

WINE AUSTRALIA

Benefit Cost Analysis of Wine Australia R&D Investments 2023-24

Report

4 April 2025



Australian Government

Wine Australia

**Wine
Australia
for
Australian
Wine**

Disclaimer

All description, figures, analyses, forecasts, and other details have been prepared in good faith from information furnished to Michael Clarke by other parties. These data are believed to be correct at the date of preparation of this report.

However, it should be noted that predictions, forecasts, and calculations are subject to assumptions which may or may not turn out to be correct and AgEconPlus expressly disclaim all and any liability to any persons in reliance, in whole or in part, on the report in total or any part of its contents.

AgEconPlus Pty Ltd

ABN 41 107 715 364

Michael Clarke

M: 0438 844 024

W: www.AgEconPlus.com.au

E: clarke@AgEconPlus.com.au

Table of Contents

<i>Executive Summary.....</i>	<i>4</i>
<i>Technical Summary.....</i>	<i>6</i>
<i>1. Introduction.....</i>	<i>9</i>
<i>2. Materials and Methods.....</i>	<i>9</i>
<i>3. Summary of Results.....</i>	<i>11</i>
<i>4. Conclusion.....</i>	<i>14</i>
<i>Appendix 1: Economic Analysis of Wine Australia's Investment in Market Access Support 2022/23.....</i>	<i>15</i>
<i>Appendix 2: Economic Analysis of Wine Australia's Investment in Managing Wine pH in a Changing Climate.....</i>	<i>26</i>
<i>Appendix 3: Economic Analysis of Wine Australia's Investment in Climate Adaptation: Developing Irrigation Strategies to Combat Dry Winters.....</i>	<i>37</i>
<i>Appendix 4: Economic Analysis of Wine Australia's Investment in Molecular Drivers of Wine Texture and Taste</i>	<i>48</i>

Executive Summary

Economic analyses of four research and development (R&D) projects funded by Wine Australia has been undertaken. The main purpose was to demonstrate the outcomes and benefits that have emerged or are likely to emerge from investment. This forms part of the process for the Council of Rural Research & Development Corporations (CRRDC) that aims to demonstrate the impact, effectiveness and return on investment from the Rural Research and Development Corporations. Wine Australia is funded by statutory levies paid by industry participants, with matching funding provided by the Australian Government up to 0.5 per cent of the industry's gross value of production.

Each of the four analyses provides a description of the constituent projects including objectives, outputs, activities, costs, outcomes, and benefits. Benefits are described qualitatively according to their contribution to the triple bottom line of economic, environmental, and social benefits. While a range of potential benefits of each project are identified, the analysis focused on the most likely and most significant benefit stream. A number of potential benefits therefore remained unquantified and hence the estimated net benefits of some projects may be considered conservative. The analyses were undertaken for total benefits and Wine Australia benefits, including those expected in the future as a result of the investment.

Investment in three of the four projects yielded positive results at a 5% discount rate and a 30 year analysis period (Table ES1). The fourth project failed to 'breakeven' when these conditions were applied.

Comparisons between project results should be made with caution due to uncertainties involved with assumptions and differing frameworks for each of the analyses.

Table ES1: Benefit Cost Analyses Four Wine Australia R&D Investments 2023-24 (discount rate 5%)

Investment Criteria	Investment Project			
	Market access support 2022/23 (AWR 2203)	Managing wine pH in a changing climate (CSU 1702-5)	Climate adaptation: developing irrigation strategies to combat dry winters (SAR 1701-2.1)	Molecular drivers of wine texture and taste (AWR 1701-3.1.3)
Benefit–cost ratio	3.96	0.86	3.05	2.09
Benefit-cost ratio range - core assumption sensitivity	1.98 to 5.17	0.43 to 1.28	1.45 to 4.58	0.84 to 5.88
Quantified benefits	Additional profitable wine sales in current and emerging wine markets.	Potential winemaker savings with reduced need to purchase tartaric acid.	Increased wine grape grower profit from additional yield of quality wine grapes in dry seasons.	Progress toward the consistent production of more profitable, premium wine with superior texture and taste.
Unquantified benefits	Industry/government with additional knowledge of issues affecting the trade in Australian wine and creating further market access gains.	Additional researcher skills in understanding the relationship between soil chemistry and wine grape quality.	Potential savings in drip irrigation infrastructure after project determined that multiple laterals are not required.	Potential winemaker efficiency and cost advantages associated with switching from cold settling to flotation.
	Additional profitable wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).	Additional grape grower understanding of soil management in order to deliver higher quality fruit.	Additional researcher skills in understanding grapevine response to water stress.	New understanding of ‘spritz’ and ‘savory’ attributes to support NOLO research.
			Additional grape grower understanding of how to manage seasonal irrigation and crop response in a future climate change scenario.	Additional researcher skills in assessment of non-volatile compounds impacting wine texture and taste.
			Additional profitable grape and wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).	Additional winemaker knowledge of techniques to improve the texture and taste of wine.
				Additional profitable grape and wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).

Technical Summary

This report presents the results of economic analyses of investments within the R&D Program of Wine Australia. The Program is funded by statutory levies paid by industry participants, with matching funding provided by the Australian Government up to 0.5 per cent of the industry's gross value of production.

The main purpose of undertaking the analyses was to demonstrate the outcomes and benefits that have emerged or are likely to emerge from investments. This forms part of the process for the Council of Rural Research & Development Corporations (CRRDC) that aims to demonstrate the impact, effectiveness and return on investment of the Rural Research and Development Corporations.

Wine Australia provided AgEconPlus with a list of the completed projects which the analyst numbered 1 to 21. An online random number generator was used to select projects. The results of random project selection are shown in Table 1.

Table 1 Projects Randomly Selected for Benefit Cost Analysis 2023-24

Code	Project Title	Investment
AWR 2203	AWRI Market access activities 2022/23.	100,000
CSU 1702-5	Managing wine pH in a changing climate.	412,737
SAR 1701-2.1	Climate adaptation: developing irrigation strategies to combat dry winters.	982,740
AWR 1701-3.3.3	Molecular drivers of wine texture and taste.	1,798,999
Investment in projects for analysis		\$3,294,476
Total of Wine Australia investment in completed projects		\$24,865,623
Analysis projects share of total investment		13%

Documentation for each of these projects was assembled with assistance from Wine Australia personnel and included project plans, progress reports, and final reports. Each of the analyses provides a description of the constituent projects including objectives, outputs, activities, costs, outcomes, and benefits. Benefits are described qualitatively according to their contribution to the triple bottom line of economic, environmental, and social benefits. While a range of potential benefits of each project are identified, the analysis focused on the most likely and most significant benefit stream. A number of potential benefits therefore remained unquantified and hence the estimated net benefit of some projects may be considered conservative.

Benefit cost analysis was conducted on the four projects to generate investment criteria. The Present Value of Benefits (PVB) and Present Value of Costs (PVC) were used to estimate investment criteria of Net Present Value and Benefit-Cost Ratio (BCR) at a discount rate of 5%. The Internal Rate of Return and Modified Internal Rate of Return were also estimated from the annual net cash flows. The PVB and PVC are the sums of the discounted streams of benefits and costs. All dollar costs and benefits were expressed in 2024 dollar terms. Future costs and benefits were discounted to the 2024/25 year while past costs were inflated to 2024 using the Gross Domestic Product deflator. A 30-year benefit time frame was used in all analyses, with benefits estimated for 30 years from the year of last investment in each project. Costs for the R&D projects included cash contributions (includes both Wine Australia and industry investment), as well as any other resources contributed by third parties (e.g., researchers or additional industry funds). Investment criteria were reported for 5-year intervals of benefits from zero to 30 years.

The analyses were undertaken for total benefits, including benefits expected in the future as a result of the investment. A degree of conservatism was used when finalising assumptions.

Sensitivity analysis was undertaken for several assumptions that had the greatest degree of uncertainty or for those that were seen to be key drivers of the investment criteria.

Table 2 presents the investment criteria for each of the projects analysed at a 5% discount rate and expressed in 2024 dollar terms. Given the assumptions made for each evaluation, three of four investments are expected to produce positive net benefits over 30 years from the last year of investment.

Table 2: Benefit Cost Analyses for Four Wine Australia R&D Investments 2023-24 (discount rate 5%)

Investment Criteria	Investment Project			
	Market access support 2022/23 (AWR 2203)	Managing wine pH in a changing climate (CSU 1702-5)	Climate adaptation: developing irrigation strategies to combat dry winters (SAR 1701-2.1)	Molecular drivers of wine texture and taste (AWR 1701-3.1.3)
Benefit-cost ratio	3.96	0.86	3.05	2.09
Benefit-cost ratio range - core assumption sensitivity	1.98 to 5.17	0.43 to 1.28	1.45 to 4.58	0.84 to 5.88
Quantified benefits	Additional profitable wine sales in current and emerging wine markets.	Potential winemaker savings with reduced need to purchase tartaric acid.	Increased wine grape grower profit from additional yield of quality wine grapes in seasons following dry winters.	Progress toward the consistent production of more profitable, premium wine with superior texture and taste.
Unquantified benefits	Industry/government with additional knowledge of issues affecting the trade in Australian wine creating further market access gains.	Additional researcher skills in understanding the relationship between soil chemistry and wine grape quality.	Potential savings in drip irrigation infrastructure after project determined that multiple laterals are not required.	Potential winemaker efficiency and cost advantages associated with switching from cold settling to flotation.
	Additional profitable wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).	Additional grape grower understanding of soil management in order to deliver higher quality fruit.	Additional researcher skills in understanding grape vine response to water stress.	New understanding of 'spritz' and 'savory' attributes to support NOLO research.
			Additional grape grower understanding of how to manage seasonal irrigation and crop response in a future climate change scenario.	Additional researcher skills in assessment of non-volatile compounds impacting wine texture and taste.
			Additional profitable grape and wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).	Additional winemaker knowledge of techniques to improve the texture and taste of wine.
				Additional profitable grape and wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).

1. Introduction

This report presents the results of economic analyses of investments within the R&D Program of Wine Australia. The Program is funded by statutory levies paid by industry participants, with matching funding provided by the Australian Government up to 0.5 per cent of the industry's gross value of production.

The main purpose of undertaking the analyses was to demonstrate the outcomes and benefits that have emerged or are likely to emerge from investments made in the program. This forms part of the process for the Council of Rural Research & Development Corporations (CRRDC) that aims to demonstrate the impact, effectiveness and return on investment from the Rural Research and Development Corporations.

Four R&D projects were randomly selected by AgEconPlus for evaluation.

Ascertaining the extent of benefits that have accrued as a result of the program investment can demonstrate to stakeholders such as levy payers, the impact of research investment. In addition, it can inform Wine Australia management regarding program performance from past investment decisions as well as for future allocation of program resources.

A summary of methods used in the analysis is provided in Section 2, including the process of project selection and the steps involved with individual benefit evaluation. Section 3 reports a summary of the benefits and of the investment criteria estimated for the four projects. A brief conclusion is provided in Section 4. Appendices 1 to 4 provide the detailed analyses for each of the projects.

2. Materials and Methods

2.1 Projects for Evaluation

Wine Australia provided AgEconPlus with a list of the completed projects which the analyst numbered 1 to 21. An online random number generator was used to select four projects. The results of random project selection are shown in Table 2.1.

Table 2.1 Projects Randomly Selected for Benefit Cost Analysis 2023-24

Code	Project Title	Investment
AWR 2203	AWRI Market access activities 2022/23.	100,000
CSU 1702-5	Managing wine pH in a changing climate.	412,737
SAR 1701-2.1	Climate adaptation: developing irrigation strategies to combat dry winters.	982,740
AWR 1701-3.3.3	Molecular drivers of wine texture and taste.	1,798,999
Investment in projects for analysis		\$3,294,476
Total of Wine Australia investment in completed projects		\$24,865,623
Analysis projects share of total investment		13%

2.2 Individual Analyses

Each investment was evaluated through the following steps:

1. Information from the original project plan, progress reports, and final report or other relevant reports and material was assembled with assistance from Wine Australia.
2. An initial description of the project background, rationale, objectives, activities, outputs and expected outcomes and impacts was drafted.
3. Initial drafts were forwarded to project principal investigators, members of any project steering committees, industry representatives, and Wine Australia personnel for comment.
4. Initial drafts were modified in light of stakeholder feedback.
5. Further information was assembled where appropriate, including from contact with industry representatives, and the quantitative analysis undertaken.
6. Some analyses proceeded through several drafts, both internally within the project team as well as externally via Wine Australia personnel and others.
7. Final drafts were passed to Wine Australia personnel for comment.

The potential benefits from each investment were identified and described in a triple bottom line context. The value of some of these benefits was then quantified.

The factors that drive the investment criteria for R&D include:

- The cost of the R&D.
- The magnitude of the net benefit per unit of production affected; this net benefit per unit also takes into account the costs of implementation.
- The quantity of production affected by the R&D, in turn a function of the size of the target audience or area, and the level of initial and maximum adoption ultimately expected, and level of adoption in the intervening years.
- The discount rate.
- The time elapsed between the R&D investment and commencement of the accrual of benefits.
- The time taken from first adoption to maximum adoption.
- An attribution factor can apply when the specific project or investment being considered is only one of several pieces of research or activity that has contributed to the outcome being evaluated.

It is also necessary when quantifying benefits to define a 'without R&D' scenario, referred to as the 'counterfactual'. The counterfactual usually lies somewhere between the *status quo* or business as usual case and the more extreme positions that the research would have happened anyway but at a later time; or the benefit would have been delivered anyway through another mechanism. The important issue is that the definition of the counterfactual scenario is made as consistently as possible between analyses.

Benefit cost analysis was conducted on all projects to generate investment criteria. The Present Value of Benefits (PVB) and Present Value of Costs (PVC) were used to estimate investment criteria of Net Present Value and Benefit-Cost Ratio (BCR) at a discount rate of 5%. The Internal Rate of Return and Modified Internal Rate of Return were also estimated from the annual net cash flows. The PVB and PVC are the sums of the discounted streams of benefits and costs. All dollar costs and benefits were expressed in 2024 dollar terms. Future costs and benefits were discounted to the 2024/25 year while past costs were inflated to 2024 using the Gross Domestic Product deflator. A 30-year benefit time frame was used in all analyses, with benefits estimated for 30 years from the year of last capital investment in each project. Costs for the R&D projects included the cash contributions of the Project (includes both Wine Australia and industry investment), as well as any other resources contributed by third parties (e.g., researchers or additional industry funds). Investment criteria were reported for 5-year intervals of benefits from zero to 30 years.

The analyses were undertaken for total benefits, including benefits expected in the future as a result of the investment. A degree of conservatism was used when finalising assumptions.

Sensitivity analysis was undertaken for several assumptions that had the greatest degree of uncertainty or for those that were seen to be key drivers of the investment criteria.

Some identified benefits were not quantified mainly due to:

- A suspected, weak, or uncertain scientific or causal relationship between the research investment and the actual R&D outcomes and associated benefits; and/or
- The magnitude of the value of the benefit was thought to be only minor.

3. Summary of Results

3.1 Qualitative Results

Table 3.1 identifies the benefits from investment in each of the projects. Each benefit is categorised as economic, environmental, or social.

Table 3.1: Summary of Benefits for the Four Projects

Project	Benefits
Market access support 2022/23 (AWR 2203)	<u>Economic</u> • Additional profitable wine sales in current and emerging wine markets. <u>Environmental</u> • Nil. <u>Social</u> • Industry and government with additional knowledge of issues affecting the trade in Australian wine. • Additional profitable wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).
Managing wine pH in a changing climate (CSU 1702-5)	<u>Economic</u> • Potential winemaker savings with reduced need to purchase tartaric acid. <u>Environmental</u> • Nil. <u>Social</u> • Additional researcher skills in understanding the relationship between soil chemistry and wine grape quality. • Additional grape grower understanding of soil management in order to deliver higher quality fruit. • Additional profitable grape and wine production and sales which will generate income, and employment benefits in warm inland regions (spill-over impact).
Climate adaptation: developing irrigation strategies to combat dry winters (SAR 1701-2.1)	<u>Economic</u> • Increased wine grape grower profit from additional yield of quality wine grapes in seasons following dry winters. • Potential savings in drip irrigation infrastructure after project determined that multiple laterals are not required. <u>Environmental</u> • Nil. <u>Social</u> • Additional researcher skills in understanding grape vine response to water stress. • Additional grape grower understanding of how to manage seasonal irrigation and crop response in a future climate change scenario. • Additional profitable grape and wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).

Molecular drivers of wine texture and taste (AWR 1701-3.1.3)	<u>Economic</u> • Progress toward the consistent production of more profitable, premium wine with superior texture and taste. • Potential winemaker efficiency and cost advantages associated with switching from cold settling to flotation. • New understanding of 'spritzy' and 'savoury' attributes to support NOLO research. <u>Environmental</u> • Nil. <u>Social</u> • Additional researcher skills in assessment of non-volatile compounds impacting wine texture and taste. • Additional winemaker knowledge of techniques to improve the texture and taste of wine. • Additional profitable grape and wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).
---	---

3.2 Quantitative Results

The investment criteria calculated for each research area were the Net Present Value (NPV), the Benefit Cost Ratio (B/C Ratio), the Internal Rate of Return (IRR) and the Modified IRR (MIRR). The NPV is the difference between the Present Value of Benefits (PVB) and the Present Value of Costs (PVC). Present values are the sum of discounted streams of benefits and/or costs. The B/C Ratio is the ratio of the PVB to the PVC. The IRR is the discount rate that would equate the PVB and the PVC, thus making the NPV zero and the B/C Ratio 1:1. The MIRR is the same as the IRR but assumes that the reinvestment rate is the same as the assumed discount rate i.e. 5%, rather than the level of the estimated IRR.

Table 3.2 presents the investment criteria for each of the project investments at a 5% discount rate.

Further details on each of these investments and the associated results are provided in the individual project reports (Appendices 1 to 4).

Table 3.2: Investment Criteria for four Wine Australia Investments (discount rate 5%, 30 years from last year of investment)

Investment Criteria	Investment Project			
	Market access support 2022/23 (AWR 2203)	Managing wine pH in a changing climate (CSU 1702-5)	Climate adaptation: developing irrigation strategies to combat dry winters (SAR 1701-2.1)	Molecular drivers of wine texture and taste (AWR 1701-3.1.3)
Present value of benefits (\$m)	0.67	1.75	13.93	6.30
Present value of costs (\$m)	0.17	2.05	4.56	3.01
Net present value (\$m)	0.50	-0.30	9.36	3.29
Benefit-cost ratio	3.96	0.86	3.05	2.09
Benefit-cost ratio range - core assumption sensitivity	1.98 to 5.17	0.43 to 1.28	1.45 to 4.58	0.84 to 5.88
Internal rate of return (%)	37.6	3.5	13.3	8.8
Modified internal rate of return (%)	9.8	4.2	8.5	7.2

4. Conclusion

Three of four investment analyses yielded positive results at the 5% discount rate, with B/C Ratios of 3.96 (AWR 2203), 3.05 (SAR 1701-2.1), and 2.09 (AWR 1701-3.1.3). The fourth investment failed to 'break even' when these conditions were applied. The fourth investment (CSU 1702-5: Managing wine pH in a changing climate) had a B/C Ratio of 0.86.

The results from the analyses are dependent on the assumptions made, which in places are uncertain. Assumptions and frameworks could be refined in the future as research outputs are realised, to improve the overall analysis. Comparisons between project results should be made with caution due to uncertainties involved in assumptions and differing frameworks for each of the analyses.

Appendix 1: Economic Analysis of Wine Australia's Investment in Market Access Support 2022/23

1. Background

Market access includes:

- Tariff measures facing imports of Australian wine (but not domestic taxes in the destination market); and
- Non-tariff barriers including those relating to (for example) wine labelling, wine composition; winemaking techniques, and analysis and certification requirements.

Generally, in order to successfully export wine from Australia, the wine (composition and labelling) must comply with the laws of the destination market, and in order to successfully import Australian wine into a foreign market, the wine (composition and labelling) must comply with the laws of that market. Accordingly, in circumstances where approximately 60% of Australian wine is exported and Wine Australia and the Australian wine industry has identified the want and need to pursue an export growth and diversification agenda, market access is pivotal to the success of the Australian grape and wine industry.

Market access is created and maintained by generating and disseminating accurate scientific and technical data to inform decision making. A 'rules based' trading system is more likely to produce a favourable outcome for the Australian wine industry when presented with accurate and timely data.

Wine Australia leads the Australian grape and wine sector's Market Access Working Group. The Working Group is made up of Wine Australia, the Australian Wine Research Institute (AWRI), and peak industry body Australian Grape and Wine (AGW). The Market Access Working Group addresses technical barriers to trade through a combination of:

- Direct negotiation with counterpart regulators in overseas markets.
- Participation in collaborative action through international forums such as the International Organisation for Wine and Vine (OIV).
- Supporting government trade negotiators with reliable and relevant technical advice, especially when negotiating free trade agreements.

The project forms part of a rolling program of investment in scientific and technical research to support market access for Australian wine. This analysis deals with a single year of investment – 2022/23.

2. Summary of Project

Table 2.1 provides a description of the project in a logical framework.

Table 2.1 Project Description

AWR 2203 Market Access Support 2022/23	
Project Details	Research Organisation: AWRI. Period: July 2022 to June 2023. Principal Investigators: Eric Wilkes and Markus Herderich. Wine Australia Program Manager: Rachel Triggs (now Ned Hewitson).
Rationale	This project was to support the market access strategy for the Australian grape and wine sector. Many impediments to the international trade in wine relate to technical issues, such as the use of agricultural chemicals or unauthorised winemaking materials. To address these issues and bolster wine exports, access to scientific expertise of the type found in the AWRI was required.
Objectives	Scientific and technical support was to be provided in order to:

	1. Maintain a current trade and market access strategy. 2. Identify and respond to existing and emerging barriers to market access. 3. Facilitate negotiation of free trade agreements. 4. Influence the international regulatory environment and build relationships with overseas counterparts. 5. Make information available and educate industry to ensure minimal non-compliance with international requirements.
Activities and Outputs	<u>OIV activities and outputs 2022/23</u> • Active participation in working groups and electronic meetings to review draft standards with OIV adopting 35 resolutions. • Key resolution: Standard that permits use of dimethyl decarbonate (DMDC) as a processing aid (rather than an additive). DMDC used to ensure shelf-life and stability during export shipments and in bottled products. • Key resolution: Standard that clarifies the appropriate use of 'total dry extract' in assessing wine authenticity- 'total dry extract' must be considered in partnership with other measures to detect possible wine frauds. Major step forward in removing a technical barrier to trade for Australian wine. • Input to the drafting of other Standards including smoke taint, use of tartaric acid, and definitions of NOLO beverages. • Examples of other achievements from OIV participation include agreement on gum Arabic, silver chloride, arsenic, allergens, CO₂, skimmed milk and use of plant fibres. Achievements contribute to regulatory and trade certainty. <u>FIVS activities and outputs 2022/23</u> • International Federation of Vins et Spiritueux (FIVS) collates emerging technical issues and develops industry-focussed resources for members to use in forums such as Codex (international food Standards body) and OIV. • A notable achievement was chairing the working group on smoke impacts which focussed on testing methods for smoke markers. Agreement on methods and variation between methods will improve overall confidence in the quality of Australian wine and facilitate trade growth. <u>World Wine Trade Group (WWTG) activities and outputs 2022/23</u> • AWRI participation in WWTG meetings focussed on improving the definition of sustainability in the international market place for wine. A survey of sustainability platforms was completed and recommendations prepared. • The WWTG also continued to monitor international technical barriers to trade and provide a robust database of emerging issues and a platform to develop common responses. <u>Access to Indian Markets activities and outputs 2022/23</u> • Participation in a trade delegation to India. Delegation investigated technical collaboration in grape and wine production, met with government officials and considered opportunities to improve ease of access for Australian wine. • A regulatory forum was convened in Australia and the India-Australia government joint dialogue advanced regulatory and technical proposals. <u>Targeted Information for Stakeholders 2022/23</u> • Information supplied to producers to reduce the impact of new European Union regulation on energy, nutritional, and ingredient labelling of wine. • Information supplied on use of allyl isothiocyanate as a microcide. • Information supplied to United Kingdom (UK) Customs on average alcohol content of Australian wine to support fair excise payments. • Analysis of Wine Australia survey results detailing wine residue levels for benzoic acid, sorbic acid, arsenic, and lead. Data generated allowed the

	Australian Government to make a successful case for a relaxation of testing of wine destined for export markets, especially the Thailand market. Update of databases that inform trade access. Data collated included alcohol content, sulphur dioxide, and microbiological stability.
Outcomes	- A strengthening of the negotiating position of the Australian wine industry. - The negation of trade barriers that would constrain Australian wine sales. - Fewer market barriers and additional Australian wine sales.
Impacts (potential)	- Economic – additional profitable wine sales in current (e.g., UK) and emerging (e.g., India, Thailand) wine markets. - Capacity – industry and government with additional knowledge of issues affecting the trade in Australian wine which in turn has potential to generate its own set of market access benefits in the future. A reoccurring impact of investment in this project. - Social – additional profitable wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).

3. Match with National Priorities

Table 3.1 Australian Government Research Priorities

Australian Government Strategies and Priorities	
National Science and Research Priorities 2024 ¹	National Agricultural Innovation Priorities ²
Transitioning to a net zero future – develop and use new technologies, materials and processes to change energy generation and storage, heavy industries and agriculture. Australia will transition to a circular economy. Workforces will have the skills for future jobs. Supporting healthy and thriving communities – develop the technologies, tools and techniques for more Australians to enjoy healthier lives from birth well into old age. New treatments, medicines and therapies to support an aging population. Elevating Aboriginal and Torres Strait Islander knowledge systems – built practices than can integrate Aboriginal and Torres Strait Islander knowledge. Position Aboriginal and Torres Strait Islander peoples to lead research that affects them – as community leaders, traditional knowledge holders or researchers. Protecting and restoring Australia’s environment –protect Australia’s unique environments from the impacts of climate change and other threats. Monitor, restore and preserve biodiversity, landscapes and ecosystems. Building a secure and resilient nation – strengthen Australia’s democratic institutions	On 11 October 2021, the National Agricultural Innovation Policy Statement was released. It highlights four long-term priorities for Australia’s agricultural innovation system to address by 2030. These priorities replace the Australian Government’s Rural Research, Development and Extension Priorities which were published in the 2015 Agricultural Competitiveness White Paper. - Australia is a trusted exporter of premium food and agricultural products by 2030. - Australia will champion climate resilience to increase the productivity, profitability, and sustainability of the agricultural sector by 2030. - Australia is a world leader in preventing and rapidly responding to significant incursions of pests and diseases through futureproofing our biosecurity system by 2030. - Australia is a mature adopter, developer, and exporter of digital agriculture by 2030.

¹ See: Australian Government Department of Industry, Science and Resources 2024 Australia’s National Science and Research Priorities. <https://www.industry.gov.au/publications/national-science-and-research-priorities-2024>

² See: 2021 National Agriculture Innovation Policy Statement. https://www.awe.gov.au/agriculture-land/farm-food-drought/innovation/research_and_development_corporations_and_companies#government-priorities-for-investment. NB: Statement checked on the DAFF website and found to current, January 2025.

and freedoms while addressing challenges from foreign interference, disinformation, and polarisation. Australia is ready to respond to shocks caused by climate change, natural disasters, geopolitical tensions, rapid technology changes and more competition for resources and supply chains.	
--	--

The Wine Australia project has addressed National Agricultural Innovation Priority one.

4. Identification of Potential Costs and Benefits

4.1 Costs

4.1.1 R&D Investment

The R&D investment costs comprised:

- Direct financial outlays by Wine Australia, the project funding body. These costs include both project and overhead expenditures.
- Research partner contributions to the project – in-kind contributions were made by AWRI to this project.
- In-kind contributions to the research project by others – time associated with meetings between the researchers, peak industry body AGW, and Wine Australia and users of the information including the Australian Government Department of Agriculture, Fisheries, and Forestry (DAFF).

4.1.2 Administration

No additional administration costs were identified.

4.1.3 Extension

The project budget included communication of information on market access opportunities and threats to trade negotiates in DAFF. No additional extension costs were incurred.

4.1.4 Adoption

Adoption costs are not relevant to this project. Information was generated, packaged and provided to trade negotiators who then used the data to inform export customer decision making.

4.2 Benefits

4.2.1 Research Output and Impact Pathway

The key output from the project is data to improve international market access for Australian wine. The impact pathway for this output is:

1. Research, package and presentation of technical and scientific data.
2. Communication of findings to DAFF and decision making bodies (e.g., OIV for international standards).
3. DAFF negotiations to ease international market restrictions.
4. Additional profitable wine sales in current and emerging wine markets.

4.2.2 Triple Bottom Line Benefits

A summary of potential benefits from the project in triple bottom line categories is shown in Table 4.1.

Table 4.1 Triple Bottom Line Categories Benefits from Project Investment

Levy Paying Industry	Spillovers		
	Other Industries	Public	Foreign
<u>Economic Benefits</u>			
Additional profitable wine sales in current and emerging wine markets.	Nil.	Nil.	Improved market access delivered by this project may also facilitate wine exports from other countries.
<u>Environmental Benefits</u>			
Nil.	Nil.	Nil.	Nil.
<u>Social Benefits</u>			
Industry and government with additional knowledge of issues affecting the trade in Australian wine. Additional profitable wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).	Nil.	Nil.	Nil.

4.2.3 Public versus Private Benefits

The majority of benefits that will arise from this project will be private in nature. The private benefits will be mostly captured by winemakers and exporters. The private benefits will focus on additional higher priced sales of Australian wine on export markets. Secondary public benefits include increased industry and government capacity and spill-over benefits for winemaking communities.

4.2.4 Distribution of Benefits along the Supply Chain

The benefits to the wine industry from investment in this project will be shared along the supply chain with exporters, wholesalers, winemakers, and grape growers all capturing some of the benefits.

4.2.5 Benefits to other Primary Industries

No benefits to other primary industries were identified. Market access protocols and regulations are product specific and in this case focus on wine.

4.2.6 Benefits Overseas

Consumers in overseas markets may benefit from access to additional wine from Australia and other wine exporting countries.

4.3 Summary of Costs and Benefits

A summary of principal categories of costs and benefits from the project is shown in Table 4.2.

Table 4.2 Incremental Cost and Benefit Categories

Costs	Benefits
R&D investment costs (cash and in-kind) incurred by Wine Australia and other project investors including project administration costs.	Additional profitable wine sales in current and emerging wine markets.
Overhead costs including time associated with meetings between the researchers, Wine Australia and collaborating organisations.	Industry and government with additional knowledge of issues affecting the trade in Australian wine.
	Additional profitable wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).

5. Valuation of Costs and Benefits

5.1 Costs

5.1.1 R&D Investment Costs including Administration

The following table shows annual investment in the project by Wine Australia (Table 5.1). Project investment was for a single year.

Table 5.1 Investment by Wine Australia in the Project for a Single Year Ending June 2023

Project Code	2018	2019	2021	2022	2023	Total
AWR 2203	0	0	0	0	100,000	100,000
Total	0	0	0	0	100,000	100,000

Source: AWR 2203 Research Agreement

There was no other cash investor in AWR 2203. However, AWRI used its laboratories and testing facilities to analyse data in support of this project. An allowance has been made by the analyst for this in-kind support (Table 5.2).

Table 5.2 Investment by Others in the Project for Years Ending June 2018 to June 2023

Project Code	2019	2020	2021	2022	2023	Total
AWR 2203 AWRI in-kind	0	0	0	0	25,000	25,000
Total	0	0	0	0	25,000	25,000

Source: AWR Research Agreement

Table 5.3 provides the total investment by year for both sources.

Table 5.3 Annual Investment in the Project (nominal \$)

Year Ending 30 June	Wine Australia	Others	Total
2023	100,000	25,000	125,000
Total	100,000	25,000	125,000

5.1.2 Overhead Costs including Meetings between the Researchers and Wine Australia

Wine Australia overhead costs are in addition to those shown in the above tables and are estimated at 12%.

5.1.3 Project Collaborator Costs

Time associated with meetings between AWRI, AGW, Wine Australia and users of the technical and scientific data (e.g., DAFF) are a project cost. These costs are estimated at \$10,000 in 2022/23 and are included in the quantitative component of the benefit cost analysis.

5.2 Benefits

Counterfactual: in the absence of this project, it is likely that DAFF, Wine Australia, GWA and others would have been dependent on political processes and negotiation skills rather than accurate scientific

and technical data to maintain and improve export market access. Consequently, it is only 20% likely that project benefits would have been generated in the absence of the project. The corresponding counterfactual is therefore 80%.

Additional Profitable Wine Sales in Current and Emerging Wine Markets

The project is expected to contribute to additional export sales of Australian wine across a broad range of countries including established markets such as the UK and emerging markets such as Thailand and India. The benefit is quantified assuming additional sales of approximately 0.2% three years after project completion.

A summary of key assumptions is shown in Table 5.4.

Table 5.4 Summary of Assumptions

Variable	Assumption	Source
Additional Profitable Wine Sales in Current and Emerging Wine Markets		
Value of Australian wine exports.	\$2.05 billion.	3 year average, Wine Australia data: 2021/22: \$2.10 billion 2022/23: \$1.86 billion 2023/24: \$2.19 billion
Wine sales growth foregone in absence of project contributions to OIV, FIVS, WWTG, and market development in India.	0.2% (or \$4M per annum).	Analyst's estimate after review of advice provided by Prof. Markus Herderich, AWRI.
Lag between investment in AWR 2203 and start of predicted market growth.	3 years (2026).	Analyst's estimate – for example, changes in OIV Standards need to filter through to importing country protocols and importer decision making.
Duration of AWR 2203 impact given emergence of new technical barriers to trade.	5 years (2031).	Analyst's estimate - market growth generated by AWR 2203 constrained by new trade issues after a relatively short time.
Attribution of benefits to the AWRI market access project after considering the importance of industry and government negotiation and other sources of scientific and technical data.	10%	Analyst's estimate after review of advice provided by Prof. Markus Herderich, AWRI.
Probability of valuable outputs.	100%	AWR 2203 has delivered valuable scientific and technical insight.
Probability of valuable outcomes.	80%	It is not certain that outputs will translate into valuable outcomes.
Probability of valuable impacts.	60%	Other factors will determine growth in Australian wine exports.
Counterfactual	80%	See above explanation.

5.2.2 Other Potential Benefits

Other potential benefits identified but not valued are summarised in Table 4.2. Other potential benefits were not quantified due to their relatively minor contribution to total impact and difficulty in securing data for quantification.

6. Results

6.1 Year of Assessment, Discount Year, Discount Rate and Analysis Period

Past and future cash flows were expressed in 2023/24-dollar terms and were discounted to the year 2024/25 using a discount rate of 5% to estimate the investment criteria and a 5% reinvestment rate to estimate the modified internal rate of return (MIRR). The base run used the best estimates of each variable, notwithstanding a high level of uncertainty for some of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2023).

Table 6.1 and Table 6.2 show the investment criteria estimated for the different periods of benefits for total investment and Wine Australia investment.

Table 6.1 Investment Criteria for Total Investment by Wine Australia and Project Partners (discount rate 5%)

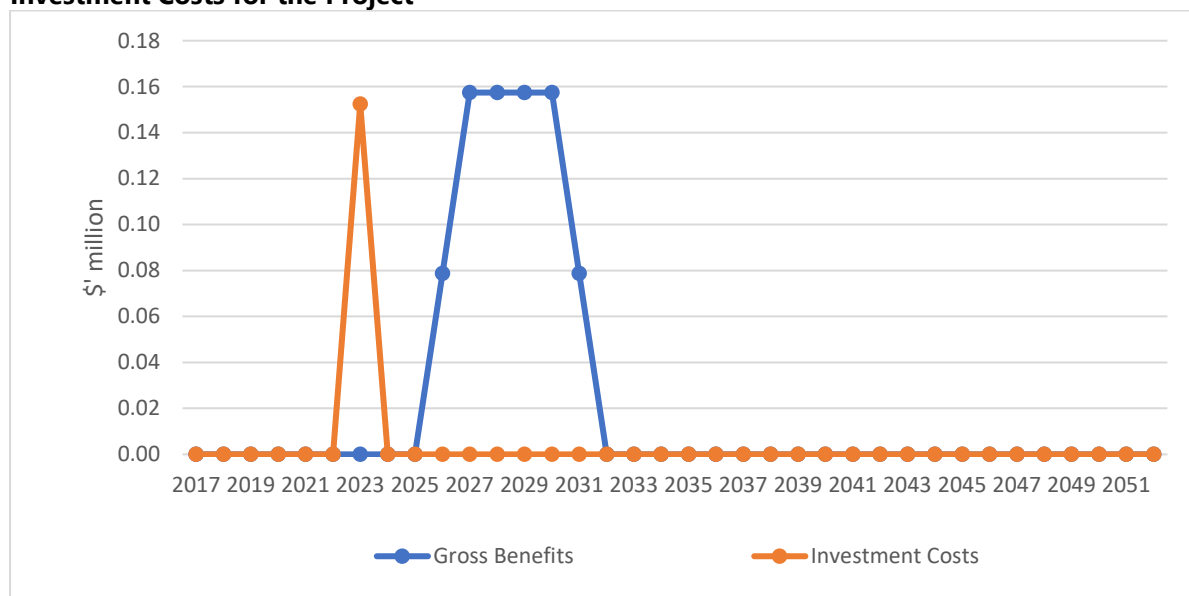
Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits (\$m)	0.00	0.35	0.67	0.67	0.67	0.67	0.67
Present value of costs (\$m)	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Net present value (\$m)	-0.17	0.19	0.50	0.50	0.50	0.50	0.50
Benefit–cost ratio	0.00	2.11	3.96	3.96	3.96	3.96	3.96
Internal rate of return (%)	Negative	25.8	37.6	37.6	37.6	37.6	37.6
MIRR (%)	Negative	18.9	19.0	14.4	12.1	10.7	9.8

Table 6.2 Investment Criteria for Wine Australia Investment (discount rate 5%)

Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits (\$m)	0.00	0.27	0.51	0.51	0.51	0.51	0.51
Present value of costs (\$m)	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Net present value (\$m)	-0.13	0.14	0.38	0.38	0.38	0.38	0.38
Benefit–cost ratio	0.00	2.11	3.96	3.96	3.96	3.96	3.96
Internal rate of return (%)	Negative	25.8	37.6	37.6	37.6	37.6	37.6
MIRR (%)	Negative	18.9	19.0	14.4	12.1	10.7	9.8

The annual undiscounted benefits and cost cash flows for the total investment for the duration of the investment period plus 30 years from the last year of the initial investment are shown in Figure 6.1.

Figure 6.1 Annual Undiscounted Cash Flows for Estimated Total Benefits and Total RD&E Investment Costs for the Project



7. Sensitivity Analysis

A sensitivity analysis was carried out for the central analysis results reported in Section 6 and variations in the discount rate. Table 7.1 presents the results. The results are not sensitive to the discount rate used. This is because project benefits are generated shortly after investment and only realised for a short period of time.

Table 7.1 Sensitivity to Discount Rate (Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present value of benefits (\$m)	0.79	0.67	0.57
Present value of costs (\$m)	0.15	0.17	0.18
Net present value (\$m)	0.63	0.50	0.39
Benefit-cost ratio	5.17	3.96	3.09

Sensitivity analyses were undertaken for those variables where there was greatest uncertainty or for those that were identified as key drivers of the investment criteria. The analyses were performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values.

For this project, the greatest uncertainty related to additional wine sales in export markets as a result of the project and attribution of benefits to the project – Table 7.2 and Table 7.3. Results show that the benefit cost ratio is sensitive to both these assumptions and if additional wine sales are only 0.05% or attribution only 2.5%, then project benefits equate to project costs (i.e., investment in the project would 'breakeven').

Table 7.2 Sensitivity to Additional Export Wine Sales from Project (Total investment, 30 years)

Investment Criteria	Additional Wine Sales Due to Project (%)		
	0.05%	0.1%	0.2% (base)
Present value of benefits (\$m)	0.17	0.33	0.67
Present value of costs (\$m)	0.17	0.17	0.17
Net present value (\$m)	0.00	0.16	0.50
Benefit-cost ratio	0.99	1.98	3.96

Table 7.3 Sensitivity to Attribution of Impacts to this Project (Total investment, 30 years)

Investment Criteria	Attribution of Impact to AWR 2203 (%)		
	2.5%	5%	10% (base)
Present value of benefits (\$m)	0.17	0.33	0.67
Present value of costs (\$m)	0.17	0.17	0.17
Net present value (\$m)	0.00	0.16	0.50
Benefit-cost ratio	0.99	1.98	3.96

8. Confidence Ratings

The results produced are highly dependent on the assumptions made, many of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made, including the linkage between the research and the assumed outcomes.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 8.1). The rating categories used are High, Medium, and Low, where:

- High: denotes a good coverage of benefits or reasonable confidence in the assumptions made
- Medium: denotes only a reasonable coverage of benefits or some uncertainties in

assumptions made
 Low: denotes a poor coverage of benefits or many uncertainties in assumptions made

Table 8.1 Confidence in Analysis of Program

Coverage of Benefits	Confidence in Assumptions
High	Medium

9. Summary of Results

Funding for AWR 2203 'investment in market access support 2022/23' had a total cost of \$0.17 million (present value terms) and is expected to produce aggregate total benefits of approximately \$0.67 million (present value terms). This gives an estimated net present value of \$0.5 million, a benefit-cost ratio of approximately 3.96, an internal rate of return of 37.6% and a modified internal rate of return of 9.8%.

Analysis results are dependent on assumptions made and are positive for core assumptions. 'Breakeven' does not occur until modest estimates of impact are modelled.

Abbreviations

AGW	Australian Grape and Wine
AWRI	Australian Wine Research Institute
DAFF	Australian Government Department of Agriculture, Fisheries, and Forestry
DFAT	Australian Government Department of Foreign Affairs and Trade
DMDC	dimethyl decarbonate
ESG	Environmental, Social, and Governance
FIVS	International Federation of Vins et Spiritueux
GDP	Gross Domestic Product
GVP	Gross Value of Production
NOLO	No and Low Alcohol (wine)
OIV	International Organisation for Wine and Vine
R&D	Research and Development
RD&E	Research, Development and Extension
UK	United Kingdom
WWTG	World Wine Trade Group

Persons Contacted

Angelica Crabb, Senior Analyst, Wine Australia
 Markus Herderich, Director of Research, AWRI
 Ned Hewitson, General Counsel and General Manager, Regulation, Wine Australia
 Mara Khem, Research and Innovation Administrator, Wine Australia
 Mark Krstic, Managing Director, AWRI
 Rachel Triggs, Previous Head of ESG and Market Access, Wine Australia
 Eric Wilkes, Affinity Labs (previously AWRI)

References

AgEconPlus (2018) Economic Analysis of Wine Australia's Investment in Increasing Australia's Influence in Market Access, Safety, Regulatory and Technical Trade Issues. Report prepared for Wine Australia.

Australian Bureau of Statistics. (2024, December 4). Australian National Accounts: National Income, Expenditure and Product Quarterly estimates of key economic flows in Australia, including gross domestic product (GDP), consumption, investment, income and saving. Table 5. Expenditure on Gross Domestic Product (GDP), Implicit price deflators. Retrieved from Australian Bureau of Statistics: <https://www.abs.gov.au/statistics/economy/national-accounts/australian-national-accounts-national->

[income-expenditure-and-product/latest-release#data-download](#)

Council of Rural Research and Development Corporations. (2018). Cross-RDC Impact Assessment Program: Guidelines. Canberra: Council of Rural Research and Development Corporations. Retrieved from http://www.ruralrdc.com.au/wp-content/uploads/2018/08/201804_RDC-IA-Guidelines-V.2.pdf

Wine Australia (December 2024) Australian Wine Sector at a Glance 2023/24. Accessed at <https://www.wineaustralia.com/market-insights/australian-wine-sector-at-a-glance>

Appendix 2: Economic Analysis of Wine Australia's Investment in Managing Wine pH in a Changing Climate

1. Background

In recent decades, wine alcohol levels have risen as a result of increased berry sugar. Similarly, over this same period, Titratable Acid (TA) has decreased, and pH has increased. TA is a measure of the acid content of juice, must, and wine. It is usually reported in units of tartaric acid, malic acid, or citric acid. Increasing pH means that the wine is less acidic, and tartaric acid may need to be added during the winemaking process which adds to production cost. Without augmentation, low acid juice may result in wine that lacks flavour and aroma.

High ambient temperature accelerates the loss of berry acidity through malic acid degeneration during ripening. Past research has demonstrated that high berry potassium is associated with low acidity and high pH. Potassium is an essential nutrient for both the grapevine and the berry. Potassium transport through the vine and into the berry is linked with the transport of both sugar and water.

Potassium accumulation can be linked to climate change for the following reasons:

1. Warmer temperatures initiate earlier ripening, which stimulates the linked sugar-potassium-water transport into the berry.
2. Warmer climates are associated with higher evaporative demand and higher vapour pressure deficit, which accelerates transpiration and the associated uptake of nutrients through the vine's vascular system.
3. Increased atmospheric carbon dioxide stimulates photosynthetic rates, leading to more vigorous vines, a more extensive root system and greater potassium uptake.

2. Summary of Project

Table 2.1 provides a description of the project in a logical framework.

Table 2.1 Project Description

CSU 1702-5 Managing Wine pH in a Changing Climate	
Project Details	Research Organisation: Charles Sturt University (CSU). Period: July 2019 to December 2022 (final report date). Principal Investigators: Suzy Y Rogiers. Wine Australia Program Manager: Alex Sas.
Rationale	Potassium (K ⁺) is the dominant cation (positive charge) of the berry. This nutrient regulates berry sugar accumulation and has a strong influence on wine microbiological stability and fermentation processes. Past research has demonstrated that a high concentration of K ⁺ in the berry is associated with high total soluble solids (TSS), however links with juice pH and TA required substantiation for wine grapes grown in warm growing regions.
Objectives	1. Characterise the relationships between soil potassium, leaf petiole and leaf lamina potassium, pH and TA. 2. Assess cation antagonism as a potential method to manipulate berry potassium, pH and TA. Antagonistic reactions are between positively charged micronutrients (e.g., Zn, Cu, Fe, and Mg) that are thought to compete for the same nutrient transport pathways in plant roots. 3. Post March 2021: Investigate barriers/pathway to adoption of soil management systems to improve berry composition.
Activities and Outputs	• Pot trials established at the National Wine & Grape Industry Centre (NWGIC) NSW Department of Primary Industries (DPI) / CSU and nutrient treatments applied to the potted vines (N, P, K, Ca, Mg).

	• Ten vineyards (5 white and 5 red varieties) identified for survey in each of the Riverina, NSW and Orange, NSW. • An additional vineyard site in the Riverina was identified and established as a fertigation trial. • Soil, vine, and berry sampling was conducted in the Riverina and Orange vineyards to investigate links between soil potassium, vine potassium, berry sugar, berry pH, and berry TA at dormancy, budburst, flowering, start of ripening (veraison), and harvest. • Sample testing suggested that a low magnesium to potassium (Mg/K) ratio in the soil and in the vine is associated with high berry pH and low TA. A low calcium to potassium (Ca/K) ratio also had some influence in some situations but this relationship was not as strong as the magnesium to potassium ratio. • Wine was made from surveyed vineyards using 2-10 kg ferments. These wines were assessed at 6 time points pre and post inoculation for pH, TA, tartaric acid, malic acid, glucose, fructose, ammonia, and primary amino nitrogen (NOPA). Wine samples were collected for potassium analysis. • Wine samples were assessed using Inductively Coupled Plasma (ICP) and showed that wines with high potassium have high pH and low TA levels. • In March 2021, the project was subject to a midpoint Stop/Go review and termination was recommended by Wine Australia ("low chance of success/ low chance of adoption"). The project was rescoped following the midpoint review with an additional focus on overcoming barriers to adoption of soil management techniques to improve berry composition. • A grape grower survey was completed to identify drivers and barriers to the implementation of sustainable grape growing and survey results may inform future strategy that links wine pH to vineyard management. • The project concluded that, "The results we have obtained so far hint that appropriate regulation of vine nutrition may offer a practical means for obtaining grapes with high natural acidity". However, more seasons are required to demonstrate an impact for soil treatments that may improve wine pH.
Outcomes (potential)	• Contribution to future recommendations that link vineyard management in warm areas to quality grapes with naturally low pH for winemaking.
Impacts (potential)	• Economic – potential winemaker savings with reduced need to purchase tartaric acid to lower wine pH. NB: consumers have expressed a preference for naturally acidic wine over acid adjusted wine (Howard 2015). • Capacity – additional researcher skills in understanding the relationship between soil chemistry and wine grape quality. • Capacity – additional grape grower understanding of soil management in order to deliver higher quality fruit.

3. Match with National Priorities

Table 3.1 Australian Government Research Priorities

Australian Government Strategies and Priorities	
National Science and Research Priorities 2024 ³	National Agricultural Innovation Priorities ⁴
1. Transitioning to a net zero future – develop and use new technologies, materials and processes to change energy generation and storage, heavy industries and agriculture. Australia will transition to a circular economy. Workforces will have the skills for future jobs. 2. Supporting healthy and thriving communities – develop the technologies, tools and techniques for more Australians to enjoy healthier lives from birth well into old age. New treatments, medicines and therapies to support an aging population. 3. Elevating Aboriginal and Torres Strait Islander knowledge systems – built practices than can integrate Aboriginal and Torres Strait Islander knowledge. Position Aboriginal and Torres Strait Islander peoples to lead research that affects them – as community leaders, traditional knowledge holders or researchers. 4. Protecting and restoring Australia’s environment –protect Australia’s unique environments from the impacts of climate change and other threats. Monitor, restore and preserve biodiversity, landscapes and ecosystems. 5. Building a secure and resilient nation – strengthen Australia’s democratic institutions and freedoms while addressing challenges from foreign interference, disinformation, and polarisation. Australia is ready to respond to shocks caused by climate change, natural disasters, geopolitical tensions, rapid technology changes and more competition for resources and supply chains.	On 11 October 2021, the National Agricultural Innovation Policy Statement was released. It highlights four long-term priorities for Australia’s agricultural innovation system to address by 2030. These priorities replace the Australian Government’s Rural Research, Development and Extension Priorities which were published in the 2015 Agricultural Competitiveness White Paper. - Australia is a trusted exporter of premium food and agricultural products by 2030. - Australia will champion climate resilience to increase the productivity, profitability, and sustainability of the agricultural sector by 2030. - Australia is a world leader in preventing and rapidly responding to significant incursions of pests and diseases through futureproofing our biosecurity system by 2030. - Australia is a mature adopter, developer, and exporter of digital agriculture by 2030.

The Wine Australia project has addressed National Science and Research Priority 5 (responding to shocks caused by climate change) and National Agricultural Innovation Priority one (trusted exporter) and Priority two (climate resilience).

³ See: Australian Government Department of Industry, Science and Resources 2024 Australia’s National Science and Research Priorities. <https://www.industry.gov.au/publications/national-science-and-research-priorities-2024>

⁴ See: 2021 National Agriculture Innovation Policy Statement. https://www.awe.gov.au/agriculture-land/farm-food-drought/innovation/research_and_development_corporations_and_companies#government-priorities-for-investment. NB: Statement checked on the DAFF website and found to current, January 2025.

4. Identification of Potential Costs and Benefits

4.1 Costs

4.1.1 R&D Investment

The R&D investment costs comprised:

- Direct financial outlays by Wine Australia, the project funding body. These costs include both project and overhead expenditures.
- Research partner contributions to the project – including extension of the project scope into 2022/23, cash and in-kind contributions made by SCU/DPI.
- Costs incurred by industry completing project surveys, extended interviews, and attending field days.

4.1.2 Administration

No additional administration costs were identified.

4.1.3 Extension

The project budget included allowance for extension and communication activities by the research team. Wine Australia concluded that “There were a few publications, conference papers, industry articles, and grower presentations – a reasonable output”, examples were:

- Rogiers SY, Greer DH, Liu Y, Baby T, Xiao Z. 2022. Impact of climate change on grape berry ripening: an assessment of adaptation strategies for the Australian vineyard. *Frontiers in Plant Science* 13:1094633. doi: 10.3389/fpls.2022.1094633
- Rogiers SY, Greer DH, FJ Moroni, Baby T. 2020. Potassium and magnesium mediate the light and CO₂ photosynthetic responses of grapevines. *Biology* 9, 144; doi:10.3390/biology9070144
- Baby T, Holzapfel BP, Schmidtke LM, Walker RR, Rogiers SY. 2022. Differential accumulation of potassium in leaf tissues and bunch stems of three grapevine cultivars. *Acta Horticulturae* 1333, 115– 124. doi: 10.17660/ActaHortic.2022.1333.16
- Presentations to the Spring Vine Health Field Days Aug/Sept 2022 which were held across six NSW wine regions
- Article in “Decanted”, the NWGIC Newsletter Managing Wine pH in a Changing Climate.
- Wine Australia News “Less K = less acid = less money”

4.1.4 Adoption

While the project has not delivered a practical outcome that can be implemented by grape growers, it may contribute to future vineyard management recommendations. For this to occur, future research would need to confirm this study’s findings. Any adoption of confirmed findings will be some years into the future.

4.2 Benefits

4.2.1 Research Output and Impact Pathway

The impact pathway for this project is:

1. Project findings confirmed by future research.
2. Practical means of obtaining grapes with high natural acidity developed.
3. Grape growers in warm growing areas may profit from sale of grapes with superior winemaking attributes (lower pH and higher TA). This link in the impact pathway assumes that winemakers would be willing to pay for improved grape composition, but there is no evidence that this would practically occur.
4. Winemakers realise costs savings with reduced need to purchase tartaric acid.

4.2.2 Triple Bottom Line Benefits

A summary of potential benefits from the project in triple bottom line categories is shown in Table 4.1.

Table 4.1 Triple Bottom Line Categories Benefits from Project Investment

Levy Paying Industry	Spillovers		
	Other Industries	Public	Foreign
<u>Economic Benefits</u>			
Potential winemaker savings with reduced need to purchase tartaric acid.	Nil.	Nil.	Nil.
<u>Environmental Benefits</u>			
Nil.	Nil.	Nil.	Nil.
<u>Social Benefits</u>			
Additional researcher skills in understanding the relationship between soil chemistry and wine grape quality. Additional grape grower understanding of soil management in order to deliver higher quality fruit.	Skills developed in understanding the relationship between soil chemistry and fruit quality may be applicable to other plant-based industries.	Nil.	Nil.

4.2.3 Public versus Private Benefits

The potential private benefit arising from this project is savings for the winemaker with a reduced need to purchase tartaric acid but the pathway to realisation of this benefit is somewhat uncertain. Potential public benefits include increased researcher and grape grower capacity and spill-over benefits for warm inland wine grape growing and winemaking communities.

4.2.4 Distribution of Benefits along the Supply Chain

The benefits to the winemakers from investment in this project are dependent on their willingness to pay growers for grapes with improved composition. If this were to occur, benefits would be shared between grape growers, winemakers, wholesalers, retailers, and consumers.

4.2.5 Benefits to other Primary Industries

Skills developed in understanding the relationship between soil chemistry and fruit quality may be applicable to other plant-based industries.

4.2.6 Benefits Overseas

None identified.

4.3 Summary of Costs and Benefits

A summary of principal categories of costs and benefits from the project is shown in Table 4.2.

Table 4.2 Incremental Cost and Benefit Categories

Costs	Benefits
R&D investment costs (cash and in-kind) incurred by Wine Australia and other project investors including project administration costs.	Potential winemaker savings with reduced need to purchase tartaric acid.
Overhead costs including time associated with meetings between the researchers, Wine Australia and collaborating organisations.	Additional researcher skills in understanding the relationship between soil chemistry and wine grape quality.
	Additional grape grower understanding of soil management in order to deliver higher quality fruit.

5. Valuation of Costs and Benefits

5.1 Costs

5.1.1 R&D Investment Costs including Administration

The following table shows annual investment in the project by Wine Australia (Table 5.1).

Table 5.1 Investment by Wine Australia in the Project for Years Ending June 2018 to June 2023

Project Code	2020	2021	2022	2023	Total
CSU 1702-5	137,208	136,248	139,281	0	412,737
Total	137,208	136,248	139,281	0	412,737

Source: CSU 1702-5 Progress Report, printed December 2024.

The researcher wished to investigate additional avenues of research, including grower attitudes and adoption pathways for project findings. Consequently, the project was extended into 2022/23 with a researcher contribution of \$126,816. CSU and DPI also made annual cash and in-kind contributions (Table 5.2).

Table 5.2 Investment by Others in the Project for Years Ending June 2018 to June 2023

Project Code	2020	2021	2022	2023	Total
CSU 1702-5 – project extension	0	0	0	126,816	126,816
CSU 1702-5 – CSU/NSW DPI cash	56,043	55,561	56,890	0	168,584
CSU 1702-5 – NSW DPI in-kind	220,638	237,122	254,238	0	711,998
Total	276,681	292,683	311,128	126,816	1,007,398

Source: Wine Australia advice, February 2025.

Table 5.3 provides the total investment by year for both sources.

Table 5.3 Annual Investment in the Project (nominal \$)

Year Ending 30 June	Wine Australia	Others	Total
2020	137,208	276,681	413,889
2021	136,248	292,683	428,931
2022	139,281	311,128	450,409
2023	0	126,816	126,816
Total	412,737	1,007,398	1,420,045

5.1.2 Overhead Costs including Meetings between the Researchers and Wine Australia

Wine Australia overhead costs are in addition to those shown in the above tables and are estimated at 12%. Contributions made by the research partner are assumed to already include the partner's overhead expenses.

5.1.3 Project Collaborator Costs

Time associated with meetings between researchers and Wine Australia and other industry stakeholders is a project cost that should be included in the analysis (CRRDC 2018). NSW DPI, CSU, CSIRO, and industry collaborated to deliver the project. Wine grape growers and winemakers completed surveys, extended interviews and attended project related field days. These costs are estimated by the analyst at \$7,000 per annum each year of the project.

5.2 Benefits

Counterfactual: in the absence of this project, it is unlikely that another research project would have undertaken fundamental research on the link between potassium, high pH and low TA. For this reason, a counterfactual of 65% has been assumed i.e., it is only 35% likely that potential project benefits would have been realised in the absence of project investment.

5.2.1 Winemaker Cost Savings with Reduced Need to Purchase Tartaric Acid

Potentially, the project has contributed to recommendations that link vineyard management in warm inland areas to the production of quality wine grapes with naturally low pH and wine that does not require the addition of tartaric acid. Under these conditions, winemakers will realise a production cost saving.

A summary of key assumptions used to quantify winemaker cost savings is summarised in Table 5.4.

Table 5.4 Summary of Assumptions

Variable	Assumption	Source
Benefit: Winemaker Cost Saving on Purchase of Tartaric Acid		
Warm inland wine production.	780,780,000 litres.	Total Australian crush of 1.43 million tonnes (Wine Australia, July 2024), 70% of total crush grown in the warm inland (Wine Australia, August 2024). 1 kg of grapes = 0.78 litres of wine (AgEconPlus 2021).
Tartaric acid cost.	\$0.01/litre of wine	Analyst assumption after considering the profile of winemaking revenue and expenditure in AgEconPlus and Gillespie Economics 2019. Assumption subsequently confirmed with Wine Australia.
Year in which soil management recommendations to improve grape quality are first adopted.	2028	Five years after project completion and allowing for further research and the development of practical soil management recommendations.
Year in which maximum adoption occurs.	2030	Rogiers 2022 using the CSIRO Adopt model: "peak adoption of 46% occurring 7 years after project completion".
Year in which project replaced.	2053	Analyst's assumption – benefit sustained throughout the analysis period.
Attribution of benefits to this project.	50%	Additional research will be required to confirm CSU 1702-5 findings.
Probability of valuable outputs.	50%	CSU 1702-5 findings only "hint" that appropriate vine nutrition may offer practical means for obtaining grapes with high natural acidity.
Probability of valuable outcomes.	50%	It is not certain that valuable outputs will translate into valuable outcomes – grape growers may not have sufficient incentive to adopt vine nutrition recommendations (i.e. increased wine grape prices).
Probability of impact.	50%	Other factors may determine if higher quality grapes are produced.
Counterfactual	35%	See above explanation.

5.2.2 Other Potential Benefits

Other potential benefits identified but not valued are summarised in Table 4.2. Other potential benefits were not quantified due to their relatively minor contribution to total impact and difficulty in securing data for quantification.

6. Results

6.1 Year of Assessment, Discount Year, Discount Rate and Analysis Period

Past and future cash flows were expressed in 2023/24-dollar terms and were discounted to the year 2024/25 using a discount rate of 5% to estimate the investment criteria and a 5% reinvestment rate to estimate the modified internal rate of return (MIRR). The base run used the best estimates of each variable, notwithstanding a high level of uncertainty for some of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2023).

Table 6.1 shows the investment criteria estimated for the different periods of benefits for total investment while Table 6.2 shows investment criteria for only the Wine Australia investment.

Table 6.1 Investment Criteria for Total Investment by Wine Australia and Project Partners (discount rate 5%)

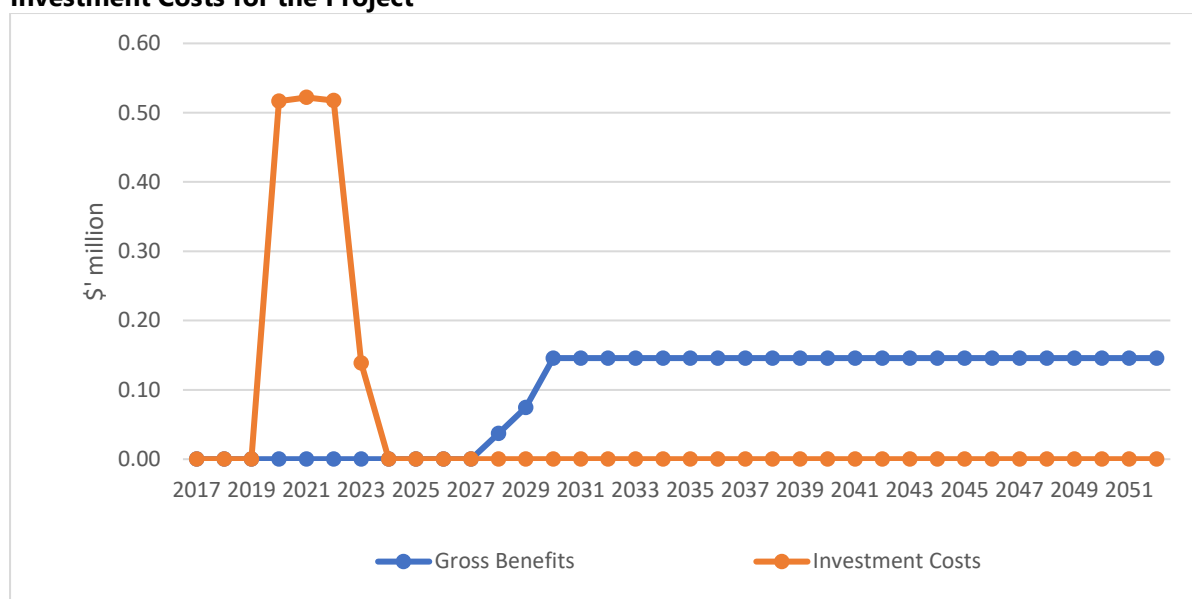
Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits (\$m)	0.00	0.03	0.52	0.95	0.95	1.54	1.75
Present value of costs (\$m)	2.05	2.05	2.05	2.05	2.05	2.05	2.05
Net present value (\$m)	-2.05	-2.01	-1.53	-1.10	-1.10	-0.50	-0.30
Benefit–cost ratio	0.00	0.02	0.25	0.46	0.46	0.75	0.86
Internal rate of return (%)	Negative	Negative	Negative	Negative	Negative	2.5	3.5
MIRR (%)	Negative	Negative	Negative	Negative	Negative	3.5	4.2

Table 6.2 Investment Criteria for Wine Australia Investment (discount rate 5%)

Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits (\$m)	0.00	0.01	0.16	0.29	0.29	0.48	0.55
Present value of costs (\$m)	0.64	0.64	0.64	0.64	0.64	0.64	0.64
Net present value (\$m)	-0.64	-0.63	-0.48	-0.34	-0.34	-0.16	-0.09
Benefit–cost ratio	0.00	0.02	0.25	0.46	0.46	0.75	0.86
Internal rate of return (%)	Negative	Negative	Negative	Negative	Negative	2.5	3.5
MIRR (%)	Negative	Negative	Negative	Negative	Negative	3.5	4.2

The annual undiscounted benefits and cost cash flows for the total investment for the duration of the investment period plus 30 years from the last year of the initial investment are shown in Figure 6.1.

Figure 6.1 Annual Undiscounted Cash Flows for Estimated Total Benefits and Total RD&E Investment Costs for the Project



7. Sensitivity Analysis

A sensitivity analysis was carried out for the central analysis results reported in Section 6 and variations in the discount rate. Table 7.1 presents the results. While the investment fails to break even at both the 5% base discount rate and the 10% sensitivity test, a positive return on investment is achieved when a zero (0%) rate is used.

Table 7.1 Sensitivity to Discount Rate (Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present value of benefits (\$m)	3.61	1.75	0.97
Present value of costs (\$m)	1.69	2.05	2.45
Net present value (\$m)	1.92	-0.30	-1.48
Benefit-cost ratio	2.13	0.86	0.40

Sensitivity analyses were undertaken for those variables where there was greatest uncertainty or for those that were identified as key drivers of the investment criteria. The analyses were performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values.

For this project, the greatest uncertainty related to the probability of project outputs leading to changes in grape vine management and the cost of tartaric acid – Table 7.2 and Table 7.3. Results show that the benefit cost ratio becomes positive if there is a 75% chance that outputs lead to changes in grape vine management. Sensitivity testing also shows that if the cost of tartaric acid is \$0.015/litre or more the project generates a positive return on investment.

Table 7.2 Sensitivity to Probability of Project Delivering Changes to Grape Vine Management (Total investment, 30 years)

Investment Criteria	Probability of Valuable Outputs (%)		
	25%	50% (base)	75%
Present value of benefits (\$m)	0.87	1.75	2.62
Present value of costs (\$m)	2.05	2.05	2.05
Net present value (\$m)	-1.17	-0.30	0.58
Benefit-cost ratio	0.43	0.86	1.28

Table 7.3 Sensitivity to Tartaric Acid Cost Saving (Total investment, 30 years)

Investment Criteria	Cost of Saved Tartaric Acid (\$/litre)		
	\$0.005/litre	\$0.01/litre (base)	\$0.015/litre
Present value of benefits (\$m)	0.35	1.75	2.62
Present value of costs (\$m)	2.05	2.05	2.05
Net present value (\$m)	-1.70	-0.30	0.58
Benefit-cost ratio	0.35	0.86	1.28

8. Confidence Ratings

The results produced are highly dependent on the assumptions made, many of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made, including the linkage between the research and the assumed outcomes.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 8.1). The rating categories used are High, Medium, and Low, where:

- High: denotes a good coverage of benefits or reasonable confidence in the assumptions made
- Medium: denotes only a reasonable coverage of benefits or some uncertainties in assumptions made
- Low: denotes a poor coverage of benefits or many uncertainties in assumptions made

Table 8.1 Confidence in Analysis of Program

Coverage of Benefits	Confidence in Assumptions
High	Medium

9. Summary of Results

Funding for CSU 1702-5 'investment in managing wine pH in a changing climate' had a total cost of \$2.05 million (present value terms) and is expected to produce aggregate total benefits of approximately \$1.75 million (present value terms). This gives an estimated net present value of minus \$0.3 million, a benefit-cost ratio of approximately 0.86 (below "breakeven"), an internal rate of return of 3.5% and a modified internal rate of return of 4.2%.

Analysis results are dependent on assumptions made and are negative for the core assumptions used in this analysis.

Abbreviations

CSU	Charles Sturt University
DPI	NSW Department of Primary Industries
GDP	Gross Domestic Product
GVP	Gross Value of Production
ICP	Inductive Coupled Plasma
NWGIC	National Wine & Grape Industry Centre
R&D	Research and Development
RD&E	Research, Development and Extension
TA	Titrateable Acid
TSS	Total Soluble Solids

Persons Contacted

Angelica Crabb, Senior Analyst, Wine Australia
Mara Khem, Research and Innovation Administrator, Wine Australia
Alex Sas, Senior Research & Innovation Program Manager, Wine Australia

References

AgEconPlus and Gillespie Economics (2019) Economic Contribution of the Australian Wine Sector 2019. Final report prepared for Wine Australia.

AgEconPlus (2021) Economic Analysis of Wine Australia Investment in Understanding Vintage Advancement and Compression.

Australian Bureau of Statistics. (2024, December 4). Australian National Accounts: National Income, Expenditure and Product Quarterly estimates of key economic flows in Australia, including gross domestic product (GDP), consumption, investment, income and saving. Table 5. Expenditure on Gross Domestic Product (GDP), Implicit price deflators. Retrieved from Australian Bureau of Statistics: <https://www.abs.gov.au/statistics/economy/national-accounts/australian-national-accounts-national-income-expenditure-and-product/latest-release#data-download>

Council of Rural Research and Development Corporations. (2018). Cross-RDC Impact Assessment Program: Guidelines. Canberra: Council of Rural Research and Development Corporations. Retrieved from http://www.ruralrdc.com.au/wp-content/uploads/2018/08/201804_RDC-IA-Guidelines-V.2.pdf

Howard, C. (2015). Natural acidity and varietal selection for a changing climate. Wine & Viticulture Journal, March/April p40

Rogiers, S Y (December 2022) Managing Wine pH in a Changing Climate. Final Report to Wine Australia.

Wine Australia (December 2024) Australian Wine Sector at a Glance 2023/24. Accessed at <https://www.wineaustralia.com/market-insights/australian-wine-sector-at-a-glance>

Wine Australia (July 2024) National Vintage Report 2024. Accessed at https://www.wineaustralia.com/getmedia/b3576546-f5b7-4210-b936-0460b618bd41/MI_VintageReport2024_F.pdf

Wine Australia (August 2024) State of the Wine Market – August 2024. Market Bulletin Issue 319. Accessed at <https://www.wineaustralia.com/news/market-bulletin/issue-319>

Appendix 3: Economic Analysis of Wine Australia's Investment in Climate Adaptation: Developing Irrigation Strategies to Combat Dry Winters

1. Background

In many Australian wine regions, grapevine production relies on soil moisture stored during the winter in addition to supplementary irrigation during the growing season. Reduced winter rainfall, expected as a consequence of climate change, together with limits on the supply of water for irrigation, are forecast to place increasing strain on these production systems. Low rainfall during winter, resulting in a soil profile that is not full by spring, has already been shown to reduce grapevine canopy growth and yield.

Observations of seasonal variation and the results of a previous SARDI/CSIRO project (SAR 1302) have demonstrated the negative effects of dry soil in spring on vine performance, and the absence of effective irrigation strategies that fully restore yield. In the earlier project, even when the soil moisture was maintained during winter with irrigation, yield was reduced compared to the Control vines exposed to winter rainfall. Filling up the empty soil profile at budburst (as opposed to attempting to maintain it through winter) resulted in the lowest yield and excessive canopy growth, which in turn impacted negatively on wine phenolic (taste) and sensory attributes. This project aimed to build on the previous work and increase vineyard resilience by developing irrigation strategies to maintain vineyard productivity following dry winters.

2. Summary of Project

Table 2.1 provides a description of the project in a logical framework.

Table 2.1 Project Description

SAR 1701-2.1 Climate Adaptation: Developing Irrigation Strategies to Combat Dry Winters	
Project Details	Research Organisation: SARDI and CSIRO. Period: July 2017 to February 2023 (final report date). Principal Investigators: Marcos Bonada, Gaston Sepulveda, and Paul Petrie. Wine Australia Program Manager: Sharon Harvey.
Rationale	The project aimed to build on previous work and increase vineyard resilience by developing irrigation strategies to maintain vineyard productivity post a dry winter.
Objectives	1. Improved knowledge on the influence of water availability during winter and spring on vine growth including the impacts on root and canopy physiology. 2. Irrigation application systems and methods that will allow vineyard productivity to be maintained despite dry winters.
Activities and Outputs	• Trials were established at Nuriootpa Research Station, Barossa Valley to simulate winter drought conditions on Shiraz vines ('rainout shelter' site). • Over three seasons (2019, 2020, 2021) the project explored irrigation strategies that aimed to restore vine performance to a similar level to the vines exposed to long-term average patterns of winter and spring rainfall (the Control). • The best performing treatment (closest to Control) from the previous project (SAR 1302) was irrigation with micro-sprinklers under the canopy that simulated the pattern of soil wetting of rainfall. However, the majority of Australian vines are irrigated using drip-based systems, consequently the first focus of this project was evaluation of drip-irrigation methods that wet the mid-row space to supplement low winter rainfall. • The second focus for the project was to extend irrigation beyond the start of spring (budburst). As with SAR 1302, elevated yields (higher than the Control) were observed when the vines received significant rainfall during spring.

	- Measures taken to gauge the impact of alternative irrigation treatments included: (i) yield, pruning mass and their components, (ii) the dynamics of canopy growth, quantified as leaf area index (LAI), and root growth during the season, (iii) vine carbohydrate reserves, (iv) fruit quality, and (v) wine chemical and sensory characteristics. - The project confirmed expectations on the importance of maintaining soil moisture during winter but also some contrast with previous project findings. - Yield in the irrigated treatments, regardless of the method and timing of water application was significantly higher than in the Control. - The irrigation treatments affected wine sensory attributes relative to Control: 'opacity' and 'purple' were rated lower, 'cooked vegetables' and 'savoury' aromas were increased, 'chocolate', 'confection', 'jammy', 'spice' and 'herb' aromas were decreased, 'savoury', 'blackcurrant' and 'sweetness' were higher. - Irrigation with multiple laterals did not increase yield more than a single lateral. - Irrigation at budburst when the soil profile was empty resulted in the lowest yield and excessive canopy growth (finding is consistent with SAR 1302). - Limited irrigation in winter plus a spring top up watering, resulting in a higher yield than for the Control. - In conclusion, maintaining a minimum level of soil moisture during winter is critical, but the extension of irrigation into spring maximised vineyard productivity. Maintenance of soil moisture over winter and spring can increase grape yield by between 20% and 40% compared to that achieved through a dry winter in the absence of irrigation.
Outcomes	- The project delivered practical irrigation advice to wine grape growers. - Wine grape growers in regions with access to surplus irrigation water can increase yield in dry seasons by maintaining some soil moisture over winter and then applying irrigation in spring from budburst through to flowering. - There is little value to producers in modifying their irrigation infrastructure to include laterals in the mid-row - increasing the volume of soil wetted by irrigation did not increase vineyard yield any more than that of a traditional single under-vine lateral.
Impacts (potential)	- Economic – profit from additional yield of quality wine grapes in dry seasons (for example, a dry season occurred in the Barossa four times in the ten years 2013-2022. Increased profit will be less any additional production costs associated with the increase in yield including the cost of additional water, other irrigation expenses, and the cost of harvesting the additional yield). - Economic – savings in upgrade of drip irrigation systems (the use of multiple laterals to increase the volume of soil wetted did not increase vineyard yield any more than a single lateral). - Capacity – additional researcher skills in understanding grape vine response to water stress. - Capacity – additional grape grower understanding of how to manage irrigation and crop response in a future climate change scenario. - Social – additional profitable grape and wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).

3. Match with National Priorities

Table 3.1 Australian Government Research Priorities

Australian Government Strategies and Priorities	
National Science and Research Priorities 2024 ⁵	National Agricultural Innovation Priorities ⁶
1. Transitioning to a net zero future – develop and use new technologies, materials and processes to change energy generation and storage, heavy industries and agriculture. Australia will transition to a circular economy. Workforces will have the skills for future jobs. 2. Supporting healthy and thriving communities – develop the technologies, tools and techniques for more Australians to enjoy healthier lives from birth well into old age. New treatments, medicines and therapies to support an aging population. 3. Elevating Aboriginal and Torres Strait Islander knowledge systems – built practices than can integrate Aboriginal and Torres Strait Islander knowledge. Position Aboriginal and Torres Strait Islander peoples to lead research that affects them – as community leaders, traditional knowledge holders or researchers. 4. Protecting and restoring Australia’s environment –protect Australia’s unique environments from the impacts of climate change and other threats. Monitor, restore and preserve biodiversity, landscapes and ecosystems. 5. Building a secure and resilient nation – strengthen Australia’s democratic institutions and freedoms while addressing challenges from foreign interference, disinformation, and polarisation. Australia is ready to respond to shocks caused by climate change, natural disasters, geopolitical tensions, rapid technology changes and more competition for resources and supply chains.	On 11 October 2021, the National Agricultural Innovation Policy Statement was released. It highlights four long-term priorities for Australia’s agricultural innovation system to address by 2030. These priorities replace the Australian Government’s Rural Research, Development and Extension Priorities which were published in the 2015 Agricultural Competitiveness White Paper. - Australia is a trusted exporter of premium food and agricultural products by 2030. - Australia will champion climate resilience to increase the productivity, profitability, and sustainability of the agricultural sector by 2030. - Australia is a world leader in preventing and rapidly responding to significant incursions of pests and diseases through futureproofing our biosecurity system by 2030. - Australia is a mature adopter, developer, and exporter of digital agriculture by 2030.

The Wine Australia project has addressed National Science and Research Priority 5 (responding to shocks caused by climate change) and National Agricultural Innovation Priority two (climate resilience).

⁵ See: Australian Government Department of Industry, Science and Resources 2024 Australia’s National Science and Research Priorities. <https://www.industry.gov.au/publications/national-science-and-research-priorities-2024>

⁶ See: 2021 National Agriculture Innovation Policy Statement. https://www.awe.gov.au/agriculture-land/farm-food-drought/innovation/research_and_development_corporations_and_companies#government-priorities-for-investment. NB: Statement checked on the DAFF website and found to current, January 2025.

4. Identification of Potential Costs and Benefits

4.1 Costs

4.1.1 R&D Investment

The R&D investment costs comprised:

- Direct financial outlays by Wine Australia, the project funding body. These costs include both project and overhead expenditures.
- Research partner contributions to the project – including both cash and in-kind contributions made by SARDI/CSIRO.
- Costs incurred by industry attending field days and seminars to understand project recommendations in relation to irrigation scheduling.

4.1.2 Administration

No additional administration costs were identified.

4.1.3 Extension

The project budget included allowance for extension and communication activities by the research team and some 22 presentations and nine industry articles were delivered, examples were:

- AWRI E-Bulletin articles and Wine Australia RD&E News articles.
- Crush – Grape and Wine Science Symposium presentation.
- Australian Society of Viticulture and Oenology presentation attended by 150 grape growers.
- Field days including Rutherglen, Bendigo, Avoca, Langhorne Creek, Mornington Peninsula, Geelong District, Yarra Valley (Rathbone Wine Group), and McLaren Vale.
- Viticulture seminar Tanunda, South Australia for 100 growers.
- Treasury Wines Estates – presentation to 15 vineyard managers and supervisors.
- Presentation to agronomists, Nuriootpa Research Station, Barossa Valley.

Dr Marcos Bonada was awarded the 2022 ASVO Oenology Paper of the Year for the work; *Soil water availability during spring modulates canopy growth and impacts the chemical and sensory composition of Shiraz fruit and wine* (Australian Journal of Grape and Wine Research, 27: 491-507

<https://doi.org/10.1111/ajgw.12506>). Dr Bonada's paper was selected by the committee because it demonstrated the importance of establishing a framework for the adoption of irrigation strategies that may maintain regional style in the context of a changing climate.

4.1.4 Adoption

The project has delivered practical advice to wine grape growers that can be immediately adopted. Growers who adopt project recommendations will not incur capital costs but will incur additional operating outlays (e.g., harvest, irrigation expenses) in dry years.

4.2 Benefits

4.2.1 Research Output and Impact Pathway

The key output from the project is practical irrigation advice. The impact pathway for this output is:

1. Project findings communicated to wine grape growers as part of the SAR 1701-2.1 project.
2. Some wine grape growers adopt project recommendation in dry winters. These growers have access to surplus irrigation water and are not currently maintaining soil moisture over winter and applying irrigation water at budburst through to flowering.
3. A proportion of wine grape growers who adopt project findings, increase their yield of quality grapes in dry years.

4.2.2 Triple Bottom Line Benefits

A summary of potential benefits from the project in triple bottom line categories is shown in Table 4.1.

Table 4.1 Triple Bottom Line Categories Benefits from Project Investment

Levy Paying Industry	Spillovers		
	Other Industries	Public	Foreign
<u>Economic Benefits</u>			
Wine grape growers realising additional yield of quality wine grapes in dry seasons. Potential savings in drip irrigation infrastructure after project determines that multiple laterals are not required.	Findings may be relevant to other vine-based industries including the dried grape sector.	Nil.	Irrigation recommendations may be applicable to wine grape growing in other countries that irrigate their vines (e.g., California in the US, and Spain).
<u>Environmental Benefits</u>			
Nil.	Nil.	Nil.	Nil.
<u>Social Benefits</u>			
Additional researcher skills in understanding grape vine response to water stress. Additional grape grower understanding of how to manage irrigation and crop response in a future climate change scenario. Additional profitable grape and wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).	Skills developed in vine response to water stress may be applicable to other plant-based industries.	Nil.	Nil.

4.2.3 Public versus Private Benefits

The project has the potential to generate both private and public benefits. However, the principal benefit will be private – profit from additional yield of quality wine grapes in dry seasons. Potential public benefits include increased researcher and winemaker capacity and spill-over benefits for winemaking communities.

4.2.4 Distribution of Benefits along the Supply Chain

The benefits to the wine industry from investment in this project will be shared along the supply chain with wine grape growers, winemakers, wholesalers, and retailers all sharing some of the benefits.

4.2.5 Benefits to other Primary Industries

Skills developed in vine response to water stress may be applicable to other plant-based industries such as dried grape production.

4.2.6 Benefits Overseas

Irrigation scheduling recommendations may contain general principles that can be applicable to wine grape growing in other countries i.e., the importance of maintaining some soil moisture in winter and irrigation through spring in dry years.

4.3 Summary of Costs and Benefits

A summary of principal categories of costs and benefits from the project is shown in Table 4.2.

Table 4.2 Incremental Cost and Benefit Categories

Costs	Benefits
R&D investment costs (cash and in-kind) incurred by Wine Australia and other project investors including project administration costs.	Increased wine grape grower profit from additional yield of quality wine grapes in dry seasons.
Overhead costs including time associated with meetings between the researchers, Wine Australia and collaborating organisations.	Potential savings in drip irrigation infrastructure after project determines that multiple laterals are not required.
	Additional researcher skills in understanding grape vine response to water stress.
	Additional grape grower understanding of how to manage irrigation and crop response in a future climate change scenario.
	Additional profitable wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).

5. Valuation of Costs and Benefits

5.1 Costs

5.1.1 R&D Investment Costs including Administration

The following table shows annual investment in the project by Wine Australia (Table 5.1).

Table 5.1 Investment by Wine Australia in the Project for Years Ending June 2018 to June 2022

Project Code	2018	2019	2020	2021	2022	Total
SAR 1701-2.1	264,006	234,575	239,735	216,343	28,081	982,740
Total	264,006	234,575	239,735	216,343	28,081	982,740

Source: SAR 1701-2.1 Progress Reports, printed December 2024

SARDI in-kind contributions to the project are shown in the table below (Table 5.2).

Table 5.2 Investment by Others in the Project for Years Ending June 2018 to June 2022

Project Code	2018	2019	2020	2021	2022	Total
SAR 1701-2.1 – in-kind	463,853	439,571	449,670	459,617	0	1,812,711
Total	463,853	439,571	449,670	459,617	0	1,812,711

Source: Wine Australia advice, February 2025

Table 5.3 provides the total investment by year for both sources.

Table 5.3 Annual Investment in the Project (nominal \$)

Year Ending 30 June	Wine Australia	Others	Total
2018	264,006	463,853	727,859
2019	234,575	439,571	674,146
2020	239,735	449,670	689,405
2021	216,343	459,617	675,960
2022	28,081	0	28,081
Total	982,740	1,812,711	2,795,451

5.1.2 Overhead Costs including Meetings between the Researchers and Wine Australia

Wine Australia overhead costs are in addition to those shown in the above tables and are estimated at 12%. Contributions made by the research partner are assumed to already include the partner's overhead expenses.

5.1.3 Project Collaborator Costs

Time associated with meetings between researchers and Wine Australia and other industry stakeholders is a project cost that should be included in the analysis (CRRDC 2018). A large number of wine grape growers and winemakers attended project related presentations at field days and seminars. These costs are estimated by the analyst at \$5,000 per annum each year of the project.

5.2 Benefits

Counterfactual: in the absence of this project, it is possible that wine grape growers facing routine dry winters would have used the results from previous research (e.g., SAR 1302) and their own experimentation to achieve similar outcomes. Consequently, a counterfactual of 60% has been assumed i.e., it is 40% likely that potential project benefits would have been realised in the absence of project investment.

5.2.1 Grape Grower Profit from Additional Yield of Quality Grapes in Dry Seasons

The project delivered practical advice to wine grape growers -when surplus irrigation water is available yield can be increased by maintaining minimum soil moisture in a dry winter and extending the irrigation season through to flowering.

A summary of key assumptions used to quantify the increase in grape grower profit from adopting project outputs is summarised in Table 5.4.

Table 5.4 Summary of Assumptions

Variable	Assumption	Source
Benefit: Grape Grower Profit from Additional Yield of Quality Grapes in Dry Seasons		
Winegrape production area irrigated using surface drippers.	87,746 ha.	Aust vineyard area in 2023/24 was 146,244 ha (Wine Australia, 2024) and the Winemakers Federation of Australia (2008) has estimated that 60% of this area is irrigated using surface drippers.
Production area irrigated using surplus drippers that also has surplus water available for irrigation in spring.	30%	Analyst's estimate and includes areas such as the Barossa (River Murray), Padthaway (aquifers), Langhorne Creek (River Murray), and McLaren Vale (recycled wastewater).
Frequency of dry winters requiring implementation of project findings i.e., winter maintenance/spring irrigation.	40%	Analyst assumption based on a dry season occurring in the Barossa four times in the ten years 2013-2022 (Bonada et al. 2023).
Increase in yield when project findings are implemented in dry years.	1.8t/ha	Average yield of 9t/ha derived from 1.32 MT grape crush grown on 146,244 ha (Wine Australia, 2024) and assuming a 20% increase in output with irrigation recommendations in place (Bonada et al. 2023).
Value of additional yield after allowing for increase in production costs (e.g., harvest and irrigation water).	\$550/t	Average crush value in 2024 of \$613/tonne (National Vintage Report 2024) less allowance for additional production costs.

Year in which irrigation scheduling recommendations are first adopted.	2024	One year after project completion in February 2023.
Year in which maximum adoption occurs.	2030	Analyst's assumption.
Year in which project replaced.	2052	Analyst's assumption – benefit sustained throughout the analysis period.
Attribution of benefits to this project.	50%	Findings confirm previous research including SAR 1302.
Probability of valuable outputs.	100%	SAR 1701-2.1 has delivered valuable findings.
Probability of valuable outcomes.	80%	It is not certain that valuable outputs will translate into valuable outcomes.
Probability of impact.	60%	Other factors may determine if additional yield has a value.
Counterfactual	40%	See above explanation.

5.2.2 Other Potential Benefits

Other potential benefits identified but not valued are summarised in Table 4.2. Other potential benefits were not quantified due to their relatively minor contribution to total impact and difficulty in securing data for quantification.

6. Results

6.1 Year of Assessment, Discount Year, Discount Rate and Analysis Period

Past and future cash flows were expressed in 2023/24-dollar terms and were discounted to the year 2024/25 using a discount rate of 5% to estimate the investment criteria and a 5% reinvestment rate to estimate the modified internal rate of return (MIRR). The base run used the best estimates of each variable, notwithstanding a high level of uncertainty for some of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2022).

Table 6.1 shows the investment criteria estimated for the different periods of benefits for total investment while Table 6.2 shows investment criteria for only the Wine Australia investment.

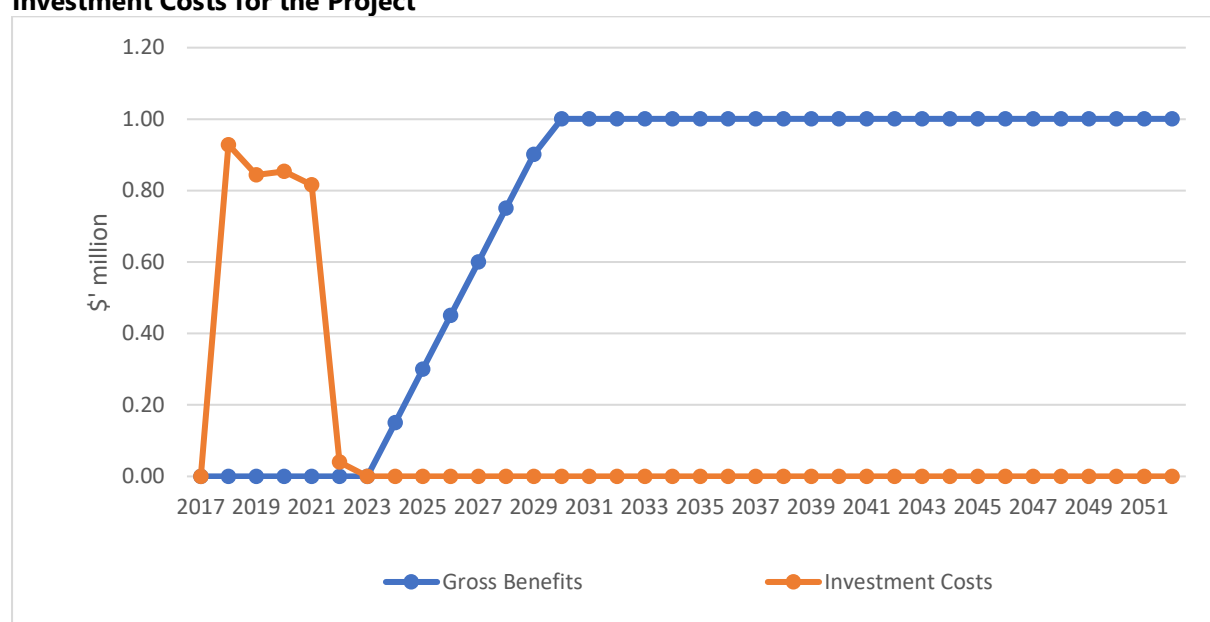
Table 6.1 Investment Criteria for Total Investment by Wine Australia and Project Partners (discount rate 5%)

Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits (\$m)	0.00	1.43	5.06	8.14	10.55	12.44	13.93
Present value of costs (\$m)	4.56	4.56	4.56	4.56	4.56	4.56	4.56
Net present value (\$m)	-4.56	-3.13	0.50	3.58	5.99	7.88	9.36
Benefit–cost ratio	0.00	0.31	1.11	1.78	2.31	2.73	3.05
Internal rate of return (%)	Negative	Negative	4.4	10.3	12.2	13.1	13.3
MIRR (%)	Negative	Negative	4.6	8.1	8.7	8.7	8.5

Table 6.2 Investment Criteria for Wine Australia Investment (discount rate 5%)

Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits (\$m)	0.00	0.54	1.90	3.05	3.95	4.66	5.21
Present value of costs (\$m)	1.71	1.71	1.71	1.71	1.71	1.71	1.71
Net present value (\$m)	-1.71	-1.17	0.19	1.34	2.24	2.95	3.50
Benefit-cost ratio	0.00	0.31	1.11	1.78	2.31	2.73	3.05
Internal rate of return (%)	Negative	Negative	4.4	10.3	12.2	13.1	13.3
MIRR (%)	Negative	Negative	4.6	8.1	8.7	8.7	8.5

The annual undiscounted benefits and cost cash flows for the total investment for the duration of the investment period plus 30 years from the last year of the initial investment are shown in Figure 6.1.

Figure 6.1 Annual Undiscounted Cash Flows for Estimated Total Benefits and Total RD&E Investment Costs for the Project

7. Sensitivity Analysis

A sensitivity analysis was carried out for the central analysis results reported in Section 6 and variations in the discount rate. Table 7.1 presents the results. The results are moderately sensitive to the discount rate and remain positive when a 10% discount rate is applied.

Table 7.1 Sensitivity to Discount Rate (Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present value of benefits (\$m)	26.17	13.93	8.62
Present value of costs (\$m)	3.48	4.56	5.93
Net present value (\$m)	22.69	9.36	2.70
Benefit-cost ratio	7.52	3.05	1.45

Sensitivity analyses were undertaken for those variables where there was greatest uncertainty or for those that were identified as key drivers of the investment criteria. The analyses were performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values.

For this project, the greatest uncertainty related to the frequency of dry winters and the yield recovered with adoption of project findings – Table 7.2 and Table 7.3. Results show that if dry winters occur more frequently (6 years in 10) rather than the 4 years in 10 assumed, then the benefit cost ratio becomes 4.58. More frequent dry winters may be associated with climate change.

Table 7.2 Sensitivity to Frequency of Dry Winters (Total investment, 30 years)

Investment Criteria	Dry Winters as a Share of Total Winters in Irrigated Production Areas (%)		
	20%	40% (base)	60%
Present value of benefits (\$m)	6.96	13.93	20.89
Present value of costs (\$m)	4.56	4.56	4.56
Net present value (\$m)	2.40	9.36	16.32
Benefit-cost ratio	1.53	3.05	4.58

The final sensitivity analysis shows that recovered grape yield would need to be as low as 0.6 t/ha before the project approaches “breaks even” (all other assumptions held constant).

Table 7.3 Sensitivity to Yield Recovery with Adoption of Project Findings (Total invest, 30 years)

Investment Criteria	Yield Recovered with Adoption of Project Findings (t/ha)		
	0.6 t/ha	0.9 t/ha	1.8 t/ha (base)
Present value of benefits (\$m)	4.64	6.96	13.93
Present value of costs (\$m)	4.56	4.56	4.56
Net present value (\$m)	0.08	2.40	9.36
Benefit-cost ratio	1.02	1.53	3.05

8. Confidence Ratings

The results produced are highly dependent on the assumptions made, many of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made, including the linkage between the research and the assumed outcomes.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 8.1). The rating categories used are High, Medium, and Low, where:

- High: denotes a good coverage of benefits or reasonable confidence in the assumptions made
- Medium: denotes only a reasonable coverage of benefits or some uncertainties in assumptions made
- Low: denotes a poor coverage of benefits or many uncertainties in assumptions made

Table 8.1 Confidence in Analysis of Program

Coverage of Benefits	Confidence in Assumptions
High	Medium

9. Summary of Results

Funding for SAR 1701-2.1 ‘climate adaptation: developing irrigation strategies to combat dry winters’ had a total cost of \$4.56 million (present value terms) and is expected to produce aggregate total benefits of approximately \$13.93 million (present value terms). This gives an estimated net present value of \$4.56 million, a benefit-cost ratio of approximately 3.05, an internal rate of return of 13.4% and a modified internal rate of return of 8.5%.

Analysis results are dependent on assumptions made and are positive for core assumptions and do not become negative using the sensitivity tests completed.

Abbreviations

AWRI	Australian Wine Research Institute
GDP	Gross Domestic Product
GVP	Gross Value of Production
R&D	Research and Development
RD&E	Research, Development and Extension
SARDI	South Australian Research and Development Institute

Persons Contacted

Marcos Bonada, Project Researcher at SARDI, now at Treasury Wine Estates
Angelica Crabb, Senior Analyst, Wine Australia
Mara Khem, Research and Innovation Administrator, Wine Australia
Sharon Harvey, Senior RD&E Program Manager, Wine Australia
Paul Petrie, Principal Investigator, SARDI

References

- AWRI 2018. Managing dry winter conditions. AWRI e-bulletin. August. [Managing dry winter conditions - The Australian Wine Research Institute](#)
- AWRI (2024) [Managing dry winter conditions in Australian vineyards - The Australian Wine Research Institute](#)
- Australian Bureau of Statistics. (2024, December 4). Australian National Accounts: National Income, Expenditure and Product Quarterly estimates of key economic flows in Australia, including gross domestic product (GDP), consumption, investment, income and saving. Table 5. Expenditure on Gross Domestic Product (GDP), Implicit price deflators. Retrieved from Australian Bureau of Statistics: <https://www.abs.gov.au/statistics/economy/national-accounts/australian-national-accounts-national-income-expenditure-and-product/latest-release#data-download>
- Bonada, M, Sepulveda, G, and Petrie, P (February 2023) Climate Adaptation: Developing Irrigation Strategies to Combat Dry Winters. Final Report to Wine Australia.
- Council of Rural Research and Development Corporations. (2018). Cross-RDC Impact Assessment Program: Guidelines. Canberra: Council of Rural Research and Development Corporations. Retrieved from http://www.ruralrdc.com.au/wp-content/uploads/2018/08/201804_RDC-IA-Guidelines-V.2.pdf
- Wine Australia (December 2024) Australian Wine Sector at a Glance 2023/24. Accessed at <https://www.wineaustralia.com/market-insights/australian-wine-sector-at-a-glance>
- Wine Australia (July 2024) National Vintage Report 2024. Accessed at https://www.wineaustralia.com/getmedia/b3576546-f5b7-4210-b936-0460b618bd41/MI_VintageReport2024_F.pdf
- Winemakers' Federation of Australia (2008) Survey of Industry Practice.

Appendix 4: Economic Analysis of Wine Australia's Investment in Molecular Drivers of Wine Texture and Taste

1. Background

Sensory perception and in-mouth texture define many of the world's great wines. However, the molecular drivers responsible for these sensory attributes are poorly defined. The purpose of this project was to generate foundational knowledge on the molecular drivers of positive taste and texture characteristics, as well as the molecular drivers of negative attributes such as bitterness, palate hardness, unpleasant acidity, hotness and pungency. Generation of this knowledge is key to an improved understanding of the impact of vineyard and winery inputs on wine composition and sensory properties.

Increasing the premiumisation of red and white wine is inseparable from the concept of texture as it defines style, and "typicality" (the interaction between terroir and winemaking practice). In-mouth texture defines the "typicality" of many of the world's most valuable wines, for example the creaminess of barrel fermented white Burgundy, the oily texture of Alsatian Pinot Gris made from high solids juice, the oily and drying nature of Viognier made with skin contact in the Northern Rhone, or the rich full-bodied expression of Shiraz produced in the Barossa. It could also be argued that the high value placed on many of these wines is also the result of a perception of uniqueness of some sensory property, whether it be taste or texture, associated with a particular region or vineyard site.

In terms of taste, many European and new Australian styles of red wines, are positively characterised by their savouriness, a term synonymous with complex, high-quality wines. However, despite knowledge of molecular drivers of savoury/"umami" flavours in food, similar compounds have not been characterised or their functions defined in wine. Compounds described by mouthfulness, or "kokumi" have also been characterised in foods but not in wine, although evidence exists that such compounds may be present in wine.

This project built on past and concurrent Australian Wine Research Institute (AWRI) research including solids trials, bitterness lead compounds, a literature review on white wine texture, a "solids contact settling time" trial, and a red wine trial on the emergence and evolution of compounds associated with bitterness and hardness. Linked projects include:

- "Managing wine extraction, retention, clarity and stability for defined styles and efficient production"
- "Factors affecting wine texture, taste, clarity, stability, and production efficiency". This project included extension of findings into wine production.

2. Summary of Project

Table 2.1 provides a description of the project in a logical framework.

Table 2.1 Project Description

AWR 1701-3.1.3 Molecular Drivers of Wine Texture and Taste	
Project Details	Research Organisation: AWRI. Period: July 2017 to November 2022 (final report date). Principal Investigators: Dr Richard Gawel and Dr Keren Bindon. Wine Australia Program Manager: Dr Paul Smith.
Rationale	The project was to identify compounds that may lead to positive and negative taste and texture outcomes, throughout the different stages of wine production, or in response to specific winemaking practices. Such characteristics can be imparted through different stages of the wine production, from grape growing (temperature and exposure impacts), throughout processing, and post-bottling.
Objectives	1. Investigate the impact of non-volatile compounds on wine texture and taste.

	- Investigate the evolution of phenolics (associated with taste and including flavonoids) and polysaccharides (compounds that can improve mouth-feel) during white wine production. - Identify new texture and taste target compounds in wine. - Better understand the bitterant tryptophol sulfonate.
Activities and Outputs	Activities: - Finalise a literature review on molecular drivers of white wine texture. - Publish research findings on tryptophol sulfonate as a white wine bitterant. - Bottle wines from 2017 "solids contact settling time" trial, analyse chemistry (polyphenolics, polysaccharides, proteins, volatiles) at a range of time points. - Design/execute a 2018 winemaking trial to quantify dynamics of non-volatile compounds identified as adding bitterness and hardness to red wine. - Develop ways to isolate compounds that contribute negative wine characters. - Develop methods to assess interactions between sensorially negative compounds with key macromolecules or matrix compounds. - Source un-fined red and white wines with bitter and other negative mouth-feel characters and relate negative mouth-feel characters to composition. - Design and execute a 2019 winemaking trial to assess factors that contribute to the evolution of potentially bitter, non-volatiles in red and white wine. - Prepare a publication on bitter and texture-related compounds, their relationship with Sulphur Dioxide (SO₂), and potential influencing factors. - Complete sensory analysis of 2017 "solids contact settling time" trial. - Prepare a publication on the influence of CO₂ on mouth-feel in wine. - Design and execute an experiment to investigate the role of polysaccharide additives (yeast-derived and grape-derived) on mouth-feel and taste. - Conduct sensory and chemical assessments of white wine made with grape seed powder as a fining agent – determine the intervention's impact on macromolecules, protein stability, and wine sensor properties. - Analyse the results of trials that tested the impact of macromolecules / polysaccharides on negative wine characters (bitterness and palate hardness). - Complete a literature review on contributors to positive mouth-feel including "umami" and "kokumi" and source suitable ingredients for testing. - Design and execute a 2020 winemaking trial to assess potential risk factors associated with negative wine characteristics such as SO₂. - Present a paper at the AWITC technical conference highlighting factors that influence wine texture and macromolecule evolution. - Develop a rapid test to quantify glutamic acid and other amino acids in wine that may contribute to savory/umami character. - Survey world wines to determine the concentration range of compounds that contribute savory character (glutamic acid, succinic acid, glutathione, salts). - Complete a sensory trial to test the impact of potential savory compounds. - Develop a model to assess the impact of saliva and wine compounds in modulating positive wine textures through carbon dioxide (CO₂) ingress. - Chemically analyse 2020 reds to assess evolution of tryptophol sulfonate. - Communicate findings on 1) tryptophol sulfonate and how to avoid wine bitterness, and 2) dissolved CO₂ and its implications for wine texture. - Analyse the role of trans-p-coumaric acid in imparting bitterness to wine. - Prepare academic papers, industry articles and deliver presentations that summarise project findings and their implications for Australian winemaking. Outputs:

	• The project showed that the bitterant tryptophol sulfonate was more important in white than red wines, with concentrations increasing in response to post-bottling SO₂ additions. While most people cannot taste this bitterant on its own, it adds to the sensory effects from other bitterness compounds. Consequently, the study recommended use of a low tryptophol-producing yeast and/or judicious application of SO₂ pre-bottling to minimise its impact. • A coumaric acid glycoside was initially identified as a potential bitterant but later shown through sensory analysis not to impart bitterness. A survey of glutamic acid revealed that it was present above detection threshold in most wines and could impart a positive "savory" flavour in red wine. • Beneficial AGP polysaccharides decline through winemaking and methods are required to preserve their positive contribution to white wine mouth-feel. • A new in-situ method for quantification of dissolved CO₂ was developed and while it was already known that dissolved CO₂ contributed to wine texture, this project established that a positive "spritz" character was more likely through management of CO₂ in semi-sparkling styles rather than still wine. Potentially, this will provide a tool to manipulate dissolved CO₂ and identify the "sweet spot" between "flabby" and overly "spritzed" red wines. • Further work is required on glutamic acid and other compounds to determine how winemakers can enhance the savory character of their wines.
Outcomes (potential)	• Winemakers with a better understanding of actions they can take to improve the quality of their wine in terms of texture and taste attributes. • Bitterness in white wine may be avoided through use of a low tryptophol-producing yeast and/or judicious application of SO₂. • Evidence was provided that flotation does not negatively affect white wine bitterness, or reduce positive attributes like viscosity, enabling winemakers to transfer from cold settling to more efficient approaches without concerns for quality loss. • Higher levels of glutamic acid may impart a positive "savory" flavour to red wine and might be enhanced at higher fermentation temperatures and be concentrated in the press fractions. • An ideal "spritz" character might be achieved in semi-sparkling wine styles through management of dissolved CO₂. • There are implications of the findings regarding 'savory' and 'spritz' attributes for NOLO product development, a strong new focus in wine-related research.
Impacts (potential)	• Economic – progress toward the consistent production of more profitable wine with superior texture and taste, i.e., wine that will sell for a higher price and more than cover the cost of any additional production inputs or changed production practices. • Economic - winemakers can benefit from the known efficiency and cost advantages of switching from cold settling to flotation, while being confident that the sensory and compositional quality of their wines is unlikely to be diminished by changing to the more efficient system of clarification. • Economic – new understanding of 'spritz' and 'savory' attributes to support NOLO research. • Capacity – additional researcher skills in assessment of non-volatile compounds impacting wine texture and taste. • Capacity – additional winemaker knowledge of techniques to improve the texture and taste of wine. • Social – additional profitable wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).

3. Match with National Priorities

Table 3.1 Australian Government Research Priorities

Australian Government Strategies and Priorities	
National Science and Research Priorities 2024 ⁷	National Agricultural Innovation Priorities ⁸
1. Transitioning to a net zero future – develop and use new technologies, materials and processes to change energy generation and storage, heavy industries and agriculture. Australia will transition to a circular economy. Workforces will have the skills for future jobs. 2. Supporting healthy and thriving communities – develop the technologies, tools and techniques for more Australians to enjoy healthier lives from birth well into old age. New treatments, medicines and therapies to support an aging population. 3. Elevating Aboriginal and Torres Strait Islander knowledge systems – built practices than can integrate Aboriginal and Torres Strait Islander knowledge. Position Aboriginal and Torres Strait Islander peoples to lead research that affects them – as community leaders, traditional knowledge holders or researchers. 4. Protecting and restoring Australia’s environment –protect Australia’s unique environments from the impacts of climate change and other threats. Monitor, restore and preserve biodiversity, landscapes and ecosystems. 5. Building a secure and resilient nation – strengthen Australia’s democratic institutions and freedoms while addressing challenges from foreign interference, disinformation, and polarisation. Australia is ready to respond to shocks caused by climate change, natural disasters, geopolitical tensions, rapid technology changes and more competition for resources and supply chains.	On 11 October 2021, the National Agricultural Innovation Policy Statement was released. It highlights four long-term priorities for Australia’s agricultural innovation system to address by 2030. These priorities replace the Australian Government’s Rural Research, Development and Extension Priorities which were published in the 2015 Agricultural Competitiveness White Paper. - Australia is a trusted exporter of premium food and agricultural products by 2030. - Australia will champion climate resilience to increase the productivity, profitability, and sustainability of the agricultural sector by 2030. - Australia is a world leader in preventing and rapidly responding to significant incursions of pests and diseases through futureproofing our biosecurity system by 2030. - Australia is a mature adopter, developer, and exporter of digital agriculture by 2030.

The Wine Australia project has addressed National Agricultural Innovation Priority one.

⁷ See: Australian Government Department of Industry, Science and Resources 2024 Australia’s National Science and Research Priorities. <https://www.industry.gov.au/publications/national-science-and-research-priorities-2024>

⁸ See: 2021 National Agriculture Innovation Policy Statement. https://www.awe.gov.au/agriculture-land/farm-food-drought/innovation/research_and_development_corporations_and_companies#government-priorities-for-investment. NB: Statement checked on the DAFF website and found to current, January 2025.

4. Identification of Potential Costs and Benefits

4.1 Costs

4.1.1 R&D Investment

The R&D investment costs comprised:

- Direct financial outlays by Wine Australia, the project funding body. These costs include both project and overhead expenditures.
- Research partner contributions to the project – cash and in-kind contributions were made by AWRI to this project.
- In-kind contributions to the research project – time associated with meetings between the researchers and Wine Australia and other project collaborators including Deakin University, Flinders University, Catholic University of the Sacred Heart, Milan, and Senomyx, Monell Chemical Senses Centre, University of Adelaide.

4.1.2 Administration

No additional administration costs were identified.

4.1.3 Extension

The project budget included extension and communication activities (journal papers, industry articles) and findings were incorporated into linked technology transfer projects at no additional cost.

4.1.4 Adoption

The project has made progress towards enabling winemakers to optimise certain textural and taste attributes while minimising negative ones. Additional investment will be required to “prove” these project outputs in a commercial winery. Once project outputs are proven, costs will be incurred adapting production practices. These costs might include purchase and use of additional inputs and equipment, training and deployment of winery staff.

4.2 Benefits

4.2.1 Research Output and Impact Pathway

The key output from the project is progress towards enabling winemakers to optimise certain positive textural and taste attributes while minimising negative ones. The impact pathway for this output is:

1. Project findings are demonstrated in a commercial winery and effectively communicated to winemakers.
2. Some winemakers modify production practices to optimise certain positive textural and taste attributes and minimise negative ones.
3. A proportion of winemakers who adopt project findings, increase the premiumisation (and profitability) of their current sales.

4.2.2 Triple Bottom Line Benefits

A summary of potential benefits from the project in triple bottom line categories is shown in Table 4.1.

Table 4.1 Triple Bottom Line Categories Benefits from Project Investment

Levy Paying Industry	Spillovers		
	Other Industries	Public	Foreign
<u>Economic Benefits</u>			
Progress toward the consistent production of more profitable, premium wine with superior texture and taste.	Nil.	Nil.	New knowledge of non-volatile compounds may inform winemaking in other countries.

Potential winemaker efficiency and cost advantages associated with switching from cold settling to flotation.			
New understanding of 'spritzy' and 'savory' attributes to support NOLO research.			
<u>Environmental Benefits</u>			
Nil.	Nil.	Nil.	Nil.
<u>Social Benefits</u>			
Additional researcher skills in assessment of non-volatile compounds impacting wine texture and taste.	Skills developed in assessment of non-volatile compounds may be applicable to the production of food and other alcoholic beverages.	Nil.	Nil.
Additional winemaker knowledge of techniques to improve the texture and taste of wine.			
Additional profitable wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).			

4.2.3 Public versus Private Benefits

The project has the potential to generate both private and public benefits. However, the principal benefit will be private – production of more profitable premium wine. Potential public benefits include increased researcher and winemaker capacity and spill-over benefits for winemaking communities.

4.2.4 Distribution of Benefits along the Supply Chain

The benefits to the wine industry from investment in this project will be shared along the supply chain with winemakers, wholesalers, exporters, and retailers all sharing some of the benefits.

4.2.5 Benefits to other Primary Industries

Skills developed in assessment of non-volatile compounds may be applicable to the production of food and other alcoholic beverages including apple and pear cider.

4.2.6 Benefits Overseas

New knowledge of non-volatile compounds generated by this project may inform winemaking in other countries. Study results have been published in scientific journals.

4.3 Summary of Costs and Benefits

A summary of principal categories of costs and benefits from the project is shown in Table 4.2.

Table 4.2 Incremental Cost and Benefit Categories

Costs	Benefits
R&D investment costs (cash and in-kind) incurred by Wine Australia and other project investors including project administration costs.	Increased winemaker profit from sale of wine with superior texture and taste.
Overhead costs including time associated with meetings between the researchers, Wine Australia and collaborating organisations.	Potential winemaker efficiency and cost advantages associated with switching from cold settling to flotation.
	New understanding of 'spritz' and 'savoury' attributes to support NOLO research.
	Additional researcher skills in assessment of non-volatile compounds impacting wine texture and taste.
	Additional winemaker knowledge of techniques to improve the texture and taste of wine.
	Additional profitable wine production and sales which will generate income, and employment benefits in regional Australia (spill-over impact).

5. Valuation of Costs and Benefits

5.1 Costs

5.1.1 R&D Investment Costs including Administration

The following table shows annual investment in the project by Wine Australia (Table 5.1). The table reports actual expenditure, noting that some of the funds originally allocated by Wine Australia were not required.

Table 5.1 Investment by Wine Australia in the Project for Years Ending June 2018 to June 2022

Project Code	2018	2019	2020	2021	2022	Total
AWR 1701-3.1.3	335,566	332,868	264,766	312,057	301,094	1,546,351
Total	335,566	332,868	264,766	312,057	301,094	1,546,351

Source: AWRI 1701-3.1.3 End of Project Financial Statement, printed December 2024

In 2021/22, AWRI contributed \$628,864 as a co-contribution to the overall Wine Australia investment portfolio. On a proportional basis AWR 1701-3.1.3 Molecular Drivers of Wine Texture and Taste represented 3.3% of the overall investment portfolio. It would be appropriate in that context to recognise \$20,752 of direct investment by the AWRI in 2021/22 (AWRI, personal communication, February 2025). An annual investment of this amount has been included in project costs by the analyst.

Furthermore, AWRI estimate the value of in-kind contribution to the project to be \$146,268 over the life of the Investment Agreement (AWRI, personal communication, February 2025). This total in-kind contribution has been allocated equally over the project's five year live.

AWRI total investment in the project is shown in Table 5.2.

Table 5.2 Investment by Others in the Project for Years Ending June 2018 to June 2022

Project Code	2018	2019	2020	2021	2022	Total
AWR 1701-3.1.3 – AWRI Cash	20,752	20,752	20,752	20,752	20,752	103,760
AWR 1701-3.1.3 – AWRI In-kind	29,254	29,254	29,254	29,253	29,253	146,268
Total	50,006	50,006	50,006	50,005	50,005	250,028

Source: AWRI personal communication, February 2025

Table 5.3 provides the total investment by year for both sources.

Table 5.3 Annual Investment in the Project (nominal \$)

Year Ending 30 June	Wine Australia	Others	Total
2018	335,566	50,006	385,572
2019	332,868	50,006	382,874
2020	264,766	50,006	314,772
2021	312,057	50,005	362,062
2022	301,094	50,005	351,099
Total	1,546,351	250,028	1,796,379

5.1.2 Overhead Costs including Meetings between the Researchers and Wine Australia

Wine Australia overhead costs are in addition to those shown in the above tables and are estimated at 12%.

5.1.3 Project Collaborator Costs

Time associated with meetings between researchers and Wine Australia and other project collaborators are a project cost. Project collaborators included Deakin University, Flinders University, Catholic University of the Sacred Heart, Milan, and Senomyx, Monell Chemical Senses Centre, University of Adelaide. These costs are estimated at \$5,000 per annum each year of the project and are included in the quantitative component of the benefit cost analysis.

5.2 Benefits

Counterfactual: in the absence of this project, there is a possibility that large Australian wine companies would have invested in R&D to identify molecular drivers of texture and taste. Consequently, a counterfactual of 75% has been assumed i.e., it is 25% likely that potential project benefits would have been realised in the absence of project investment.

5.2.1 Increase in Winemaker Profit on Wine with Improved Texture and Taste

The project has identified molecular compounds that can be managed during winemaking to mitigate negative wine traits and enhance positive traits. Compounds are relevant to both white and red wine and have the potential to contribute to the ongoing premiumisation of Australian wine. Further investment is required to prove the compounds in a commercial winery setting.

A summary of key assumptions used to quantify the potential increase in winemaker profit from adopting project outputs is summarised in Table 5.4.

Table 5.4 Summary of Assumptions

Variable	Assumption	Source
Increase in Winemaker Profit with Improved Texture and Taste		
Year of first benefit – white and red wine incorporating project findings available to consumers.	2029/30.	Project findings need testing under commercial conditions, successfully incorporated into production and the resultant wine marketed to consumers.
Australian wine production.	1.042 million litres.	Wine Australia (2024).
Share of Australian wine production that will make use of project findings.	2.5%.	Analyst's estimate after considering that compounds identified through project R&D will only be relevant to some wine styles and winemaking practices.
Increase in profit on wine incorporating project findings.	\$0.24/litre.	Derived from net revenue estimate of \$1.22/litre (Wine Australia 2019) and assumes a 20% increase in profit after

		allowing for costs associated with adoption of project findings.
Attribution of benefits to this project (AWR 1701-3.1.3).	40%.	Attribution of benefits to this project was estimated after considering the contribution made by past R&D and the need for extension of project findings into commercial wine production.
Probability of valuable outputs.	100%.	Outputs have been delivered.
Probability of valuable outcomes.	70%	Winemakers have indicated their interest in compounds that will improve wine texture and taste. However, commercial use is not 100% assured.
Probability of impact.	50%	It is likely that wine with improved texture and taste will be more profitable for winemakers. There is also a risk that ruling market conditions (e.g., a supply and demand imbalance) will prevent this from occurring.
Counterfactual	75%	See above explanation.

5.2.2 Other Potential Benefits

Other potential benefits identified but not valued are summarised in Table 4.2. Other potential benefits were not quantified due to their relatively minor contribution to total impact and difficulty in securing data for quantification.

6. Results

6.1 Year of Assessment, Discount Year, Discount Rate and Analysis Period

Past and future cash flows were expressed in 2023/24-dollar terms and were discounted to the year 2024/25 using a discount rate of 5% to estimate the investment criteria and a 5% reinvestment rate to estimate the modified internal rate of return (MIRR). The base run used the best estimates of each variable, notwithstanding a high level of uncertainty for some of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2022).

Table 6.1 and Table 6.2 show the investment criteria estimated for the different periods of benefits for total investment and Wine Australia investment.

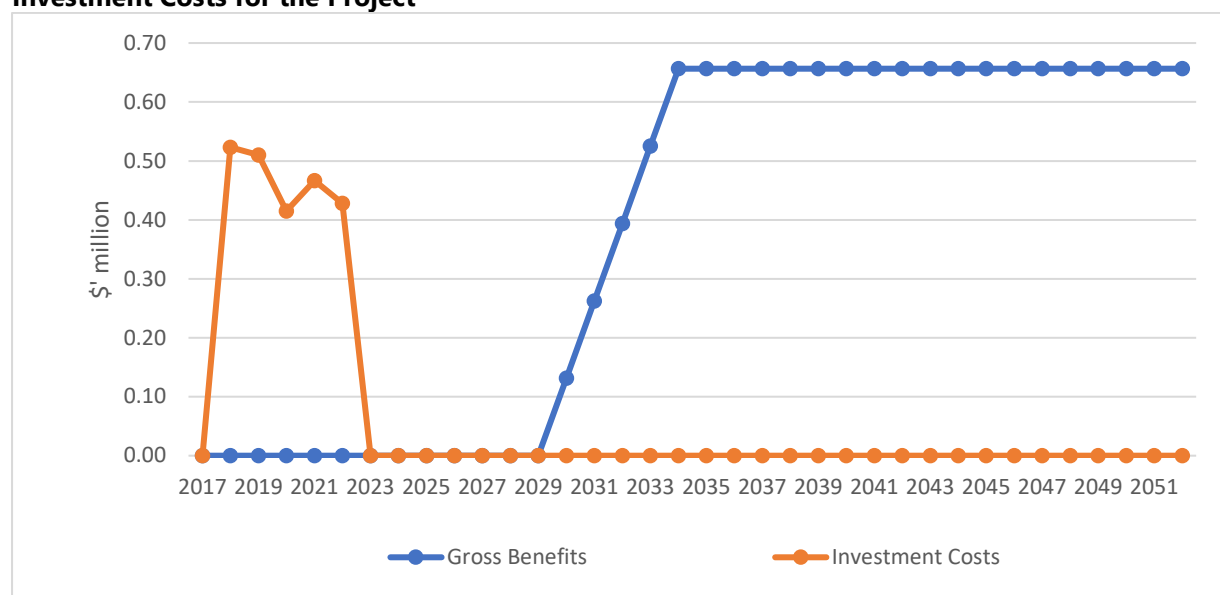
Table 6.1 Investment Criteria for Total Investment by Wine Australia and Project Partners (discount rate 5%)

Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits (\$m)	0.00	0.00	0.58	2.51	4.09	5.33	6.30
Present value of costs (\$m)	3.01	3.01	3.01	3.01	3.01	3.01	3.01
Net present value (\$m)	-3.01	-3.01	-2.43	-0.50	1.08	2.32	3.29
Benefit–cost ratio	0.00	0.00	0.19	0.83	1.36	1.77	2.09
Internal rate of return (%)	Negative	Negative	Negative	2.4	6.3	8.0	8.8
MIRR (%)	Negative	Negative	Negative	2.9	6.0	6.9	7.2

The annual undiscounted benefits and cost cash flows for the total investment for the duration of the investment period plus 30 years from the last year of the initial investment are shown in Figure 6.1.

Table 6.2 Investment Criteria for Investment by Wine Australia (discount rate 5%)

Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits (\$m)	0.00	0.00	0.50	2.17	3.53	4.60	5.44
Present value of costs (\$m)	2.60	2.60	2.60	2.60	2.60	2.60	2.60
Net present value (\$m)	-2.60	-2.60	-2.10	-0.43	0.93	2.00	2.84
Benefit-cost ratio	0.00	0.00	0.19	0.83	1.36	1.77	2.09
Internal rate of return (%)	Negative	Negative	Negative	2.4	6.3	8.0	8.8
MIRR (%)	Negative	Negative	Negative	2.9	6.0	6.9	7.2

Figure 6.1 Annual Undiscounted Cash Flows for Estimated Total Benefits and Total RD&E Investment Costs for the Project

7. Sensitivity Analysis

A sensitivity analysis was carried out for the central analysis results reported in Section 6 and variations in the discount rate. Table 7.1 presents the results. The results are sensitive to the discount rate and become negative when a 10% discount rate is applied. This is because project benefits are not generated until eight years after the final year of investment.

Table 7.1 Sensitivity to Discount Rate (Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present value of benefits (\$m)	13.79	6.30	3.24
Present value of costs (\$m)	2.34	3.01	3.85
Net present value (\$m)	11.44	3.29	-0.61
Benefit-cost ratio	5.88	2.09	0.84

Sensitivity analyses were undertaken for those variables where there was greatest uncertainty or for those that were identified as key drivers of the investment criteria. The analyses were performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values.

For this project, the greatest uncertainty related to the share of Australian wine production adopting project findings and the subsequent increase in winemaker profit – Table 7.2 and Table 7.3. Results show that the benefit cost ratio is sensitive to both these key assumptions and if the share of Australian wine

production adopting project findings was only 1.25% or the profit increase only \$0.12/litre, then project benefits would only equate to project costs (i.e., investment in the project would 'breakeven').

Table 7.2 Sensitivity to Share of Production Adopting Findings (Total investment, 30 years)

Investment Criteria	Share of Australian Wine Production Adopting Project Findings (%)		
	1.25%	1.5%	2.5% (base)
Present value of benefits (\$m)	3.15	3.78	6.30
Present value of costs (\$m)	3.01	3.01	3.01
Net present value (\$m)	0.14	0.77	3.29
Benefit-cost ratio	1.05	1.26	2.09

Table 7.3 Sensitivity to Increase in Profit Adopting Project Findings (Total investment, 30 years)

Investment Criteria	Profit Increase for Wines Incorporating Project Findings (\$/litre)		
	\$0.12/litre	\$0.18/litre	\$0.24/litre (base)
Present value of benefits (\$m)	3.15	4.73	6.30
Present value of costs (\$m)	3.01	3.01	3.01
Net present value (\$m)	0.14	1.72	3.29
Benefit-cost ratio	1.05	1.57	2.09

8. Confidence Ratings

The results produced are highly dependent on the assumptions made, many of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made, including the linkage between the research and the assumed outcomes.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 8.1). The rating categories used are High, Medium, and Low, where:

- High: denotes a good coverage of benefits or reasonable confidence in the assumptions made
- Medium: denotes only a reasonable coverage of benefits or some uncertainties in assumptions made
- Low: denotes a poor coverage of benefits or many uncertainties in assumptions made

Table 8.1 Confidence in Analysis of Program

Coverage of Benefits	Confidence in Assumptions
Medium	Medium

9. Summary of Results

Funding for AWR 1701-3.1.3 'investment in molecular drivers of wine texture and taste' had a total cost of \$3.01 million (present value terms) and is expected to produce aggregate total benefits of approximately \$6.3 million (present value terms). This gives an estimated net present value of \$3.29 million, a benefit-cost ratio of approximately 2.09, an internal rate of return of 8.8% and a modified internal rate of return of 7.2%.

Analysis results are dependent on assumptions made and are positive for core assumptions and do not become negative until 'lower end' assumptions are applied.

Abbreviations

AWITC	Australian Wine Industry Technical Conference
AWRI	Australian Wine Research Institute
GDP	Gross Domestic Product
GVP	Gross Value of Production
NOLO	No and Low Alcohol (wines)
R&D	Research and Development
RD&E	Research, Development and Extension

Persons Contacted

Keren Bindon, Project Principal Researcher, AWRI
Angelica Crabb, Senior Analyst, Wine Australia
Richard Gawel, Project Principal Researcher, AWRI
Markus Herderich, Researcher, AWRI
Mara Khem, Research and Innovation Administrator, Wine Australia
Peter Nguyen, AWRI
Tony Robinson, AWRI
Paul Smith, Senior RD&E Program Manager, Wine Australia

References

- Australian Bureau of Statistics. (2024, December 4). Australian National Accounts: National Income, Expenditure and Product Quarterly estimates of key economic flows in Australia, including gross domestic product (GDP), consumption, investment, income and saving. Table 5. Expenditure on Gross Domestic Product (GDP), Implicit price deflators. Retrieved from Australian Bureau of Statistics: <https://www.abs.gov.au/statistics/economy/national-accounts/australian-national-accounts-national-income-expenditure-and-product/latest-release#data-download>
- AWRI 2017-2025 RDE Plan Projects – Project 3.1.3. Accessed at https://www.awri.com.au/research_and_development/2017-2025-rde-plan-projects/project-3-1-3/
- Gawel, R and Bindon, K (November 2022) Molecular Drivers of Texture and Taste. Project Final Report prepared for Wine Australia.
- Council of Rural Research and Development Corporations. (2018). Cross-RDC Impact Assessment Program: Guidelines. Canberra: Council of Rural Research and Development Corporations. Retrieved from http://www.ruralrdc.com.au/wp-content/uploads/2018/08/201804_RDC-IA-Guidelines-V.2.pdf
- Wine Australia (2019) Economic Contribution of the Australian Wine Sector, 2019.
- Wine Australia (December 2024) Australian Wine Sector at a Glance 2023/24. Accessed at <https://www.wineaustralia.com/market-insights/australian-wine-sector-at-a-glance>