalposts and in this aspect, the AWRI will concentrate on issues where its capabilities can be exploited and the chance of success is high. This type of research is essential to maintain the momentum of change and innovation that will build the Australian wine industry of the future but the AWRI recognises that it is important only if it can lead to direct industry benefits as soon as possible, so projects that fit this area will be subject to a value filter.

The integrated solutions activity will provide industry members with opportunities for ' body contact' with the AWRI staff, to learn from the results of research activities, whether they are exclusively AWRI benefits or the result of collaboration with Wine Innovation Cluster and other members of AWRI's collaborative network. The communication and knowledge transfer activities will further embrace digital delivery technologies, to boost the industry's ability to access vital information and knowledge at optimum timeframes.

The AWRI's aim in its RD&E Plan is to be the industry's first stop for innovation in grape and wine composition and production, technical assistance (including winemaking, process improvement, rapid instrumental analysis, wine bottle closures and packaging), regulatory support, health and environmental issues, agrochemicals advice, quality assurance, extension and information resources, and analytical services.

Built on the foundation of this RD&E Plan, the mix of services will support the *whole-of-chain* process from vineyard to consumer.

Components of the Seven-Year RD&E Plan

In accordance with the market-driven ethos of the AWRI, the RD&E Plan is divided into four Themes, each with a series of Streams in which lie the intended Projects (Figure 8). The themes are:

1. Grape and wine composition
   Improving definition and control of wine composition and quality to better meet product specifications and consumer expectations, and to enable targeted improvements to production processes
2. Grape and wine production
   Enhancing efficiency and profitability across the production chain through innovative winemaking technology
3. Wine in society
   Enhancing the triple-bottom-line positioning of the Australian wine industry
4. Information and knowledge transfer
   Maintaining Australia's technological advantage by building the knowledge and skills of industry personnel

These themes are provided with functional support through the Office of the Managing Director and Corporate Services.

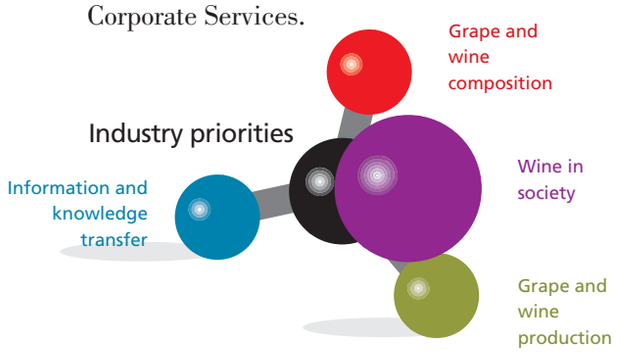

Figure 8. RD&E activities of the AWRI structured into four themes, which align with and support industry's priorities

Theme 1: Grape and wine composition

Improving definition and control of wine composition and quality to better meet product specifications and consumer expectations, and to enable targeted improvements to production processes

This theme is intended to improve definition and control of wine composition and quality to better meet product specifications and consumer expectations, and to enable targeted improvements to production processes.

It aligns with the GWRDC program areas of Innovation and Technology Adoption, and Quality and Differentiation; and with the SDG priority areas of Monitoring and Preserving Grape Quality; Managing Vineyards to Produce Quality Grapes; Monitoring and Manipulating Wine Quality; and Innovation in Winemaking Microbiology. It also addresses the following National Research Priorities: Frontier technologies for building and transforming Australian industries; An environmentally sustainable Australia; and Promoting and maintaining good health.

Research at the AWRI and elsewhere has shown how some wine compounds contribute to characteristic wine aromas and flavours, and how those are formed, enhanced or degraded in wine. Many key compounds of wine, both desirable and undesirable, remain poorly explained or yet to be identified, and the factors affecting their intensity in wine are poorly understood.

Knowledge of what factors are responsible for particular sensory properties, and reasons for the variability in the concentration of wine components, is necessary to devise methodologies to enable the

wine industry to modulate these sensory characteristics.

Previous work has also shown that choice of yeast and fermentation processes affects the composition of wine, influencing ethanol content and many crucial sensory attributes. Thus, microorganisms and fermentation processes provide practical targets for modulating the sensory attributes of wine without the need for major changes in winemaking practices or processing hardware.

In this context, the future of winemaking that aims to deliver consistently on consumer expectations will certainly rely on a wide selection of new and improved wine yeasts and methods for their efficient use that can impart to wine a range of desirable characters, enhanced flavour diversity and reduced alcohol content.

The activities of Theme 1 build on established research into the chemical nature, formation and fate of important wine compounds that play a key role in sensory attributes, including colour intensity and stability, aroma, mouth-feel, astringency and taste, and aim to develop the scientific framework for methodical improvements in red and white winemaking.

Objectives of Theme 1 include establishing the identity and relevance of many of the individual key compounds influencing wine quality, style and sensory properties, and developing robust and selective methods for measurement of key compounds. A fundamental increase in understanding the reactivity, structural and physicochemical properties of grape and wine compounds will provide knowledge to understand how production inputs, yeast strain selection and processing factors affect wine composition and sensory properties. In addition, improved insight into control and management options of the transformation of grape components will enable targeted development of optimised yeast strains and systematic improvements to viticultural and winemaking practices.

The reward for establishing such knowledge will be the capacity to manage both grapegrowing and winemaking to optimise key grape and wine components, and this will in turn translate to increased capacity to meet wine specifications, consumer expectations and profitability.

The *Streams* and *Projects* within Theme 1 are as follows:

Stream 1.1: Defining and controlling important volatile compounds in wine and their impact on wine aroma and flavour

> Defining the aroma and flavour impact of volatile wine components

> The formation and fate of important aroma and flavour compounds and precursors

> Interactions of non-volatile and volatile compounds in wine: major influences on flavour and mouth-feel perception

> Manipulation of nitrogen application in the vineyard and winery to optimise the secondary metabolite profile of wines to meet consumer demand

> Devlelopment and application of methods for the analysis of volatile aroma and flavour compounds and their precursors

Stream 1.2: Phenolics and their contribution to wine composition and sensory properties

> Structure and function of phenolic compounds in grapes and wine
> Grape phenolics and their contribution to wine composition and sensory properties
> Innovative phenolic analysis techniques

Stream 1.3: Microbial modulation of wine composition to increase wine value

> Flavour-enhancing yeast: developing wine yeast as a tool to adjust wine flavour and aroma to market specifications
> Generating wine yeast that make reduced levels of ethanol during wine fermentations
> Interspecies hybrid yeast to provide flavour diversity in wines
> Managing fermentation nutrients to meet wine composition and sensory specification
> Novel non-conventional yeast and inoculation strategies for modulating the flavour diversity of wine

Theme 2: Grape and wine production

Enhancing efficiency and profitability across the production chain through innovative winemaking technology

This theme is designed to increase efficiency and profitability throughout the production chain through innovative winemaking technology. It aligns with the GWRDC Program Areas of Innovation and Technology Adoption, and Quality and Differentiation; and with the SDG priority areas of Innovation in Winemaking Microbiology; Monitoring Grape and Wine Quality; Excellence in Winemaking Technology; Sustainability of Industry Processes; and Presentation and Distribution of Wine. It also addresses the following National Research Priorities: Frontier technologies for building and transforming Australian industries; An environmentally sustainable Australia; and Safeguarding Australia.

Australia is rightly seen as a technologically advanced producer of wines of high quality and integrity, and the AWRI has been instrumental in enabling the industry to develop and maintain that status by providing world-class and industry-relevant science. Equally importantly, the AWRI has actively facilitated adoption and application of new technologies. In an increasingly competitive global environment, innovation in winemaking technology across the grape-to-wine production chain will facilitate continued market success for Australia.

The key goals for this theme are to establish innovative, profitable, sustainable and flexible production techniques that allow winemakers to meet planned style and wine quality specification; accelerate the speed with which industry can respond to changing consumer preferences, and market opportunities and requirements; and safeguard the Australian wine industry and further strengthen its ability to meet the high quality, integrity and authenticity standards required to gain and maintain access to international markets.

Objectives of this theme include development of robust wine yeast strains that will reduce the risk of stuck and/or sluggish ferments and the improvement of malolactic fermentation to ensure efficient, successful and cost-effective fermentations.

Several projects focus on improving the efficiency and monitoring of post-fermentation processing operations. These projects include development of alternatives to bentonite fining through novel proteolytic enzymes and development of new heat treatment regimes. Research into the influences of winemaking practices, packaging choices, and transport and storage conditions on oxygen ingress, wine development, oxidative spoilage and shelf life in bottles will assist industry in its quest to maintain and optimise the quality of 'bottled sunshine' beyond the winery gates until it reaches the point of sale and consumer.

To refine decision-making protocols along the grape-to-wine production chain and to improve productivity and sustainability of grapegrowing and winemaking, the AWRI will continue investigations into, and adaptation of, innovative techniques for rapid analysis. These will target a wide range of applications including wine authentication, consumer and sensory evaluation of wine, grape and wine composition, and on-line and real-time analysis.

It is planned to facilitate the integration and assimilation of knowledge from other industries through strong collaboration with a range of disciplines, including process engineering, and exploration of promising technologies such as hyperspectral imaging, Raman spectroscopy and aroma sensors.

To complement its RD&E activities, this theme also encompasses the industry's front-line emergency response team, which is essential in providing identification and early warning of potential threats. In close collaboration with industry personnel, practical industry-wide solutions will be developed for widely-encountered technical problems and emerging issues. These can, potentially, have large scale negative impacts on quality, integrity or perception of Australian wine and will be addressed and resolved as quickly as possible .

The *Streams* and *Projects* within Theme 2 are as follows:

Stream 2.1: Optimising fermentation performance to maximise wine-production efficiency

> Improving stress-tolerance in wine yeast to reduce the incidence of suboptimal fermentations

> Optimising malolactic fermentation and other desirable bacterial inputs in wine fermentations

> Construction of a wine yeast gene deletion library and its application to improving wine diversity, quality and fermentation efficiency

> Development of a world-class microorganism culture collection for the Australian wine industry

Stream 2.2: Novel winemaking processes to stabilise and package wine and deliver it to the consumer in optimum condition whilst maintaining or improving quality, value and sustainability

> Predicting shelf life of bottled wines
> Protein stabilisation - developing viable alternatives to bentonite fining
> The role of oxygen ingress at bottling and oxygen transmission during storage on wine development

Stream 2.3: Process measurement and improvement

> Rapid analytical methods
> Process engineering and optimisation

Stream 2.4: Industry applications

> Investigations into the relationship between *Dekkera/Brettanomyces* yeast and wine spoilage
> Industry applications future projects

Stream 2.5: Protecting the quality and integrity of Australian wine

> Applications of mass spectrometry to ensure the quality and integrity of Australian wine
> Technical problem solving
> Emergency response

Theme 3: Wine in society

Enhancing the triple-bottom-line positioning of the Australian wine industry

This theme is designed to enhance the triple-bottom-line positioning of the Australian wine industry.

It aligns with the GWRDC Program Areas of Market Intelligence and Sustainable Production, and the SDG priority areas of Knowing our Consumers, Wine and Society; and Sustainability of all Industry Processes. It also addresses the following National Research Priorities: An Environmentally Sustainable Australia; and Promoting and maintaining good health.

The growth of the Australian wine industry has led to an inevitable increase in its profile in Australia and overseas. This in turn has led to increased interest and awareness of the industry in public spheres, particularly interest in its practices, governance, growing economic importance and use of natural resources.

As a consequence, interest from media, corporate customers, government organisations and non-government organisations (NGOs), and the general public concerning the position of the Australian wine industry on social and environmental matters is also increasing. Requests for information or for intervention on various issues are also regularly received from wine industry personnel and industry bodies in regard to approaches they have received. Many of these approaches are potential threats to the image of the industry in that they often result from ill-informed or negative comment, particularly

with regard to the anti-alcohol lobby, agrochemical use and other environmental matters, particularly those related to water, CCA (copper, chrome and arsenic)-treated timber, and management of winery effluents and other parts of the waste stream. When such issues arise, it is considered crucial that sound technical information is placed in the public domain, and that the industry's position is protected.

The AWRI performs an important function for the industry in this regard by developing and maintaining a knowledge base related to consumer, societal and environmental issues, and a capability to disseminate that knowledge to callers from all the categories listed. This is greatly facilitated by the AWRI staff members maintaining strong and positive relationships with opinion leaders in the media, government and NGOs. The effect is to enhance the positioning of the Australian wine industry with regard to its triple-bottom-line.

The AWRI proposes to create a new position for an environmental scientist who will take a leading role in understanding and responding to questions regarding environmental issues analogous to the AWRI's industry role on wine and health matters. This position will work closely with the Rapid Instrumental Analysis team as it develops methods to monitor winery wastewater in the first instance and other environmental indicators in due course.

As well, the industry's relationship with its consumers is developing in other ways and the AWRI has assumed a lead role with regard to understanding and defining consumers' wine product preferences. Synergies are seen here with regard to the promotion of wine as a healthy and socially responsible lifestyle beverage.

This theme has been developed to bring together the AWRI functions that relate to its, and the industry's, relationships with consumers and society in general. The AWRI foresees an increasing need to manage the industry's relationships with consumers and society as industry growth continues, public awareness of environmental matters increases, and consumers become more demanding in terms of product specification and preference.

The *Streams* and *Projects* within Theme 3 are as follows:

Stream 3.1: Wine and consumer needs

> Wine quality and consumer preferences

> Optimisation of sensory analysis methodology: efficiently delivering sound sensory data relevant to consumer requirements

Stream 3.2: Consumer health and safety

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

Stream 3.3: Environmental and technical, regulatory and trade issues

> Compilation, interpretation and communication of issues pertaining to responsible use of agrochemicals in Australian viticulture

> Regulatory, technical and trade issues impacting on the Australian wine industry

Stream 3.4: Environmental impact and sustainability

> Environmental impact and sustainability

Theme 4: Information and knowledge transfer

Maintaining our technological advantage by building the knowledge and skills of industry personnel

This theme is designed to maintain the AWRI's technological advantage by building the knowledge and skills of industry personnel.

It aligns with the SDG Priority Areas of Monitoring and Preserving Grape Quality; Managing Vineyards to Produce Quality Grapes; Excellence in Winemaking Technology; Monitoring and Manipulating Wine Quality; and Innovation in Winemaking Microbiology. It also addresses the following National Research Priorities: Frontier technologies for building and transforming Australian industries; An environmentally sustainable Australia; and Promoting and maintaining good health.

Australia has a global reputation as a technologically advanced wine producer. The AWRI has been at the forefront in providing the industry with the means to develop and maintain that status through a 50-year history of world-class and relevant science. Importantly, the AWRI has also actively facilitated adoption and application of science by the Australian wine industry, fostering a culture of life-long learning that, in turn, has been instrumental in building the capacity to experiment and innovate. This capacity is directly linked to the industry's market success.

Building the capacity to rapidly take up and benefit from new science and technology has helped to create a dynamic industry that is flexible and able to modify its products according to changing market demands. Entrenchment of this practice of adopting scientific and technological advances is at the core of the industry's culture and confers an important market advantage in an increasingly competitive global environment.

A great wealth of information relating to grape and wine production exists in the public domain and, as communication systems become faster and more accessible, that information is equally available to Australia's competitors.

The speed at which information and knowledge has been adopted and applied might have been the most important factor in developing the industry's current technologically advanced status. If that advantage over our global competitors is to be maintained, the speed of adoption and application will become even more crucial.

Therefore, the speed at which new technology is adopted becomes the key to maintaining the industry's technological advantage, and the speed at which industry is able to adopt will be dictated by the availability of easily accessible information, and the speed at which available information is converted to knowledge that can be applied to create positive outcomes on grape and wine quality.

Four steps are necessary to convert the available information into positive outcomes on grape and wine quality. First, the body of available information must be made readily available to industry in packaged forms that are customised for particular target groups. Second, for many end-user groups that information must be converted into knowledge that is appropriately packaged for those target audiences. Third, that knowledge and the information sources on which it is based must be

made available and disseminated to those audiences through efficient mechanisms that are constantly adapted in line with advances in information technology, and fourth, those dissemination mechanisms must be continually developed to favour the rapid adoption and application of the information and knowledge by the grape and wine industries.

This Theme has been designed to deliver all four of these steps, and has been divided into three Streams. Stream 1 covers the formation and presentation to industry of knowledge developed in the areas of viticulture, wine and health and regulatory issues, and on winemaking; Stream 2 covers the development of efficient delivery mechanisms for the provision of information and knowledge; and Stream 3 covers communication services and customised information delivery including the collection of technical information.

Theme 4, therefore, comprises the AWRI's many formal knowledge, collection, packaging and delivery mechanisms, which have been instrumental in enabling the Australian wine industry to develop and maintain its technologically advanced status.

The *Streams* and *Projects* within this Theme are:

Stream 4.1: Extension and knowledge transfer - the development and presentation of knowledge to industry personnel

> Transfer of knowledge relating to viticulture

> Transfer of knowledge relating to health, regulatory and technical matters pertaining to viticulture and winemaking

> Transfer of knowledge relating to winemaking

Stream 4.2: Creation of delivery mechanisms for the efficient transfer of knowledge and provision of technical information to the Australian grape and wine industries

> Organisation and staging of the AWRI's external knowledge transfer activities

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

Stream 4.3: Communication services and customised information delivery

> Provision of scientific, technical and regulatory information

> Improvement of knowledge management, stakeholder communication and culture at The Australian Wine Research Institute

Stream 4.4: Establishment of regional nodes of the AWRI

> A collaborative node in New South Wales

> A collaborative node in Victoria

> A collaborative node in Western Australia

> A collaborative node in Queensland

> A collaborative node in Tasmania

Support function: Executive management and administration

This support function assists the activities of all of the above Themes. It provides visionary and inspirational leadership, commercial and strategic business acumen, and an amalgam of operational services to underpin the AWRI's ability to achieve the objectives as stated in its Business Plan Towards 2015.

The two support functions are as follows:

Support Function 1: Office of the Managing Director

> Managing Director providing visionary, inspirational and thought leadership with scientific rigour, enhancing collaboration, ensuring the achievement of AWRI's objectives and that these objectives align with industry and government priorities

> Business Development Manager maximising AWRI's outputs of benefit to the industry by securing greater traditional and non-traditional funding

> Personal Assistant to the Managing Director providing high level administrative support for these activities with a qualified legal perspective

Support Function 2: Corporate Services

> Application of best practice accounting principles and reporting to ensure long term viability of the AWRI

> Financial management

> Risk management

> Accounts payable and receivable

> Compliance with the *Principles of Good Corporate Governance*

> Development and application of 'Employer of Choice' program

> Identification and provision of enabling information technology

> Compliance with occupational health, safety and welfare legislation

> Undertaking repairs and maintenance and responsibility for the general functionality and overall appearance of the physical infrastructure

Concluding remarks

It is true for grape and wine research, as for all science, that one of the biggest challenges is to show value and benefits in what can be achieved when innovators look over the horizon and see a future that awaits the general public, and in particular the consumer. We are reminded constantly in our daily lives of the contributions of science and technology that were barely foreseen when the research was being done decades earlier. Many benefits we enjoy today are the fruits of research planted decades ago. It is in this context that our Seven-Year RD&E Plan is aimed at increasing innovation and success for the Australian wine industry to 2012. We are determined to deliver high value and contribute substantially in a measurable way to the ongoing success of the Australian wine industry through the research, development and extension activities articulated in this plan.

In the highly competitive globalised wine sector, it could be that 'objects in the rear vision mirror are closer than they appear', therefore entertaining complacency is not an option. The road to success is always under construction and the AWRI staff members involved in this RD&E plan are the construction workers building that road for the industry's journey towards the horizon, rather than a destination. Times have changed: innovation at all levels is no longer just an option for a market-driven industry, it is a necessity. We believe that a scientific and technological response such as this RD&E plan is crucial to meeting the consumer challenge and opportunity. We consider science and technology to be an integral part of the 'marketing mix'. Through this plan, we will be geared to help grow the global wine market for Australia by delivering benefit to wine producers and consumers.

As the Australian wine industry's own RD&E facility with a 50-year history, the AWRI has fully aligned its RD&E plan with our industry's priorities and credo of a 'total commitment to innovation and style from vine to palate'. We realise that successful innovation needs creativity, persistence and a strong willingness to 'break the mould.' It is a truism that 'the world hates change, yet it is the only thing that has brought progress.' And some future changes might even be considered as 'radical' today. It is worthwhile reminding ourselves that 'the electric light did not come from the continuous improvement of candles.' The ongoing metamorphosis of the global wine sector has placed its product at the centre of an arena between the forces of 'market pull' and 'technology push', where tradition and innovation must co-exist (Figure 9).

Figure 9. A *whole-of-chain* approach to RD&E in support of a market-driven wine industry

However, consistent with the adage 'the Stone Age did not end because we ran out of stones', the Australian wine industry, despite the abundance of traditional approaches to grapegrowing and winemaking, will continue on the path of technological progress because this has given Australia an important edge in world markets.

Future RD&E activities at the AWRI and collaborating research and industry partnerships will focus strongly on four key areas of endeavour:

1. Grape and wine composition - improving definition and control of wine composition and quality to better meet product specifications and consumer expectations, and to enable targeted improvements to production processes

2. Grape and wine production - enhancing efficiency and profitability across the production chain through innovative winemaking technology

3. Wine in society - enhancing the triple-bottom-line positioning of the Australian wine industry

4. Information and knowledge transfer - maintaining our technological advantage by building the knowledge and skills of industry personnel

With this program of research, development and extension activity, coupled with a targeted integrated solutions strategy, The Australian Wine Research Institute plans to deliver improved consumer preference information, microbial strains, analytical methods, viticultural management and winemaking technologies to drive the Australian wine industry's future path to success.