Benefit Cost Analysis of Wine Australia R&D Investments 2016-17

Report: 23 March 2018

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EXECUTIVE SUMMARY

Economic analyses of five programs of selected research and development (R&D) investments funded by Wine Australia have been undertaken. The main purpose of undertaking the analyses 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 five 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 program 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 programs 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.

Investments in Phylloxera Soil Sampling Strategies, Managing Root Zone Salinity and Extension all yielded positive results at a 5% discount rate, with benefit cost ratios ranging from 1.8 to 4.2. Investment in the Lees project did not achieve its principal objective and a relatively minor secondary benefit was quantified. The Lees project yielded a cost benefit ratio of 0.8 (costs exceeded benefits). The Market Access project achieved its objectives but a low attribution of benefit to project investment was agreed with Wine Australia. The Market Access project yielded a cost benefit ratio of 0.8 (costs exceeded benefits). Comparisons between project results should be made with caution due to uncertainties involved with assumptions and differing frameworks for each of the five analyses. Comparisons to analyses of previous investments should also be made with caution as the latest CRRDC guidelines require practitioners to take a conservative approach to the estimation of costs and benefits. This will result in lower benefit cost ratios than for analyses of research and development projects in previous years.

Table ES1: Benefit Cost Analyses Five Wine Australia R&D Investments 2016-17 (discount rate 5%)

Investment Criteria	Investment Program				
	Phylloxera	**Root Zone Salinity**	**Lees**	**Extension**	**Market Access**
Benefit–cost ratio	4.2	1.8	0.8	3.0	0.8
Benefit-cost ratio range - core assumption sensitivity	2.10 to 8.41	0.9 to 3.5	0.4 to 1.2	1.8 to 5.4	0.3 to 2.1
Potential unquantified benefits	Creation of a tool that will collect data on phylloxera exotics.	Project findings relevant to other irrigated agriculture.	Nil.	Improvements in public policy formulation for wine industry.	Project findings relevant to industries in other countries.
	Growers with new skills in phylloxera testing.	Project findings relevant to industries in other countries.		Capacity – grape growers and wine makers with new skills.	Enhanced Australian wine industry reputation and capacity.

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.

Consistent with Council of Rural Research and Development Corporation Guidelines for random project selection, projects in a list provided by Wine Australia 31 October 2017 were numbered one to twenty-nine and an online random number generator was used to select projects. Projects selected for analysis were:

- PGI 1201 Sampling strategies for sensitive, accurate and cost effective detections of **Phylloxera** for quantifying area freedom status;
- SAR 0902 Managing vineyards **root zone salinity** and maximising water saving by sub-surface irrigation techniques;
- AWR 1307 Removal of **lees** from underneath wine to reduce wine movements and tank cleaning;
- AWRI 4.1.1 The staging and conduct of **extension** programs; and
- AWRI 2.2.4 Increasing Australia's influence in **market access**, safety, regulatory and technical trade issues.

Documentation for each of these projects was assembled with assistance from Wine Australia personnel and included project applications, revised schedules and final reports. Each of the five 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 program 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 of some projects may be considered conservative.

Benefit cost analysis was conducted on all five 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 2017/18 dollar terms. Future costs and benefits were discounted to the 2017/18 year while past costs were inflated to 2017/18 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 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.

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.

Table 1 presents the investment criteria for each of the five projects analysed at a 5% discount rate and expressed in 2017/18 dollar terms. Given the assumptions made for each evaluation, four of the five investments are expected to produce positive net benefits over 30 years from the last year of investment. The Lees project did not achieve its principal objective and a relatively minor secondary benefit was quantified.

Table 1: Benefit Cost Analyses Five Wine Australia R&D Investments 2016-17 (discount rate 5%)

Investment Criteria	**Investment Program**				
	Phylloxera	**Root Zone Salinity**	**Lees**	**Extension**	**Market Access**
Present value of benefits ($m)	4.21	1.82	0.58	7.28	0.31
Present value of costs ($m)	1.00	1.04	0.70	2.42	0.37
Net present value ($m)	3.21	0.78	-0.12	4.86	-0.06
Benefit–cost ratio	4.21	1.75	0.83	3.00	0.84
Internal rate of return (%)	30.00	40.00	2.00	16.00	2.00
Modified internal rate of return (%)	10.00	8.00	4.00	9.00	4.00
Unquantified benefits	Creation of a tool that will collect data on phylloxera exotics.	Project findings relevant to other irrigated agriculture.	Nil.	Improvements in public policy formulation for wine industry.	Project findings relevant to industries in other countries.
	Growers with new skills in phylloxera testing.	Project findings relevant to industries in other countries.		Capacity – grape growers and wine makers with new skills.	Enhanced Australian wine industry reputation and capacity.

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.

Five 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 five projects. A brief conclusion is provided in Section 4. Appendices 1 to 5 provide the detailed analyses for each of the projects.

2. MATERIALS & METHODS

2.1 Projects for Evaluation

Consistent with Council of Rural Research and Development Corporation Guidelines for random project selection, projects in a list provided by Wine Australia 31 October 2017 were numbered one to twenty-nine and an online random number generator was used by AgEconPlus to select projects. Projects selected for analysis were:

- PGI 1201 Sampling strategies for sensitive, accurate and cost effective detections of **Phylloxera** for quantifying area freedom status;
- SAR 0902 Managing vineyards **root zone salinity** and maximising water saving by sub-surface irrigation techniques;
- AWR 1307 Removal of **lees** from underneath wine to reduce wine movements and tank cleaning;
- AWRI 4.1.1 The staging and conduct of **extension** programs; and
- AWRI 2.2.4 Increasing Australia's influence in **market access**, safety, regulatory and technical trade issues.

2.2 Individual Analyses

Each investment was evaluated through the following steps:

1. Information from the original project application, revised schedule and final report or other relevant reports and material was assembled with assistance from Wine Australia.
2. An initial description of the project background, objectives, activities, costs, outputs, and expected outcomes and benefits was drafted. Additional information needs were identified.
3. Telephone discussions were held with relevant Wine Australia personnel and principal investigators.

4. Further information was assembled where appropriate, including from contact with key industry representatives, and the quantitative analysis undertaken.
5. Some analyses proceeded through several drafts, both internally within the project team as well as externally via Wine Australia personnel and others.
6. 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. Some of these benefits were then valued.

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 have contributed to the outcome being valued.

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 five 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 2017/18 dollar terms. Future costs and benefits were discounted to the 2017/18 year while past costs were inflated to 2017/18 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 five programs. Each benefit is categorised as economic, environmental or social.

Table 3.1: Summary of Benefits for the Five Projects

Project	Benefits
Phylloxera	Economic • Avoided vine removal, replant and lost income due to earlier detection of phylloxera. • Technology available for adoption in other grape industries e.g. table and dried grape production. • Phylloxera is a devastating wine grape pest worldwide and the sampling protocol for DNA testing can be adapted to grape growing in other countries. Environmental • Creation of a tool that will collect data on phylloxera and provide early warning on biosecurity breaches and the presence of phylloxera exotics. Social • Growers with new skills in phylloxera testing.
Root zone salinity	Economic • Saved capital and operating costs from not investing in sub-surface irrigation systems. • Project findings relevant to other irrigated agriculture. • Project findings relevant to industries in other countries. Environmental • Nil. Social • Nil.
Lees	Economic • A minor reduction in the cost of producing wine due to increased knowledge about how to use current filtration technologies. Environmental • Nil. Social • Nil.
Extension	Economic • Increased adoption of research outputs resulting in reduced costs of production. • Increased adoption of research outputs resulting in increased demand for Australian wine. • Improvements in public policy formulation for the wine industry. Environmental • Nil. Social • Australian grape growers and winemakers with improved knowledge and skills.
Market access	Economic • Additional sales of Australian wine on domestic and export markets noting that in the first instance this benefit will manifest itself as enhanced risk mitigation. • Lower winemaking costs facilitated by acceptance of new techniques e.g. lower cost processing aids. • Improved market access delivered by this project will also assist wine exporters from other countries access Australian wine markets. Environmental • Nil. Social • Enhanced Australian wine industry reputation and capacity.

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 five project investments analysed 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 5).

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

Investment Criteria	Investment Program				
	Phylloxera	Root Zone Salinity	Lees	Extension	Market Access
Present value of benefits ($m)	4.20	1.82	0.58	7.28	0.31
Present value of costs ($m)	1.00	1.04	0.70	2.42	0.37
Net present value ($m)	3.20	0.78	-0.12	4.86	-0.06
Benefit–cost ratio	4.21	1.75	0.83	3.00	0.84
Internal rate of return (%)	30.00	40.00	2.00	16.00	2.00
Modified internal rate of return (%)	10.00	8.00	4.00	9.00	4.00

4. CONCLUSION

Three of the five investment analyses yielded positive results at the 5% discount rate, with B/C Ratios ranging from 1.8 to 4.2. For these investments, the results show a positive result in terms of those benefits valued and also in terms of the range of benefits identified. Investment in the Lees project did not achieve its principal objective and a relatively minor secondary benefit was quantified. The Lees project yielded a cost benefit ratio of 0.8 (costs exceeded benefits). The Market Access project achieved its objectives but a low attribution of benefit to project investment was agreed with Wine Australia. The Market Access project yielded a cost benefit ratio of 0.8 (costs exceeded benefits).

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 five analyses. Comparisons to analyses of previous investments should also be made with caution as the latest CRRDC guidelines require practitioners to take a conservative approach to the estimation of costs and benefits. This will result in lower benefit cost ratios than for analyses of research and development projects in previous years.

APPENDIX 1: ECONOMIC ANALYSIS WINE AUSTRALIA'S INVESTMENT IN PHYLLOXERA SAMPLING STRATEGIES

1. Background

Grape phylloxera (*Daktulosphaira vitifoliae*) is a devastating insect pest of grapevines worldwide. Phylloxera destroys grape vines by feeding on their roots. A lack of chemical or biological controls for phylloxera means that pulling out infested vines and replanting with new vines grafted onto phylloxera-resistant rootstock is the only control option. In Australia, phylloxera was first detected in the late nineteenth century and quarantine zones were rapidly defined to help prevent its spread. Currently, phylloxera is confined to parts of Victoria (North East, Maroondah, Nagambie, Mooroopna, Upton and Whitebridge) and NSW (Sydney region and Albury/Corowa). Movement of people, machinery, equipment, grapes, grape products, propagation material and diagnostic samples between winegrowing regions and states increases the risk of spreading phylloxera and detections inside the Maroondah Phylloxera Infested Zone (PIZ) in Victoria have been on the increase.

2. Summary of Projects

A single phylloxera sampling project was supported by Wine Australia and Table 2.1 provides a description.

Table 2.1 Project Description

Project No. PGI 1201 Sampling strategies for sensitive, accurate and cost effective detections of phylloxera for quantifying area freedom status	
Project Details	Research Organisation: Phylloxera and Grape Industry Board of South Australia (PGIBSA now trading as Vinehealth Australia) Period: 1 January 2013 to 30 June 2016 Principal Investigator: Allan Nankivell
Rationale	To prevent the spread of phylloxera, state-based, nationally agreed restrictions on the movement of phylloxera vectors are in place and enforced through state Plant Quarantine Standards, or equivalent, underpinned by the National Phylloxera Management Protocol. Maintaining whole or part-state area freedom from phylloxera and minimising spread out of infested areas requires accurate surveillance to determine where phylloxera is and is not. Currently there are two on ground phylloxera surveillance methods used by industry – emergence traps and visual root inspection (dig method). Only the visual root inspection method is endorsed under the National Phylloxera Management Protocol and used by regulators in official ground surveillance capacity. The visual root inspection method is resource and skill intensive and is limited to times of the year when phylloxera are closest to the soil surface and soil moisture is suitable for digging. The aim of this study was to develop a DNA based method of detecting phylloxera in a soil sample collected using a strong soil sampling protocol. The use of a DNA diagnostic tool to identify and quantify the presence of phylloxera in a soil sample has been tested and validated as an accurate and cost-effective method of diagnosing phylloxera. However, little was known about how to most effectively sample a vineyard to gain the most confidence that phylloxera is not present when surveying for area freedom. The project set out to develop a sampling methodology that can be carried out by the grape grower to provide the most accurate sample for diagnostic analysis.

	A DNA based protocol will be used as part of an integrated approach to phylloxera surveillance of vineyards, alongside the emergence traps and dig methods.
Objectives	The project had the following objectives. 1. Determine the number of soil samples needed for at least 95% confidence that phylloxera is not present and to achieve this in a cost effective way. 2. Establish the number of vines and the number of samples from a vine that need to be factored into the methodology. 3. Assess the impact of different soils and locations on the sampling efficacy. 4. Establish guidelines to improve confidence and efficacy. 5. Assess the impacts of time taken transporting the sample from the field to the processing laboratory before sample degradation occurs. 6. Validate the methodology in different areas – three regions (Yarra Valley, King Valley and Rutherglen), different times of the year, and the impact of moisture content on the sample. 7. Assess whether practitioners (grape growers) can accurately follow and perform the proposed sampling methodology.
Activities and Outputs	• Test the integrity of phylloxera DNA in soil samples collected near the trunk, dripper and mid-row, stored at a range of temperatures and storage durations. • Develop an assay to confirm field sample integrity. • Run trials to determine the number of vines that must be tested and the number of soil samples required for a confident conclusion on the presence or absence of phylloxera. • Prepare draft sampling guidelines. • Test and refine the guidelines with practitioners (grape growers). • Communicate study results at field days, workshops and seminars in different grape growing regions and via the Vineheath Australia newsletter and website.
Outcomes	• A new DNA sample delivery protocol and vineyard sampling protocol that is cost effective and easy to use.
Impacts	• Grape growers will be able to test their soils, develop proactive management strategies and avoid the cost of vine replant due to phylloxera damage. • The creation of a tool that will collect data on phylloxera and provide early warning on biosecurity breaches and the presence of phylloxera exotics. • Growers with new skills in phylloxera testing.

The Wine Australia project was part of a larger Plant Biosecurity Cooperative Research Centre (PBCRC) investment, project number 2601 that will conclude in 2018.

3. Match with Government Priorities

Table 3.1 Strategic Science/Research Priorities and Rural R&D Research Priorities

Australian Government	
Strategic Science/Research Priorities	**Rural R&D Priorities**
1. **Food** – optimising food and fibre production and processing, agricultural productivity and supply chains within Australia and global markets 2. **Soil and water** – improve use of soil and water resources, both terrestrial, marine 3. **Transport** – moving essential commodities, alternative fuels, lowering emissions	1. **Advanced technology**: to enhance innovation of products, processes and practices across the food and fibre supply chains through technologies such as robotics, digitalisation, big data, genetics and precision agriculture. 2. **Biosecurity**: to improve understanding and evidence of pest and disease pathways to help direct biosecurity resources to their best uses, minimising biosecurity threats and improving market access for primary producers.

4. **Cybersecurity** – for individuals, businesses, government, national infrastructure 5. **Energy** – improve efficiency, reduce emissions and integrate diverse sources into the grid. 6. **Resources** – support exploration traditional resources, rare earths and new technologies. 7. **Advanced manufacturing** – high value and innovative industries in Australia. 8. **Environmental change** – mitigating, managing or adapting to changes. 9. **Health** – improving health outcomes for all Australians.	3. **Soil, water and managing natural resources:** to manage soil health, improve water use efficiency and certainty of supply, sustainably develop new production areas and improve resilience to climate events and impacts. 4. **Adoption of R&D:** focussing on flexible delivery of extension services that meet primary producers' needs and recognising the growing role of private service delivery.

The Wine Australia project has addressed Strategic Science/ Research Priorities 1 and 2. The major focus of the project has been on the third of the Rural R&D Priorities.

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 collaborators and participants in the research project, namely Wine Australia and PGIBSA
- In-kind contributions to the research project – non-cash contributions made by research partners including SARDI, University of Adelaide, DPI NSW, DPI Victoria and PGIBSA
- In-kind contributions to the research project – time associated with meetings between the researchers and Wine Australia (project overhead costs).

4.1.2 Administration

No additional administration costs were identified.

4.1.3 Extension

Extension costs such as communication of project progress to grape growers are included in the project budget.

Additional work post PGI 1201 completion will include finalising sampling protocol, undertaking a case study during vintage 2017, developing an end user delivery model, seeking national endorsement, integrating the method into national and state phylloxera protocols/regulations and extending the protocol to end users.

4.1.4 Adoption

Adoption costs will be incurred by grape growers understanding the new protocol (training), collecting soil samples and having them tested in a laboratory.

4.2 Benefits

4.2.1 Research Output and Impact Pathway

The output of the project is a new DNA based phylloxera testing protocol that can be used by growers. Use of the test will permit early detection of phylloxera and avoid the cost of vine replant.

The impact pathway is:

1. Initial research on prototype protocol 2013 to 2016

2. Protocol finalisation, securing national endorsement, integration of the test into regulations and extension – investment proposed until mid-2018
3. Grower use of DNA based protocol.

4.2.2 Triple Bottom Line Benefits

A summary of the 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**
Economic Benefits			
Avoided vine replant due to earlier detection of phylloxera.	Technology available for adoption in other grape industries e.g. table and dried grape production.	Nil	Phylloxera is a devastating wine grape pest worldwide and the sampling protocol for DNA testing can be adapted to grape growing in other countries.
Environmental Benefits			
Creation of a tool that will collect data on phylloxera and provide early warning on biosecurity breaches and the presence of phylloxera exotics.	Nil	Nil	Nil
Social Benefits			
Growers with new skills in phylloxera testing.	Nil	Nil	Nil

4.2.3 Public versus Private Benefits

The majority of benefits that will arise from project investment will be private in nature. The private benefits will be captured largely by the wine grape growing sector. Private benefits will focus on avoided vine replant due to earlier detection of phylloxera.

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, wine makers, wholesalers and exporters all sharing some of the benefits.

4.2.5 Benefits to other Primary Industries

Benefits to other primary industries include development of a technique that may be relevant to table grape and dried grape production in the future. Neither industry is presently affected by phylloxera. It may also be possible to adapt the technology for nematode detection.

4.2.6 Benefits Overseas

With modification for local conditions, the sampling protocol for DNA based testing of phylloxera will be relevant to other countries where phylloxera has become established and may be a useful biosecurity tool in countries that do not have phylloxera.

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) as well as project administration costs	Avoided vine replant due to earlier detection of phylloxera.
Overhead costs including time associated with meetings between the researchers and Wine Australia	Creation of a tool that will collect data on phylloxera and provide early warning on biosecurity breaches and the presence of phylloxera exotics.
Extension costs including finalisation of the sampling protocol, undertaking a case study, developing a grape grower delivery model, seeking national endorsement, integrating the method into regulations and grower extension.	Growers with new skills in phylloxera testing.
Adoption costs incurred by grape growers – understanding the new protocol, collecting soil samples and having them tested in a laboratory.	

5. Valuation of Costs and Benefits

5.1 Costs

5.1.1 R&D Investment Costs including Administration

The following tables show annual investment in the Project by Wine Australia (Table 5.1) and for researchers and other investors (Table 5.2). Table 5.3 provides the total investment by year for both sources.

Table 5.1 Investment by Wine Australia in the Project for Years Ending June 2012 to June 2016

Project Code	2013	2014	2015	2016	Total
PGI 1201 – Wine Australia	36,300	45,600	47,900	39,100	**168,900**
Total	**36,300**	**45,600**	**47,900**	**39,100**	**168,900**

Source: Wine Australia Project Application

Table 5.2 Investment by Researchers/Others in the Project for Years Ending June 2012 to June 2016

Project Code	2013	2014	2015	2016	Total
PGI 1201 – PGIBSA cash	38,300	45,600	47,900	39,100	**170,900**
PGI 1201 – PGIBSA in-kind	40,000	45,000	45,000	65,000	**195,000**
PGI 1201 – PBCRC cash	36,300	45,600	47,900	39,100	**168,900**
PGI 1201 – SARDI, University of Adelaide, NSW DPI, Vic DPI in-kind	25,000	30,000	30,000	30,000	**115,000**
Total	**139,600**	**166,200**	**170,800**	**173,200**	**649,800**

Source: Wine Australia Project Application

Table 5.3 Annual Investment in the Project (nominal $)

Year Ending 30 June	Wine Australia	Researchers/Others	Total
2013	36,300	139,600	175,900
2014	45,600	166,200	211,800
2015	47,900	170,800	218,700
2016	39,100	173,200	212,300
Total	**168,900**	**649,800**	**818,700**

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 Extension Costs

Extension costs including finalisation of the sampling protocol, undertaking a case study, developing a grape grower delivery model, seeking national endorsement, integrating the method into regulations and grower extension. Vinehealth Australia advises that these tasks have been delivered as part of PBCRC Project 2601 and have required 0.8 of an FTE at a cost of approximately $120,000. The expenditure will be incurred in the year ending June 2018.

5.1.4 Adoption Costs

Adoption costs will be incurred by grape growers who adopt DNA based phylloxera testing and these costs will include understanding the new protocol, collecting soil samples, packing soil samples and having them tested in a laboratory. Sample costs were estimated following discussions with Inca Pearce, CEO, Vinehealth Australia at a minimum of $110/ha plus laboratory testing. An allowance of $140/ha for laboratory testing of soil samples has been made.

5.2 Benefits

5.2.1 Avoided Vine Replant Due to Earlier Detection of Phylloxera

The Counterfactual

In the absence of this project a simple cost effective phylloxera test would not be available to grape growers for a further 5 years, the rate of phylloxera spread would be higher and growers affected by phylloxera would incur replant costs. Replanting would use vines grafted to phylloxera resistant rootstocks.

Avoided Vine Replant Due to Earlier Detection of Phylloxera

The project is expected to result in saved vine removal, replant and income loss costs.

The benefit is quantified assuming that grape growers in areas susceptible to phylloxera adopt project outputs, take proactive measures to avoid phylloxera and do not incur costs associated with existing vine removal, replant and income loss. A summary of key assumptions used to quantify this benefit is shown in Table 5.5.

Table 5.5 Summary of Assumptions

Variable	Assumption	Source
Avoided Vine Replant Due to Earlier Detection of Phylloxera		
Area of wine grapes where the project generated DNA sampling protocol will be employed.	135,178 ha	Total wine grape growing area in Australia (ABS 2016)
Annual area of wine grapes where the sampling protocol will be used, an early positive test for phylloxera recorded and proactive strategies put in place to avoid vine removal and replant.	40ha	Consultant assumption tested using sensitivity analysis.
Cost of vine removal and replant in the absence of phylloxera testing using project generated DNA sampling protocol.	$21,750/ha	Cost consists of: • $5,000/ha old vine removal cost • $3,900/ha planting labour for new vines • $12,600/ha new vines (3,000 vines/ha X $4.20/vine for grafted vines)

		• $250/ha forgone gross margin on grape sales until new vines come into full production. Estimates sourced from DPIPWE 2017, AGWA 2016 and PGI 1201 final report.
Cost of soil sampling and soil testing using the project generated DNA sampling protocol.	$250/ha	Soil sampling cost of at least $110/ha established following discussions with Inca Pearce, CEO, Vinehealth Australia plus an allowance of $140/ha for laboratory testing.
Year in which project generated DNA sampling protocol first adopted by grape growers.	2020	Assumes lobbying for inclusion of DNA based testing in regulations commences in 2018 and it takes two years to achieve regulatory change and grower adoption.
Year in which DNA based phylloxera testing is replaced by an alternative technology e.g. imaging.	2029	Estimate prepared following discussions with Inca Pearce, CEO Vinehealth Australia.
Attribution of benefits to this project.	100%	Relevant expenditure from other projects (e.g. PBCRC 2601) has been included in the analysis.

5.2.2 Other Potential Benefits

Other potential benefits identified but not valued include:

- Early warning on biosecurity breaches
- Growers with new skills in phylloxera testing.

Other potential benefits were not quantified due to a combination of reasons including time and resources.

6. Results

All past costs were expressed in 2018 dollar terms using the implicit price deflator for GDP. All costs and benefits from 2018 onwards were discounted to 2018 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating 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 (2018).

Table 6.1 and Table 6.2 show the investment criteria estimated for the different periods of benefits for both the total investment and for Wine Australia investment. The present value of benefits (PVB) for the Wine Australia investment, shown in Table 6.2, are estimated by multiplying the total PVB by the Wine Australia proportion of 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	1.69	4.08	4.20	4.20	4.20	4.20

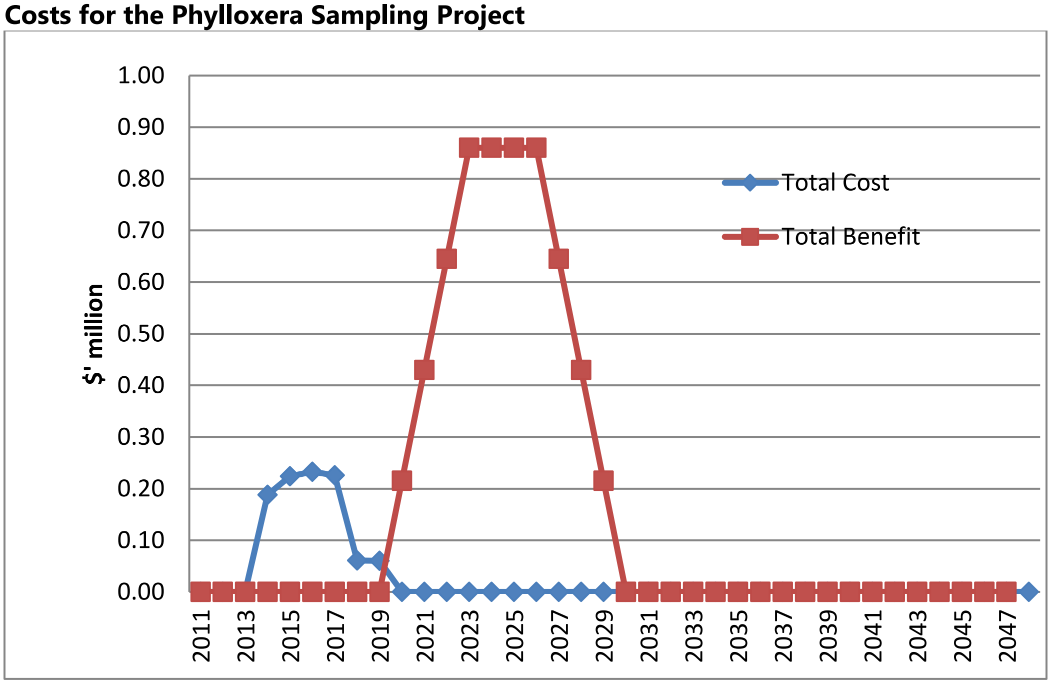
Present value of costs ($m)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Net present value ($m)	-1.00	0.69	3.08	3.20	3.20	3.20	3.20
Benefit–cost ratio	0.00	1.69	4.09	4.21	4.21	4.21	4.21
Internal rate of return (%)	Negative	17	30	30	30	30	30
Modified internal rate of return (%)	Negative	15	19	15	12	11	10

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

Years	**0 years**	**5 years**	**10 years**	**15 years**	**20 years**	**25 years**	**30 years**
Present value of benefits ($m)	0.00	0.33	0.81	0.83	0.83	0.83	0.83
Present value of costs ($m)	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Net present value ($m)	-0.20	0.13	0.61	0.63	0.63	0.63	0.63
Benefit–cost ratio	0.00	1.68	4.08	4.20	4.20	4.20	4.20
Internal rate of return (%)	Negative	17	30	30	30	30	30
Modified internal rate of return (%)	Negative	15	19	15	12	11	10

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 Phylloxera Sampling 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. These indicate that all indicators remain positive for all discount rate assumptions.

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

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present value of benefits ($m)	6.02	4.20	3.02
Present value of costs ($m)	1.00	1.00	1.00
Net present value ($m)	5.02	3.20	2.02
Benefit-cost ratio	6.01	4.21	3.03

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 tested area that returns a positive result for phylloxera – Table 7.2. Results show that at half the level of phylloxera detections project benefits continue to exceed project costs.

Table 7.2 Sensitivity to % of Area Tested Returning a Positive Result for Phylloxera (Total investment, 30 years)

Investment Criteria	Tested Area Returning a Positive Result		
	20 ha	40 ha (base)	80 ha
Present value of benefits ($m)	2.10	4.20	8.40
Present value of costs ($m)	1.00	1.00	1.00
Net present value ($m)	1.10	3.20	7.40
Benefit-cost ratio	2.10	4.21	8.41

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 good coverage of benefits or reasonable confidence in 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 the phylloxera sampling project, including expected future costs, was valued at $1.00M (present value terms) and is expected to produce aggregate total benefits of approximately $4.20M (present value terms). This gives an estimated net present value of $3.20M, a benefit-cost ratio of approximately 4.21, an internal rate of return of 30% and a modified internal rate of return of 10%.

All investment indicators remain positive for different discount rate assumptions and different assumptions around area of RPZ adopting and increase in grape price.

Abbreviations

AGWA	Australian Grape and Wine Authority
DPI NSW	Department of Primary Industries New South Wales
FTE	Full Time Equivalent
GDP	Gross Domestic Product
PBCRC	Plant Biosecurity Cooperative Research Centre
PGIBSA	Phylloxera and Grape Industry Board of South Australia
PIRSA	Primary Industries and Regions South Australia
PRZ	Phylloxera Risk Zones
SARDI	South Australian Research and Development Institute

Persons Contacted

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Suzanne McLoughlin, Technical Manager, Vinehealth Australia
Inca Pearce, Chief Executive Officer, Vinehealth Australia

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APPENDIX 2: ECONOMIC ANALYSIS WINE AUSTRALIA'S INVESTMENT IN ROOT ZONE SALINITY AND SUB-SURFACE DRIP IRRIGATION TECHNIQUES

1. Background

This project builds on a Tri-State salinity project completed by SARDI in the McLaren Vale South Australia. Results from the Tri-State salinity project suggested that sub-surface drip irrigation conserved more water and lowered root zone salinity compared to above ground conventional drip irrigation. The Winemakers' Federation of Australia report that more than 60% of Australia's grape growers utilised standard above-ground drip irrigation systems.

2. Summary of Projects

A single sub-surface drip irrigation project was supported and Table 2.1 provides a description.

Table 2.1 Project Description

Project No. SAR 0902 Managing vineyards root zone salinity and maximising water savings by sub-surface drip irrigation techniques	
Project Details	Research Organisation: South Australian Research & Development Institute (SARDI) Period: 1 August 2010 to 31 December 2015 Principal Investigator: Michael McCarthy
Rationale	The supply of irrigation water is constrained in Australia and soil salinity threatens the quality of wine grape production. Consequently, it is imperative that more efficient methods of irrigation such as sub-surface irrigation are identified and their impact on water use, root zone salinity and nutrition loss is evaluated. The purpose of this project was to assess the potential benefits of sub-surface drip irrigation i.e. a lower water requirement and lower root zone salinity in times of limited water.
Objectives	The project had the following objectives. 1. Review the international literature on sub-surface drip irrigation in vineyards 2. Quantify potential water and nutrient savings with sub-surface irrigation compared with conventional above-ground drip irrigation 3. Quantify changes in soil salinity with sub-surface irrigation techniques using strategic field experimentations 4. Understand the dynamics of root zone salinity, deep drainage and vineyard water movement under sub-surface and conventional irrigation techniques 5. Develop sustainable management systems to maximise salt leaching and minimise nutrient loss from irrigated vineyards 6. Generate knowledge to enable growers to better manage periods of low supply and elevated irrigation salinity water as projected under climate change 7. Transfer knowledge to the grape and wine industries.
Activities and Outputs	• A peer reviewed literature survey on sub-surface drip irrigation • Biometrically designed irrigation trials in both the Riverland and McLaren Vale • An assessment of the long-term impacts of sub-surface irrigation on soil • A computer simulation model that can predict water and solute behavior • Sub-surface drip irrigation best management practice guidelines • On-farm demonstrations/field days to facilitate rapid technology transfer • An assessment of how to maximise the potential benefits of sub-surface drip irrigation.

Outcomes	• The project generated unexpected results. It showed that under non-restricted irrigation allocations there were no water use savings or improvements in root zone salinity with the use of sub-surface irrigation; either using conventional sub-surface drip line or when the sub-surface was enclosed in porous fabric strips designed to improve the lateral movement of water. Only under severely reduced irrigation volume was there some yield advantage with the two types of sub-surface irrigation system. Furthermore, there was deposition of fine colloidal clay within the fabric covering of one system which may limit the life of this technology in areas served with irrigation water from the Murray-Darling Basin.
Impacts	• Results from the project have been widely communicated through the scientific literature and field days. Cost savings through reduced purchase of irrigation water and productivity gains through avoided salinity, yield and quality loss did not eventuate. However, the project has resulted in vineyards, especially larger corporate operations, who were previously scheduling investments in sub-surface irrigation, cancelling their plans. • The benefit from this research is avoided costs associated with the purchase, installation and maintenance of sub-surface irrigation systems which offer no water cost saving or gain in productivity over conventional drip irrigation.

3. Match with Government Priorities

Table 3.1 Strategic Science/Research Priorities and Rural R&D Research Priorities

Australian Government	
Strategic Science/Research Priorities	**Rural R&D Priorities**
1. **Food** – optimising food and fibre production and processing, agricultural productivity and supply chains within Australia and global markets 2. **Soil and water** – improve use of soil and water resources, both terrestrial, marine 3. **Transport** – moving essential commodities, alternative fuels, lowering emissions 4. **Cybersecurity** – for individuals, businesses, government, national infrastructure 5. **Energy** – improve efficiency, reduce emissions and integrate diverse sources into the grid. 6. **Resources** – support exploration for traditional resources, rare earths and new technologies. 7. **Advanced manufacturing** – high value and innovative industries in Australia. 8. **Environmental change** – mitigating, managing or adapting to changes. 9. **Health** – improving health outcomes for all Australians.	1. **Advanced technology**: to enhance innovation of products, processes and practices across the food and fibre supply chains through technologies such as robotics, digitalisation, big data, genetics and precision agriculture. 5. **Biosecurity**: to improve understanding and evidence of pest and disease pathways to help direct biosecurity resources to their best uses, minimising biosecurity threats and improving market access for primary producers. 6. **Soil, water and managing natural resources:** to manage soil health, improve water use efficiency and certainty of supply, sustainably develop new production areas and improve resilience to climate events and impacts. 7. **Adoption of R&D:** focussing on flexible delivery of extension services that meet primary producers' needs and recognising the growing role of private service delivery.

The Wine Australia project has addressed Strategic Science/ Research Priorities 1 and 2. The major focus of the project has been on the first, third and fourth of the Rural R&D Priorities.

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 collaborators and participants in the research project, namely Wine Australia and the South Australian Murray-Darling Basin Natural Resource Management Board
- In-kind contributions to the research project – non-cash contributions made by research partner SARDI
- In-kind contributions to the research project – time associated with meetings between the researchers and Wine Australia (project overhead costs).

4.1.2 Administration
No additional administration costs were identified.

4.1.3 Extension
Extension costs such as communication of project outcomes to grape growers are included in the project budget. South Australian Murray Darling Basin Natural Resource Management (SAMDBNRM) Board contributions specifically address technology diffusion and capacity building.

4.1.4 Adoption
No adoption costs are anticipated. Costs will be saved when planned investment in sub-surface irrigation is abandoned.

4.2 Benefits
4.2.1 Research Output and Impact Pathway
The output from this project is information that shows that there is no production gain from switching from conventional drip irrigation to sub-surface drip irrigation.

The impact pathway is:

4. 5-year research program showing that there are no water use savings or improvements in root zone salinity by switching from conventional drip irrigation to sub-surface drip irrigation
5. Communication of research findings through the relevant scientific literature and field days
6. Grape growers cancel plans to switch from conventional drip irrigation to sub-surface drip irrigation saving capital and maintenance costs.

4.2.2 Triple Bottom Line Benefits
A summary of the 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**
Economic Benefits			
Saved capital and operating costs from not investing in sub-surface irrigation systems.	Project findings may be relevant to other irrigated agricultural industries especially Murray Darling Basin permanent plantings.	Nil	Project findings may be relevant to wine grape and other agricultural industries in other countries.
Environmental Benefits			
Nil	Nil	Nil	Nil
Social Benefits			
Nil	Nil	Nil	Nil

4.2.3 Public versus Private Benefits
The majority of benefits that will arise from project investment will be private in nature. The private benefits will be captured largely by the wine grape growing sector. Private benefits will focus on saved capital and operating costs from not investing in sub-surface irrigation systems.

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 and winemakers sharing the benefits.

4.2.5 Benefits to other Primary Industries
Benefits to other primary industries include the possibility that the major project finding, there is no production or environmental gain from switching from conventional drip irrigation to sub-surface drip irrigation, may be relevant to other irrigated agricultural industries. Findings are most likely to be relevant to other Murray Darling Basin permanent plantings including other vine and tree crops.

4.2.6 Benefits Overseas
Project findings may be relevant to wine grape and other agricultural industries in other 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) as well as project administration costs.	Saved capital and operating costs from not adopting sub-surface irrigation.
Overhead costs including time associated with meetings between the researchers and Wine Australia.	
Extension costs including contributions specifically addressing technology diffusion and capacity building made by the SAMDBNRM Board as part of project R&D investment costs.	
Adoption costs – none anticipated.	

5. Valuation of Costs and Benefits

5.1 Costs
5.1.1 R&D Investment Costs including Administration

The following tables show annual investment in the project by Wine Australia (Table 5.1) and for researchers and other investors (Table 5.2). Table 5.3 provides the total investment by year for both sources.

Table 5.1 Investment by AGWA in the Project for Years Ending June 2012 to June 2016

Project Code	2011	2012	2013	2014	2015	2016	Total
SAR 0902 – Wine Australia cash	148,500	154,000	0	140,250	0	24,750	**467,500**
Total	**148,500**	**154,000**	**0**	**140,250**	**0**	**24,750**	**467,500**

Source: AGWA End of Project Financial Statement

Table 5.2 Investment by Researchers/Others in the Project for Years Ending June 2012 to June 2016

Project Code	2011	2012	2013	2014	2015	2016	Total
SAR 0902 – SAMDBNRM Board cash	10,000	10,000	0	5,000	0	5,000	**30,000**
SAR 0902 – SARDI in-kind	145,000	145,000	0	120,000	0	28,000	**438,000**
Total	**155,000**	**155,000**	**0**	**125,000**	**0**	**33,000**	**468,000**

Source: AGWA End of Project Financial Statement

Table 5.3 Annual Investment in the Project (nominal $)

Year Ending 30 June	Wine Australia	Researchers/Others	Total
2011	148,500	155,000	303,500
2012	154,000	155,000	309,000
2013	0	0	0
2014	140,250	125,000	265,250
2015	0	0	0
2016	24,750	33,000	57,750
Total	**467,500**	**468,000**	**935,500**

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 Extension Costs

Extension costs are included in the R&D Investment Cost totals.

5.1.4 Adoption Costs

There are no adoption costs associated with this project.

5.2 Benefits

5.2.1 Capital Cost Savings, Non Adoption Sub-Surface Irrigation

The Counterfactual

If this project had not been funded vineyard operators would have made investment decisions on the basis of existing, if somewhat limited, research results. A previous SARDI project had shown that there were water saving and root zone salinity benefits from switching from conventional drip irrigation to sub-surface irrigation. Large, mainly corporate, vineyards were implementing the technology on a trial commercial basis. The technology is expensive and costs approximately $6,000/ha to implement (Wrigley et al 2010). This contrasts with conventional drip irrigation which is laid on the surface and does not require expensive trenching. Conventional drip irrigation costs approximately $4,000/ha to implement (DPI Vic. 2015). In the absence of Wine Australia investment in this project it is assumed that investment in sub-surface irrigation would have continued for 5 years before empirical results and or results from a new research project resulted in its discontinuation.

Capital Cost Savings, Non Adoption Sub-Surface Irrigation

This project is expected to result in saved capital costs from not adopting sub-surface irrigation.

The benefit is quantified assuming that in the absence of the research project a small area of conventionally irrigated vineyard would have converted to sub-surface irrigation and incurred an unnecessary cost. Key data used to quantify this cost saving benefit is shown in Table 5.4.

Table 5.4 Summary of Assumptions

Variable	Assumption	Source/explanation

Capital Cost Savings, Non Adoption Sub-Surface Irrigation		
Wine grape growing area in Australia.	135,178 ha	ABS 2016.
Percentage of Australian wine grape growing area conventionally irrigated using surface drippers.	60%	Winemakers' Federation of Australia 2008.
Percentage of conventionally irrigated area replanted or new planted each year.	7%	Vineyards have a 25 year life therefore 4% replanted on average plus an assumed annual industry growth rate of 3%.
Percentage of conventionally irrigated area that would have adopted sub-surface irrigation in the absence of research findings.	3%	Consultant assumption based on review of project reports.
Capital cost of sub-surface irrigation.	$6,000/ha	Wrigley et al 2010
Capital cost of conventional drip irrigation.	$4,000/ha	DPI Vic. 2015
Capital cost saving from not implementing sub-surface irrigation.	$2,000/ha	$6,000/ha minus $4,000/ha
Year in which first investments in sub-surface irrigation would have been made in the absence of research findings.	2017	Project results communicated to industry following research completion in 2016.
Year in which empirical data becomes available and new investment in sub-surface irrigation ceases.	2022	Consultant assumption based on the fact that it took 5 years to establish research project findings.
Attribution of benefits to this project.	100%	Project provided new information that contradicted limited, previous research findings.

5.2.2 Other Potential Benefits

Other potential benefits identified but not valued include:

- Avoided higher operating costs associated with implementation of sub-surface drainage.

Avoided higher operating costs were not quantified due to the absence of reliable data on sub-surface irrigation operation in Australian vineyards.

6. Results

All past costs were expressed in 2018 dollar terms using the implicit price deflator for GDP. All costs and benefits from 2018 onwards were discounted to 2018 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating 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 (2018). Table 6.1 and Table 6.2 show the investment criteria estimated for the different periods of benefits for both the total investment and for Wine Australia investment. The present value of benefits (PVB) for the Wine Australia investment, shown in Table 6.2, are estimated by multiplying the total PVB by the Wine Australia proportion of investment.

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

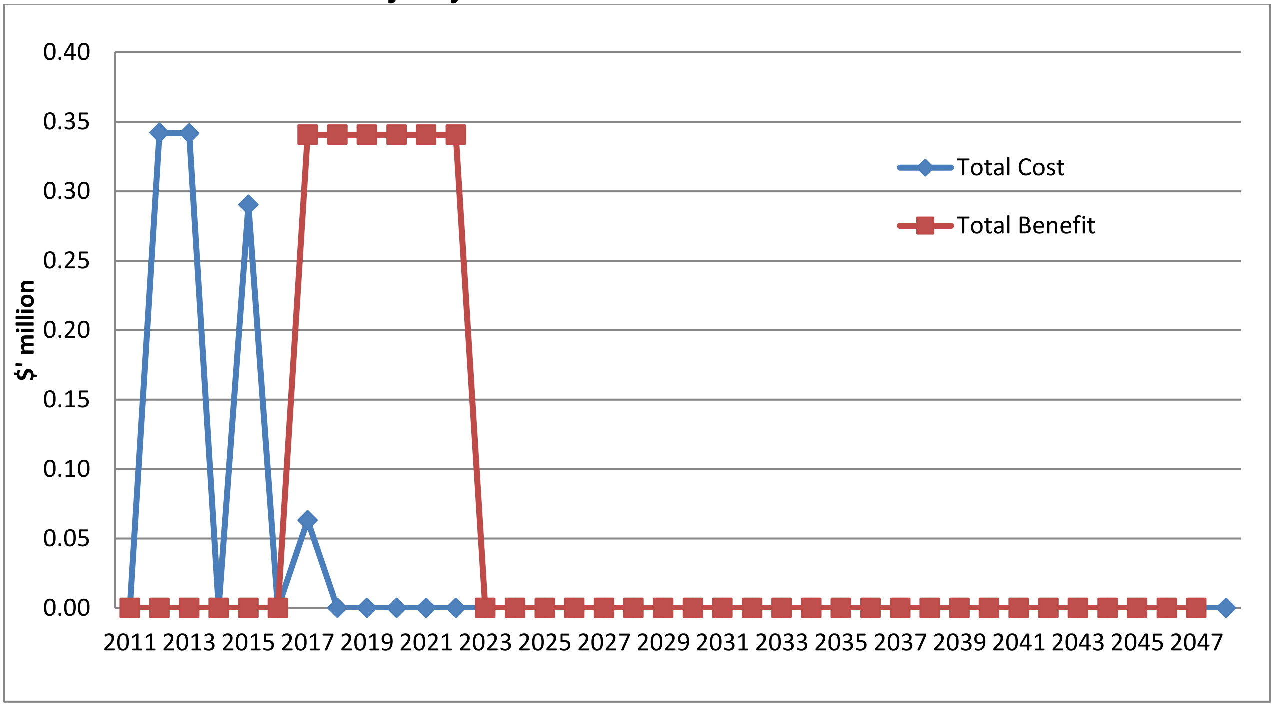
Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits ($m)	0.67	1.82	1.82	1.82	1.82	1.82	1.82
Present value of costs ($m)	1.04	1.04	1.04	1.04	1.04	1.04	1.04
Net present value ($m)	-0.37	0.78	0.78	0.78	0.78	0.78	0.78
Benefit–cost ratio	0.64	1.75	1.75	1.75	1.75	1.75	1.75
Internal rate of return (%)	Negative	40	40	40	40	40	40
Modified internal rate of return (%)	Negative	19	12	10	9	8	8

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

Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits ($m)	0.35	0.96	0.96	0.96	0.96	0.96	0.96
Present value of costs ($m)	0.55	0.55	0.55	0.55	0.55	0.55	0.55
Net present value ($m)	-0.19	0.41	0.41	0.41	0.41	0.41	0.41
Benefit–cost ratio	0.64	1.75	1.75	1.75	1.75	1.75	1.75
Internal rate of return (%)	Negative	40	4%	40	40	40	40
Modified internal rate of return (%)	Negative	19	12	10	9	8	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 Root Zone Salinity 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. These indicate that all indicators remain positive for all discount rate assumptions.

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

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present value of benefits ($m)	2.05	1.82	1.64
Present value of costs ($m)	1.04	1.04	1.04
Net present value ($m)	1.01	0.78	0.60
Benefit-cost ratio	1.97	1.75	1.57

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 percentage of conventional drip irrigation area that would have converted to sub-surface irrigation and the capital cost saving from not adopting sub-surface irrigation – Table 7.2 and Table 7.3. Results show that a halving of area converting to sub-surface drip irrigation and capital cost saving result in project costs exceeding project benefits.

Table 7.2 Sensitivity to Uptake of Sub-surface Drip Irrigation (Total investment, 30 years)

Investment Criteria	Conventional Drip Irrigation Area Converting to Sub-Surface without Research Project		
	1.5%	3% (base)	6%
Present value of benefits ($m)	0.91	1.82	3.64
Present value of costs ($m)	1.04	1.04	1.04
Net present value ($m)	-0.13	0.78	2.60
Benefit-cost ratio	0.88	1.75	3.50

Table 7.3 Sensitivity to Capital Cost Savings from Not Adopting Sub-surface Irrigation (Total investment, 30 years)

Investment Criteria	Capital Saving		
	$1,000/ha	$2,000/ha (base)	$3,000/ha
Present value of benefits ($m)	0.91	1.82	2.73
Present value of costs ($m)	1.04	1.04	1.04
Net present value ($m)	-0.13	0.78	1.69
Benefit-cost ratio	0.88	1.75	2.63

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 good coverage of benefits or reasonable confidence in 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	High

9. Summary of Results

Funding for the root zone salinity project, including expected future costs, was valued at $1.04M (present value terms) and are expected to produce aggregate total benefits of approximately $1.82M (present value terms). This gives an estimated net present value of $0.78M, a benefit-cost ratio of approximately 1.75, an internal rate of return of 40% and a modified internal rate of return of 8%.

Halving of estimates for area converting to sub-surface drip irrigation and capital cost saving result in project costs exceeding project benefits.

Abbreviations

ABS	Australian Bureau of Statistics
DPI Vic	Department of Primary Industries Victoria
SAMDBNRM	South Australian Murray Darling Basin Natural Resource Management Board
SARDI	South Australian Research and Development Institute

Persons Contacted

Keith Hayes, Senior R&D Program Manager, Wine Australia
Mike McCarthy, SARDI michael.mccarthy@sa.gov.au

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APPENDIX 3: ECONOMIC ANALYSIS WINE AUSTRALIA'S INVESTMENT IN THE REMOVAL OF LEES FROM UNDERNEATH WINE

1. Background

Racking (moving wine from one tank to another) is the most basic method of wine clarification. The lees (sediment) occlude up to 5% of wine volume that is either lost or more commonly recovered (but downgraded) by rotary drum vacuum filtration. Moving juice or wine between tanks requiring labour, water and cleaning chemicals and produces wastewater.

Instead of racking the large quantity of juice or wine off the top of the lees, researchers associated with this project suggested that it might be more efficient to remove the small quantity of lees from underneath the juice or wine. The clear liquid would remain in the same tank and a tank cleaning operation would be avoided.

Settled solids are removed from underneath liquid in the beer industry, where yeast is removed from the bottom of cylindroconical fermenters. Typical winery tanks are different, having only a gentle slope from one side to the other where the bottom valve is located. The beer industry process illustrates a concept that may be relevant to wine production.

2. Summary of Projects

A single lees project was supported and Table 2.1 provides a description.

Table 2.1 Project Description

Project No. AWR 1307 Removal of lees from underneath wine to reduce wine movements and tank cleaning	
Project Details	Research Organisation: Australian Wine Research Institute Period: 16 June 2014 to 30 November 2016 Principal Investigator: Simon Nordestgaard
Rationale	Production costs and wine downgrades directly impact wine company profitability. This project set out to develop techniques to reduce production costs associated with the movement of wine between tanks and avoid downgrade of wine recovered from lees.
Objectives	The principal objective of this project was to develop a prototype device that can be retrofitted to existing winery tanks to remove lees from underneath wine negating the need to move the wine. To achieve this objective the project addressed the following researchable questions: 1. What are the characteristics of lees at various stages of the winemaking process? 2. How do different fining agents and enzymes alter lees characteristics and can they be advantageously used to facilitate lees removal? 3. How do different tank bottom and valve configurations influence lees accumulation and potential for removal?
Activities and Outputs	• Collate information from wineries on lee types, volumes and availability. • Collect lee samples for analysis - test solids content, particle size, zeta potential (electrical charge, stability) and complete rheological analysis (flow measure).

	• Collect and publish information on winery lees management practices including volumes generated and protocols for lees recovery. • Conduct experiments on lees formation and removal for four wine types (post ferment white, clarified white, post-pressing red and clarified red) and three fining agents/enzymes (e.g. bentonite, protein, silica and diatomaceous earth). • Identify and test new winery lees removal devices and compare the economic performance of each device. • Conduct a workshop at the 16th Australian Wine Industry Technical Conference to present findings on (1) winery lees characterisation and laboratory settling experiments and (2) equipment and techniques for lees processing. • The research showed that grape solids are the largest source of lees and that bentonite is the other major source of lees in white wine production. • Flotation appears to be a means of achieving low juice lees volumes compared with settling, with less capital cost than required for centrifugation. • Most winery lees are thin and easily pumped. This is not the case with red wine. Oak chips in both red and white ferments that bleed through to settling tanks are a processing challenge. • Some success was achieved in removing lees from underneath clears using brewery-style cylindroconical tanks with a 55° slope. With normal winery-style tanks with a 5° slope, clears broke through the lees almost immediately. • Some limited success was achieving in removing lees from underneath clears when the lees were agitated underneath the surface by a sweeping arm, but efforts to recreate this using other less costly techniques were not successful. • Overall, laboratory trials were not sufficiently successful to justify development of a winery prototype or winery scale trials of underneath removal of lees.
Outcomes	• The project did not deliver on its principal objective – a prototype device that can be retrofitted to existing winery tanks. Other outcomes were achieved. • Improved knowledge on the composition of winery lees relevant to the use of current filtration technologies. • Knowledge that cylindroconical tanks with a 55° slope may be relevant to the fit out of new medium and large wineries. Capital cost precludes retrofitting cylindroconical tanks to existing wineries. Consequently impact will be limited. • Confirmation that flotation was a way of reducing lee volume and cost in the production of white wine juice. Flotation has been trialled in medium and large Australian wineries since the 1990s. • Communication of knowledge to winemakers on wine waste associated with lees and how to maximise the efficiency of existing filtration equipment.
Impacts	• A minor reduction in the cost of producing wine due to increased knowledge about how to use current filtration technologies.

3. Match with Government Priorities

Table 3.1 Strategic Science/Research Priorities and Rural R&D Research Priorities

Australian Government	
Strategic Science/Research Priorities	**Rural R&D Priorities**
1. **Food** – optimising food and fibre production and processing, agricultural productivity and supply chains within Australia and global markets	1. **Advanced technology**: to enhance innovation of products, processes and practices across the food and fibre supply chains through technologies such as robotics, digitalisation, big data, genetics and precision agriculture.

2. **Soil and water** – improve use of soil and water resources, both terrestrial, marine 3. **Transport** – moving essential commodities, alternative fuels, lowering emissions 4. **Cybersecurity** – for individuals, businesses, government, national infrastructure 5. **Energy** – improve efficiency, reduce emissions and integrate diverse sources into the grid. 6. **Resources** – support exploration traditional resources, rare earths and new technologies. 7. **Advanced manufacturing** – high value and innovative industries in Australia. 8. **Environmental change** – mitigating, managing or adapting to changes. 9. **Health** – improving health outcomes for all Australians.	2. **Biosecurity**: to improve understanding and evidence of pest and disease pathways to help direct biosecurity resources to their best uses, minimising biosecurity threats and improving market access for primary producers. 3. **Soil, water and managing natural resources:** to manage soil health, improve water use efficiency and certainty of supply, sustainably develop new production areas and improve resilience to climate events and impacts. 4. **Adoption of R&D:** focussing on flexible delivery of extension services that meet primary producers' needs and recognising the growing role of private service delivery.

The project has addressed Strategic Science/ Research Priorities 1. The major focus of the project has been on the first of the Rural R&D Priorities.

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
- In-kind contributions to the research project – time associated with project meetings between the researchers and Wine Australia (project overhead costs).

4.1.2 Administration

No additional administration costs were identified.

4.1.3 Extension

Extension costs were included as part of the project budget. Information on the characterisation of winery lees, wine loss and effective use of existing filtration technologies was presented to industry via the 16th Australian Wine Industry Technical Conference.

4.1.4 Adoption

No adoption costs are incurred. Implementation relies on better use of existing filtration equipment.

4.2 Benefits

4.2.1 Research Output and Impact Pathway

The key output from this project is increased winemaker knowledge about how to use current filtration technologies.

The impact pathway is:

1. Research and presentation of facts to the 16th Australian Wine Industry Technical Conference
2. Medium and large winemakers at conference develop additional knowledge about how to use current filtration technologies
3. New knowledge on how to use current filtration technologies is applied to winemaking
4. A minor reduction in the cost of winemaking is realised by those applying new filtration knowledge.

4.2.2 Triple Bottom Line Benefits
A summary of the 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
Economic Benefits			
A minor reduction in the cost of producing wine due to increased knowledge about how to use current filtration technologies.	Nil	Nil	Nil
Environmental Benefits			
Nil	Nil	Nil	Nil
Social Benefits			
Nil	Nil	Nil	Nil

4.2.3 Public versus Private Benefits
The majority of benefits that will arise from project investment will be private in nature. The private benefits will be largely captured by winemakers. The private benefits will focus on a minor reduction in the cost of producing wine due to increased knowledge about how to use current filtration technologies.

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 and winemakers all capturing some of the benefits.

4.2.5 Benefits to other Primary Industries
No benefits to other primary industries were identified. Lees characteristics are product specific.

4.2.6 Benefits Overseas
No benefits to overseas wine industries were 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) as well as project administration costs.	A minor reduction in the cost of producing wine due to increased knowledge about how to use current filtration technologies.
Overhead costs including time associated with meetings between the researchers and Wine Australia.	

5. Valuation of Costs and Benefits

5.1 Costs
5.1.1 R&D Investment Costs including Administration
The following tables show annual investment in the Project by Wine Australia (Table 5.1) and for researchers and other investors (Table 5.2). Table 5.3 provides the total investment by year for both sources.

Table 5.1 Investment by AGWA in the Project for Years Ending June 2014 to June 2017

Project Code	2014	2015	2016	2017	Total
AWR 1307 –cash	116,760	155,950	137,106	46,472	**456,288**
Total	**116,760**	**155,950**	**137,106**	**46,472**	**456,288**

Source: AGWA Revised Schedule

Table 5.2 Investment by Researchers/Others in the Project for Years Ending June 2014 to June 2017

Project Code	2014	2015	2016	2017	Total
AWRI	17,261	29,591	28,033	11,681	**86,566**
F. Millar & Co	4,600	4,600	4,600	30,000	**43,800**
Premium Wine Brands, Accolade Wines, Angove Family Winemakers	3,700	3,700	3,700	15,900	**27,000**
Total	**25,561**	**37,891**	**36,333**	**57,581**	**157,366**

Source: AGWA Revised Schedule

Table 5.3 Annual Investment in the Project (nominal $)

Year Ending 30 June	AGWA	Others	Total
2014	116,760	25,561	142,321
2015	155,950	37,891	193,841
2016	137,106	36,333	173,439
2017	46,472	57,581	104,053
Total	**456,288**	**157,366**	**613,654**

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 Extension Costs

Extension costs are considered in the R&D Investment Cost totals.

5.1.4 Adoption Costs

No incremental additional adoption costs incurred.

5.2 Benefits

5.2.1 Minor Reduction in Winemaking Cost Due to Increased Lees Filtration Knowledge

The Counterfactual

If this project had not been funded medium and large winemakers would have had less knowledge about the use of existing filtration equipment and a winemaking cost saving would not have been realised.

Minor Reduction in Winemaking Cost Due to Increased Lees Filtration Knowledge

This project is expected to result in a minor reduction in the cost of producing wine due to increased knowledge about how to better use current filtration technologies over that which would have occurred under the counterfactual.

A summary of key assumptions used to quantify benefits to winemakers is shown in Table 5.4.

Table 5.4 Summary of Assumptions

Variable	Assumption	Source

Cost Reduction Due to Increased Lees Filtration Knowledge		
Total production of Australian wine.	1,231,000,000 litres	Wine Australia.
Share of Australian wine produced in medium or large wineries where lees are recovered.	50%	Consultant estimate after discussions with Simon Nordestgaard, AWRI.
Lees as a percentage of wine produced.	2%	AWR 1307 final report which indicates lees are usually less than 5% of total wine volume.
Cost of wine loss and waste treatment during winemaking – base case	$0.13/litre	Winemaking and expenditure profile sourced from Australian Grape and Wine Authority (2016).
Cost of wine loss and waste treatment during winemaking – new knowledge	$0.10/litre	Consultant estimate
Year in which increased filtration knowledge first adopted and cost savings realised from lower winemaking costs.	2018	Consultant estimate after discussions with Simon Nordestgaard, AWRI.
Year in which superior filtration technology replaces current equipment.	2028	Consultant estimate after discussions with Simon Nordestgaard, AWRI.
Percentage of wine production from medium or large wineries where new knowledge is adopted.	2018 = 10% 2022 = 30% 2029 = 0%	Consultant estimate.
Attribution of cost saving from improved filtration knowledge to this project.	80%	Project benefits will also be dependent on winemaker analysis of returns from improved filtration.

5.2.2 Other Potential Benefits

No additional benefits identified.

6. Results

All past costs were expressed in 2018 dollar terms using the implicit price deflator for GDP. All costs and benefits from 2018 onwards were discounted to 2018 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating 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 (2017).

Table 6.1 and Table 6.2 show the investment criteria estimated for the different periods of benefits for both the total investment and for Wine Australia investment. The present value of benefits (PVBs) for the Wine Australia investment, shown in Table 6.2, are estimated by multiplying the total PVB by the Wine Australia proportion of investment.

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

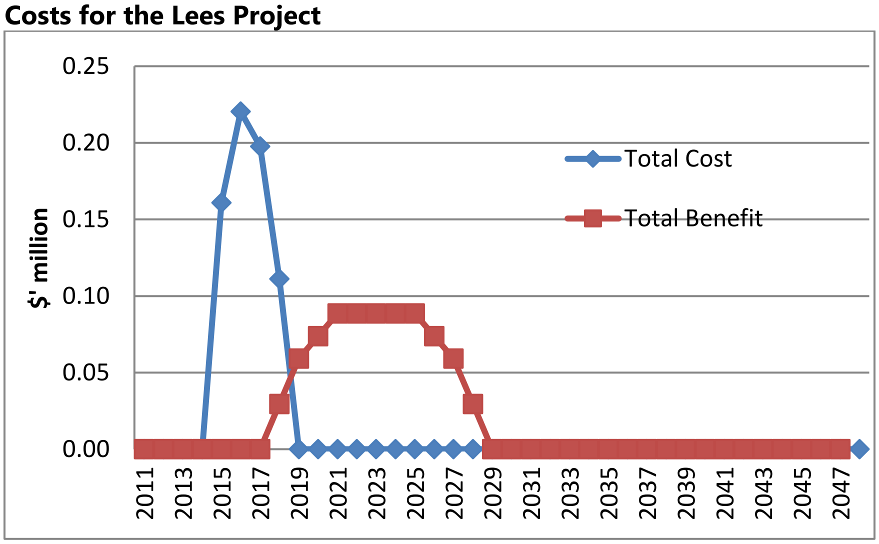
Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits ($m)	0.03	0.35	0.58	0.58	0.58	0.58	0.58
Present value of costs ($m)	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Net present value ($m)	-0.67	-0.35	-0.12	-0.12	-0.12	-0.12	-0.12
Benefit–cost ratio	0.04	0.51	0.83	0.83	0.83	0.83	0.83
Internal rate of return (%)	Negative	Negative	2.00	2.00	2.00	2.00	2.00
Modified internal rate of return (%)	Negative	Negative	4.00	4.00	4.00	4.00	4.00

Table 6.2 Investment Criteria for Total 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 ($m)	0.02	0.27	0.44	0.44	0.44	0.44	0.44
Present value of costs ($m)	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Net present value ($m)	-0.52	-0.27	-0.10	-0.10	-0.10	-0.10	-0.10
Benefit–cost ratio	0.04	-0.51	0.83	0.83	0.83	0.83	0.83
Internal rate of return (%)	Negative	Negative	2.00	2.00	2.00	2.00	2.00
Modified internal rate of return (%)	Negative	Negative	3.00	4.00	4.00	4.00	4.00

The annual undiscounted benefit 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 Lees 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. These indicate that base negative indicators become positive when a discount rate of zero 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 ($m)	0.77	0.58	0.45
Present value of costs ($m)	0.70	0.70	0.70
Net present value ($m)	0.07	-0.12	-0.25
Benefit-cost ratio	1.10	0.83	0.64

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 percentage of production from medium and large wineries adopting research outputs and attribution of lower winemaking cost to this project. The results of a sensitivity test for each of these estimates are shown in Table 7.2 and Table 7.3. Results show that at adoption peaks at 50% of medium and large winery production or a 100% attribution of benefit to the Wine Australia project, a positive benefit cost ratio is achieved.

Table 7.2 Sensitivity to Adoption by Medium and Large Wineries (Total investment, 30 years)

Investment Criteria	Maximum % of production medium and large wineries adopting research		
	15%	**30% (base)**	**50%**
Present value of benefits ($m)	0.29	0.58	0.82
Present value of costs ($m)	0.70	0.70	0.70
Net present value ($m)	-0.41	-0.12	0.12
Benefit-cost ratio	0.41	0.83	1.17

Table 7.3 Sensitivity to Attribution of Benefit to the AWRI Project (Total investment, 30 years)

Investment Criteria	Attribution of Benefit to AWRI		
	40%	**80% (base)**	**100%**
Present value of benefits ($m)	0.29	0.58	0.72
Present value of costs ($m)	0.70	0.70	0.70
Net present value ($m)	-0.41	-0.12	0.02
Benefit-cost ratio	0.41	0.83	1.03

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 the lees project was valued at $0.7M (present value terms) and is expected to produce aggregate total benefits of approximately $0.58M (present value terms). This gives an estimated net present value of negative $0.12M, a benefit-cost ratio of approximately 0.83, an internal rate of return of 2% and a modified internal rate of return of 4%.

The project did not achieve its principle objective i.e. the development of a prototype device that can be retrofitted to existing winery tanks to remove lees from underneath wine negating the need to move the wine. A relatively minor secondary benefit of more knowledge about current wine filtration methods was achieved. On its own this secondary benefit was not enough to create a positive investment return.

Abbreviations

CRRDC	Council of Rural Research and Development Corporations
AGWA	Australian Grape and Wine Authority
AWRI	Australian Wine Research Institute
PVB	Present Value of Benefits

Persons Contacted

Simon Nordestgaard, Principal Researcher, Australian Wine Research Institute
Paul Smith, Senior R&D Program Manager, Wine Australia

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APPENDIX 4: ECONOMIC ANALYSIS WINE AUSTRALIA'S INVESTMENT IN THE STAGING AND CONDUCT OF EXTENSION PROGRAMS

1. Background

Research is only of value to the wine industry if it is adopted. The AWRI has a long history of delivering extension programs to grape growers and winemakers that lead to improved rates of research adoption. This project built on elements of past successful extension programs and developed new approaches to ensure research uptake. The project targeted cost savings and demand growth for grape growers and winemakers.

2. Summary of Projects

A single extension project was supported and Table 2.1 provides a description.

Table 2.1 Project Description

Project No. AWRI 4.1.1 The staging and conduct of extension programs	
Project Details	Research Organisation: Australian Wine Research Institute (AWRI) Period: 1 July 2013 to 30 June 2017 Principal Investigator: Con Simos
Rationale	The aim of this project was to continue to raise awareness of research outputs, assist grape growers and winemakers to understand the practical value of research outputs, overcome barriers to adoption and ensure relevant research is adopted. The project is one of the critical mechanisms by which Australian investment in grape and wine research is realised.
Objectives	The project had the following objectives: 1. Deliver roadshow seminars to keep producers up to date with research outputs 2. Complete roadshow workshops to provide hands on training for producers 3. Deliver face to face information dissemination and training for producers 4. Support Wine Australia's efforts to promote and advance 'Brand Australia' 5. Monitor emerging quality issues through Help Desk Services (AWRI 4.1.2) and disseminate rapid response strategies to growers and winemakers 6. Provide up to date and relevant web-based information and training 7. Contribute to the design, interpretation and dissemination of results from on-farm trials.
Activities and Outputs	• Prepare content and deliver roadshow seminars. A total of 118 roadshow events were completed over four years reaching a total of 3,132 attendees. • Prepare and deliver roadshow training workshops. Three new workshops prepared and delivered - 'Adapting to difficult vintages', 'Addressing regional challenges' and 'Pinot noir winemaking trial tastings'. • Publish the AWRI Technical Review and e-News, Wine Australia R&D @ Work, Wine Australia RD&E News, Ask the AWRI columns and ad hoc e-Bulletins. A total of 237 articles were prepared and published between 2013 and 2017. • Develop and post web content on the AWRI website. Update web-based extension tools with the findings from research. A total of 90 webinars were delivered to 1,463 attendees and 20,993 fact sheets were downloaded. • Prepare submissions on regulatory, scientific and technical issues. • Identify and respond to any emerging quality issues identified via Help Desk

	• Develop an industry 'snapshot' detailing current wine composition, oenological practices and processing technologies. Snapshot was prepared each year and used as an industry benchmarking tool. • Provide advice to, and communicate results from, regional trials.
Outcomes	• Higher levels of research adoption than would otherwise have been the case. Grape growers and winemakers adopting measures that reduce production cost and increase demand. Demand increase originating from ongoing improvements in product alignment with consumer and regulatory requirements. More than 60% of grape growers and winemakers surveyed by AWRI indicated they would reevaluate their current production practices in light of extension material provided via this project (AWRI 2017). • A more relevant research program with priorities identified during extension. AWRI's Help Desk is a particularly effective way of collecting information on research needs. • Information in an easily digested form and in the public domain that can be used to develop government policy. • Grape growers and wine makers trained and skilled in the latest production and marketing techniques.
Impacts	• Reduced production costs and additional demand for Australian wine. • Improvements in public policy formulation for the wine industry. • Australian grape growers and winemakers with improved knowledge and skills.

3. Match with Government Priorities

Table 3.1 Strategic Science/Research Priorities and Rural R&D Research Priorities

Australian Government	
Strategic Science/Research Priorities	**Rural R&D Priorities**
1. **Food** – optimising food and fibre production and processing, agricultural productivity and supply chains within Australia and global markets 2. **Soil and water** – improve use of soil and water resources, both terrestrial and marine 3. **Transport** – moving essential commodities, alternative fuels, lowering emissions 4. **Cybersecurity** – for individuals, businesses, government, national infrastructure 5. **Energy** – improve efficiency, reduce emissions and integrate diverse sources into the grid. 6. **Resources** – support exploration for traditional resources, rare earths and new technologies. 7. **Advanced manufacturing** – high value and innovative industries in Australia. 8. **Environmental change** – mitigating, managing or adapting to changes. 9. **Health** – improving health outcomes for all Australians.	1. **Advanced technology**: to enhance innovation of products, processes and practices across the food and fibre supply chains through technologies such as robotics, digitalisation, big data, genetics and precision agriculture. 2. **Biosecurity**: to improve understanding and evidence of pest and disease pathways to help direct biosecurity resources to their best uses, minimising biosecurity threats and improving market access for primary producers. 3. **Soil, water and managing natural resources:** to manage soil health, improve water use efficiency and certainty of supply, sustainably develop new production areas and improve resilience to climate events and impacts. 4. **Adoption of R&D:** focussing on flexible delivery of extension services that meet primary producers' needs and recognising the growing role of private service delivery.

The Wine Australia project has addressed Strategic Science/ Research Priorities 1 and 2. The major focus of the project has been on the fourth of the Rural R&D Priorities.

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
- In-kind contributions to the research project – non-cash contributions made by Australian grape and wine region associations in the organisation and promoting of roadshow events
- In-kind contributions to the research project – time associated with meetings between the researchers and Wine Australia (project overhead costs).

4.1.2 Administration

No additional administration costs were identified.

4.1.3 Extension

No additional extension costs were identified.

4.1.4 Adoption

Adoption costs will be incurred by grape growers and winemakers who take up research communicated through this extension project.

4.2 Benefits

4.2.1 Research Output and Impact Pathway

The output from this project is increased awareness of research outputs leading to research adoption.

The impact pathway is:

1. 4-year extension program raising grape grower and winemaker awareness of research outputs
2. Grape growers and winemakers discussing relevant innovations with trusted peers and local networks and viewing the innovation trialled in practice (AWRI 2017)
3. Grape growers and winemakers intending to consider the adoption of innovations that reduce production costs and increase the demand for Australian wine.

4.2.2 Triple Bottom Line Benefits

A summary of the 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>			
Increased adoption of research outputs resulting in reduced costs of production. Increased adoption of research outputs resulting in increased demand for Australian wine. Improvements in public policy formulation for the wine industry.	Nil	Nil	Nil
<u>Environmental Benefits</u>			
Nil	Nil	Nil	Nil

Social Benefits			
Australian grape growers and winemakers with improved knowledge and skills.	Nil	Nil	Nil

4.2.3 Public versus Private Benefits

The majority of benefits that will arise from project investment will be private in nature. The private benefits will be captured largely by the grape growing and winemaking sectors. Private benefits will focus on reduced production costs and increased demand for Australian wine.

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 exporters all sharing some of the benefits.

4.2.5 Benefits to other Primary Industries

No benefits to other primary industries identified.

4.2.6 Benefits Overseas

No benefits to overseas industries 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) as well as project administration costs.	Increased adoption of research outputs resulting in reduced costs of production.
Overhead costs including time associated with meetings between the researchers and Wine Australia.	Increased adoption of research outputs resulting in increased demand for Australian wine.
Adoption costs incurred by grape growers and winemakers who take up research communicated through this extension project.	Improvements in public policy formulation for the wine industry.
	Australian grape growers and winemakers with improved knowledge and skills

5. Valuation of Costs and Benefits

5.1 Costs

5.1.1 R&D Investment Costs including Administration

Table 5.1 shows annual investment in the project by Wine Australia. Wine Australia met 100% of the project's cash cost.

Table 5.1 Investment by AGWA in the Project for Years Ending June 2012 to June 2016

Project Code	2014	2015	2016	2017	Total
AWRI 4.1.1 – Wine Australia cash	478,293	497,425	517,322	538,015	**2,031,055**
Total	**478,293**	**497,425**	**517,322**	**538,015**	**2,031,055**

Source: Wine Australia project proposal

In-kind contributions to the research project were made by Australian grape and wine region associations in the organisation and promoting of roadshow events. It is estimated that each event took a total of fifteen hours to organise at a cost of $25/hour and there were 30 events held each year. Annual investment costs are shown in Table 5.2.

Table 5.1 Investment by Others in the Project for Years Ending June 2012 to June 2016

Project Code	2014	2015	2016	2017	Total
AWRI 4.1.1 –Australian grape and wine regional associations	$11,250	$11,250	$11,250	$11,250	**45,000**
Total	**$11,250**	**$11,250**	**$11,250**	**$11,250**	**45,000**

Source: AgEconPlus estimate

Table 5.3 summarises total investment by year for both Wine Australia and Australian grape and wine region associations.

Table 5.3 Annual Investment in the Project (nominal $)

Year Ending 30 June	Wine Australia	Others	Total
2014	478,293	$11,250	489,543
2015	497,425	$11,250	508,675
2016	517,322	$11,250	528,572
2017	538,015	$11,250	549,265
Total	**2,031,055**	**45,000**	**2,076,055**

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 Extension Costs

Extension costs are included in the R&D Investment Cost totals.

5.1.4 Adoption Costs

Adoption costs are considered when benefits were estimated.

5.2 Benefits

5.2.1 Reduced Production Costs and Additional Demand for Australian wine

The Counterfactual

If this project had not been funded grape growers and winemakers would have relied on researchers from individual projects, internal resources of the types found in large corporate winemakers and the work of regional associations to interpret and communicate research outputs. Each of these bodies does an admirable job in encouraging research adoption. AWRI work completed as part of this project adds to this base level of extension resources. A lower level of adoption would have been achieved under the counterfactual.

Reduced Production Costs and Additional Demand for Australian Wine

This project is expected to result in a further marginal reduction in production costs and further marginal increase in demand for Australian wine than would have occurred under the base case.

Benefits are estimated separately for grape growers and wine makers. A summary of key assumptions made is shown in Table 5.4.

Table 5.4 Summary of Assumptions

Item	Grape Growers	Winemakers
Business population	5,160	2,900
Number of businesses involved in AWRI extension program+	15%	10%
Proportion of business involved that make changes#	10%	10%
Proportion of businesses that make changes that reduce costs and stimulate demand	50%	50%
Average turnover per business	$150,000 per annum	$2,000,000 per annum
Costs as a proportion of turnover	98%	65%
Cost reduction impact^	4%	4%
Demand impact^	1.5%	1.5%
Year of first impact	2022	2022
Year of maximum impact	2025	2025
Longevity of maximum impact	10 years	10 years
Attribution of quantified benefit to the AWRI 4.1.1 project*	75%	75%

+ Estimate prepared following discussions with Con Simos, Principal Researcher, AWRI
# AWRI 2017 data indicates that 62% of grape growers and winemakers would re-evaluate current practices.
^ includes allowance for adoption costs
* Share of benefits attributable to other projects including AWRI 4.1.2 helpdesk services. Wine Australia note that this could be as low as 20% and a 20% attribution factor is tested in the sensitivity analysis. It is also important to note that assumed adoption is a function of 5,160 grape growers X 15% attendance X 10% that make changes to their business X 50% who make a change that generates a cost saving or stimulates demand X 75% attribution to this project i.e. the analysis is not claiming a 75% attribution all grape growers that attend a AWRI 4.1.1 extension event. The same is also true for the winemaker analysis.

5.2.2 Other Potential Benefits

Other potential benefits identified but not valued include:
- Improvements in public policy formulation for the wine industry
- Australian grape growers and winemakers with improved knowledge and skills.

Other potential benefits were not quantified due to a combination of reasons including time and resources, availability of baseline data, difficulty in quantifying the causal relationships between the research outputs and the specific impact and the difficulty of placing credible monetary values on social benefits.

6. Results

All past costs were expressed in 2018 dollar terms using the implicit price deflator for GDP. All costs and benefits from 2018 onwards were discounted to 2018 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating 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 (2017).

Table 6.1 and Table 6.2 show the investment criteria estimated for the different periods of benefits for both the total investment and for Wine Australia investment. The present value of benefits (PVBs) for the Wine Australia investment, shown in Table 6.2, are estimated by multiplying the total PVB by the Wine Australia proportion of investment.

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

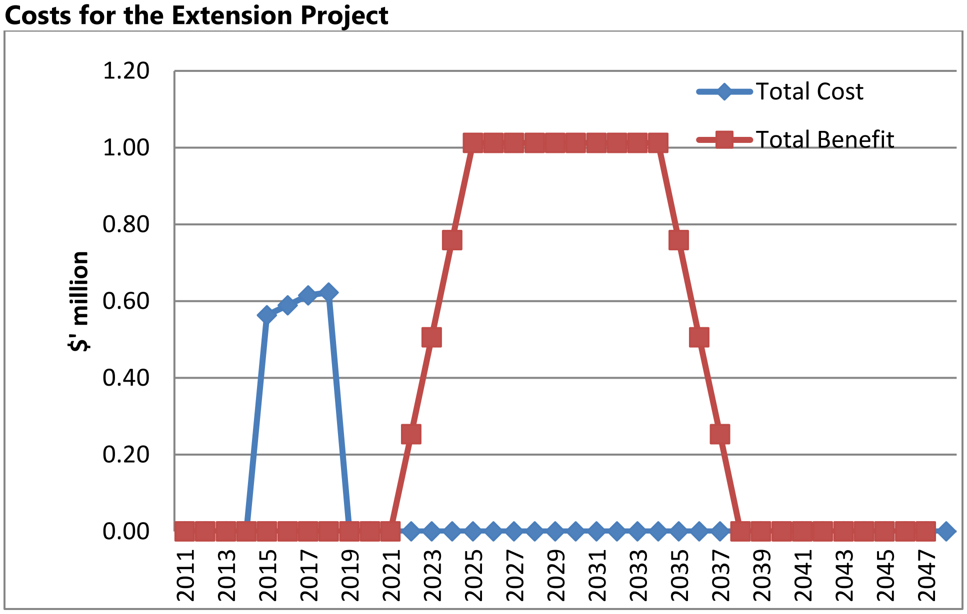
Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits ($m)	0.00	0.58	3.67	6.23	7.28	7.28	7.28
Present value of costs ($m)	2.42	2.42	2.42	2.42	2.42	2.42	2.42
Net present value ($m)	-2.42	-1.58	1.24	3.80	4.86	4.86	4.86
Benefit–cost ratio	0.00	0.24	1.51	2.57	3.00	3.00	3.00
Internal rate of return (%)	Negative	Negative	10.00	15.00	16.00	16.00	16.00
Modified internal rate of return (%)	Negative	Negative	9.00	11.00	11.00	10.00	9.00

Table 6.2 Investment Criteria for Total 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 ($m)	0.00	0.56	3.60	6.11	7.14	7.14	7.14
Present value of costs ($m)	2.38	2.38	2.38	2.38	2.38	2.38	2.38
Net present value ($m)	-2.38	-1.81	1.22	3.73	4.76	4.76	4.76
Benefit–cost ratio	0.00	0.24	1.51	2.57	3.00	3.00	3.00
Internal rate of return (%)	Negative	Negative	10.00	15.00	16.00	16.00	16.00
Modified internal rate of return (%)	Negative	Negative	9.00	11.00	11.00	10.00	9.00

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 Extension 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. These indicate that all indicators remain positive for all discount rate assumptions.

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

Investment Criteria	Discount rate		
	0%	**5% (base)**	**10%**
Present value of benefits ($m)	13.16	7.28	4.28
Present value of costs ($m)	2.42	2.42	2.42
Net present value ($m)	10.73	4.86	1.86
Benefit-cost ratio	5.43	3.00	1.77

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 cost reduction impact, demand impact and attribution of benefit to the project – Table 7.2, Table 7.3 and Table 7.4. Results show that at a 2% cost reduction and a 0.5% increase in demand, project benefits continue to exceed project costs. At a 20% attribution factor, project costs exceed project benefits.

Table 7.2 Sensitivity to Cost Reduction Impact (Total investment, 30 years)

Investment Criteria	Cost Reduction Due to AWRI Extension 4.1.1		
	2%	**4% (base)**	**8%**
Present value of benefits ($m)	4.63	7.28	12.58
Present value of costs ($m)	2.42	2.42	2.42
Net present value ($m)	2.21	4.86	10.15
Benefit-cost ratio	1.91	3.00	5.19

Table 7.3 Sensitivity to Demand Increase Impact (Total investment, 30 years)

Investment Criteria	Demand Increase Due to AWRI Extension		
	0.5%	**1.5% (base)**	**3%**
Present value of benefits ($m)	5.96	7.28	9.27
Present value of costs ($m)	2.42	2.42	2.42
Net present value ($m)	3.53	4.86	6.84
Benefit-cost ratio	2.46	3.00	3.82

Table 7.4 Sensitivity to Attribution of Benefits to the Project (Total investment, 30 years)

Investment Criteria	Attribution Factor		
	20%	**75% (base)**	**80%**
Present value of benefits ($m)	1.94	7.28	7.77
Present value of costs ($m)	2.42	2.42	2.42
Net present value ($m)	-0.48	4.86	5.34
Benefit-cost ratio	0.80	3.00	3.20

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 the extension project was valued at $2.42M (present value terms) and is expected to produce aggregate total benefits of approximately $7.28M (present value terms). This gives an estimated net present value of $4.86M, a benefit-cost ratio of approximately 3.00, an internal rate of return of 16% and a modified internal rate of return of 9%.

All investment indicators remain positive for different discount rate assumptions and different assumptions around cost reduction and demand increase for grape growers and winemakers. If the attribution factor is reduced from 75% to 20% project costs exceed project benefits.

Abbreviations

AWRI	Australian Wine Research Institute
SARDI	South Australian Research and Development Institute

Persons Contacted

Con Simos, Principal Researcher, Australian Wine Research Institute

References

AWRI (2017) Project 4.1.1 The Staging and Conduct of Extension Programs, Final Report

APPENDIX 5: ECONOMIC ANALYSIS WINE AUSTRALIA'S INVESTMENT IN MARKET ACCESS, SAFETY, REGULATORY AND TECHNICAL TRADE ISSUES

1. Background

Market access is created and maintained by generating and disseminating accurate scientific and technical data to inform decision making. A 'rules based' domestic and international trading system is more likely to produce a favourable outcome for the Australian wine industry when presented with hard data. This project set out to generate and communicate hard data to influence market access, safety, regulatory and technical trade issues.

2. Summary of Projects

A single market access project was supported by Wine Australia and Table 2.1 provides a description.

Table 2.1 Project Description

Project No. AWRI 2.2.4 Increasing Australia's Influence in Market Access, Safety, Regulatory and Technical Trade Issues	
Project Details	Research Organisation: Australian Wine Research Institute (AWRI) Period: 1 July 2013 to 30 June 2017 Principal Investigator: Creina Stockley
Rationale	Maintaining market access or opening markets for Australian wine, nationally and internationally, is facilitated by managing and reducing current and potential barriers to trade. The Australian wine industry needs to be proactive and to anticipate, facilitate and influence changes to regulations regarding wine composition, production, labelling and marketing, rather than take a passive approach where changes are imposed upon the industry and market access is at risk. For example, in response to the growing volume of Australian wine imports, some countries have creating technical trade barriers. To anticipate and address these trade barriers accurate and timely scientific and technical data is required and this information has been generated by AWRI through this project.
Objectives	The project had the following objectives: 1. Provide advice and assistance to industry and government on domestic and international market access issues especially Wine Australia, DAWR, WFA and AV in relation to OIV deliberations and resolutions. 2. Serve on domestic and international committees addressing market access. 3. Provide technical advice to committees and the Australian Wine Industry Crisis and Emergency Management Plan. 4. Maintain a repository of information impacting market access. 5. Review and interpret research relevant to market access.
Activities and Outputs	Project activities included: • Contributions to relevant market access and standard setting meetings e.g. OIV • Creation and dissemination of information to inform policy and regulation. • Responding to stakeholder requests for scientific and technical information. • Preparation of position papers and submissions. • Making material available on the AWRI website and keeping it up to date. • Provision of expert advice to industry stakeholders. • Reporting to Wine Australia on specific issues being addressed by the project.

	Target audiences for materials prepared and presented were as diverse as the OIV in Paris and domestic retailers considering consumer and environmental labelling policies. Key outputs included: • Analysis of 1,500 wines to show that while a significant number exceeded China's manganese limit, all were below regulatory limits used by other countries. In 2016 China revoked its maximum limit for manganese in wine. • Establishing that phthalates are absent from wine to address a FSANZ Inquiry into Chemical Migration from Packaging to Food (Proposal P10034). • Demonstration to the OIV that there was no toxicological justification for maximum limits on phthalates in wine proposed by some importing countries. • Tentative positive provisions by WHO/FAO for additives metatartaric acid and yeast mannoproteins to wine following the preparation of submissions by AWRI. These additives lower the cost of keeping wine clear of crystals. • FSANZ permission to use lower cost wine clarification agent/processing aid Aspergillopepsin I & II (AGP) following an AWRI submission. OIV authorisation for AGP and dimethylpolysiloxane is also well advanced. • Potassium carbonate permitted by OIV to manage wine acidity following a AWRI submission. • Australian workshop on the growing influence of the anti-alcohol lobby on health warning labels. • AWRI website expanded to include information on analytical requirements for the export of Australian wine to limit impact of incorrect tests and disputes. • Working with OIV Expert Groups to ensure that EU regulations for Australian wine are consistent with, and not more restrictive, than domestic provisions.
Outcomes	• Relevant scientific and technical information, researched, assembled and disseminated to industry and government. • 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	• Current and future decisions that make it easier to produce and sell Australian wine.

3. Match with Government Priorities

Table 3.1 Strategic Science/Research Priorities and Rural R&D Research Priorities

Australian Government	
Strategic Science/Research Priorities	**Rural R&D Priorities**
1. **Food** – optimising food and fibre production and processing, agricultural productivity and supply chains within Australia and global markets 2. **Soil and water** – improve use of soil and water resources, both terrestrial, marine 3. **Transport** – moving essential commodities, alternative fuels, lowering emissions 4. **Cybersecurity** – for individuals, businesses, government, national infrastructure 5. **Energy** – improve efficiency, reduce emissions and integrate diverse sources into the grid. 6. **Resources** – support exploration traditional resources, rare earths and new technologies.	1. **Advanced technology**: to enhance innovation of products, processes and practices across the food and fibre supply chains through technologies such as robotics, digitalisation, big data, genetics and precision agriculture. 2. **Biosecurity**: to improve understanding and evidence of pest and disease pathways to help direct biosecurity resources to their best uses, minimising biosecurity threats and improving market access for primary producers. 3. **Soil, water and managing natural resources:** to manage soil health, improve water use efficiency and certainty of supply, sustainably develop new production areas and improve resilience to climate events and impacts.

7. **Advanced manufacturing** – high value and innovative industries in Australia. 8. **Environmental change** – mitigating, managing or adapting to changes. 9. **Health** – improving health outcomes for all Australians.	4. **Adoption of R&D:** focussing on flexible delivery of extension services that meet primary producers' needs and recognising the growing role of private service delivery.

The project has addressed Strategic Science/ Research Priorities 1. The project does not align with the Rural R&D Priorities.

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
- In-kind contributions to the research project – time associated with project meetings between the researchers and Wine Australia (project overhead costs).

4.1.2 Administration

No additional administration costs were identified.

4.1.3 Extension

Extension costs were included as part of the project budget. Sensitive information was communicated directly to government and industry leaders. Awareness raising on matters of concern to the whole Australian wine industry was achieved through presentations to industry committees and through trade publications and the AWRI website.

4.1.4 Adoption

Adoption costs are not relevant to this project. Information was generated, packaged and provided to regulators who then made decisions on market access rules. In many instances 'adoption' was about not implementing some type of trade barrier e.g. the Chinese Government dropping a requirement for a lower limit on manganese in imported wine.

4.2 Benefits

4.2.1 Research Output and Impact Pathway

The output from this project is progress toward a series of decisions and actual decisions that make it easier to produce and sell Australian wine.

The impact pathway is:

4. Research, package and presentation of facts
5. Representations and lobbying by the Australian wine industry and government officials
6. The making of decisions that make it easier to produce and sell Australian wine
7. Cost savings and additional sales realised by Australian winemakers.

4.2.2 Triple Bottom Line Benefits

A summary of the 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**
Economic Benefits			
Additional sales of Australian wine on domestic and export markets#. Lower winemaking costs facilitated by acceptance of new techniques e.g. lower cost processing aids.	Nil	Nil	Improved market access delivered by this project will also assist wine exporters from other countries access Australian wine markets.
Environmental Benefits			
Nil	Nil	Nil	Nil
Social Benefits			
Enhanced Australian wine industry reputation and capacity.	Nil	Nil	Nil

In the first instance the benefit from this project will be enhanced risk mitigation and a lower risk of market closure/market restrictions which in turn will increase Australian wine sales over and above the 'no project counterfactual'.

4.2.3 Public versus Private Benefits

The majority of benefits that will arise from project investment will be private in nature. The private benefits will be largely captured by winemakers and exporters. The private benefits will focus on reduced market risk and additional Australian wine sales over and above the 'no project counterfactual'.

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

Improved market access delivered by this project will also assist wine exporters from other countries access Australian domestic and international wine markets. For example, demonstrating to the OIV that there was no toxicological justification for maximum limits on phthalates in wine proposed by some importing countries will provide opportunities for both Australia and its competitors.

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) as well as project administration costs	Additional sales of Australian wine on domestic and export markets.
Overhead costs including time associated with meetings between the researchers and Wine Australia	Lower winemaking costs facilitated by acceptance of new techniques e.g. lower cost processing aids.
	Enhanced Australian wine industry reputation and capacity.

5. Valuation of Costs and Benefits

5.1 Costs

5.1.1 R&D Investment Costs including Administration

Table 5.1 shows annual investment in the project by Wine Australia. Wine Australia met 100% of project cost and there were no contributions by researchers or other parties.

Table 5.1 Investment by Wine Australia in the Project for Years Ending June 2012 to June 2016

Project Code	2014	2015	2016	2017	Total
AWRI 2.2.4 – Wine Australia	75,366	78,381	81,516	84,777	**320,039**
Total	**75,366**	**78,381**	**81,516**	**84,777**	**320,039**

Source: Wine Australia Project Application

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%.

5.2 Benefits

5.2.1 Additional, Higher Priced Sales of Australian Wine

The Counterfactual

If this project had not been funded DAWR, Wine Australia, WFA and others would have been dependent on political processes and negotiation skills, on their own, to deliver market access outcomes for the Australian wine industry. Investment in the market access, safety, regulatory and technical trade issues project provided a sound evidence base and the additional confidence required to pursue market access solutions on behalf of the Australian wine industry. In the case of China rejecting wine with elevated natural manganese levels, Australia would have experienced disruption to 25% of its sales to this market. Australian wine destined for China with high natural manganese would have been withdrawn from sale to China and sold in lower priced domestic and export markets. Additional Australian wine would have to be sourced for China.

As part of AWRI's Wine Australia research program the Institute tested 1,500 bottles of Australian wine and found that one quarter of all wine produced in Australia had manganese levels greater than the 2mg/L prescribed by China and that red wine, the dominant source of sales to the PRC, was even more prone to elevated manganese. The evidence base assembled by AWRI showed that elevated manganese was characteristic of wine from all destinations and that this was not a concern to other wine importing countries. The evidence base assembled by AWRI through its research program, AWRI 2.2.4 plus negotiation resulted in the rewriting of China's wine import regulation.

Additional, Higher Priced Sales of Australian Wine

AWRI 2.2.4, as part of a package of investments, contributed to additional sales of Australian wine to China that would otherwise have been sold on lower priced domestic and export markets. In general Australia receives higher prices for its wine in China than it does in other markets (Steve Guy, General Manager, Market Access, Wine Australia, pers. comm., February 2018).

The benefit of additional higher priced sales of Australian wine to China is quantified assuming that 25% of Australian wine sales to China would have been disrupted if the issue around elevated natural manganese levels had not been resolved in Australia's favour. However, only a small portion of this benefit, say 5%, is attributable to the AWRI 2.2.4 project, most of the benefit is due to successful negotiations completed with Chinese authorities by the Australian industry and government (Steve Guy, General Manager, Market Access, Wine Australia, pers. comm., December 2017).

A summary of key assumptions is shown in Table 5.4.

Table 5.4 Summary of Assumptions

Variable	Assumption	Source
Additional Sales of Australian Wine		
Value of Australian wine sales to China.	$528 million	3 year average, Wine Australia data: 2015: $370 million 2016: $474 million 2017: $739 million
Australian wine sales affected by a restriction on manganese.	25%	Personal communication Steve Guy, GM Market Access, Wine Australia and based on percentage of Australian wine tested with manganese levels above 2mg/L. Assumption is conservative – red wine has higher positive tests and red wine sales dominate Australia's trade with China. NB sales are disrupted rather than lost – wine ruled ineligible for export to China can be substituted with alternative Australian product.
Dispute duration in the absence of the AWRI project.	5 years	Consultant estimate after discussions with Steve Guy, GM Market Access, Wine Australia.
Anticipated loss in wine value as product originally destined for China is reassigned to a lower value market.	5%	Consultant estimate after discussions with Steve Guy, GM Market Access, Wine Australia.
Attribution of benefits to the AWRI market access project after considering the importance of other research, industry and government negotiation.	2%	Consultant estimate after discussions with Steve Guy, GM Market Access, Wine Australia.

5.2.2 Other Potential Benefits

Other potential benefits identified but not valued include:

- Lower winemaking costs facilitated by acceptance of new techniques e.g. lower cost processing aids
- Enhanced Australian wine industry reputation and capacity.

Other potential benefits were not quantified due to a combination of reasons including time and resources, availability of baseline data, difficulty in quantifying the causal relationships between the research outputs and the specific impact and the difficulty of placing credible monetary values on some of the environmental and social benefits.

6. Results

All past costs were expressed in 2018 dollar terms using the implicit price deflator for GDP. All costs and benefits from 2018 onwards were discounted to 2018 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating 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 (2017).

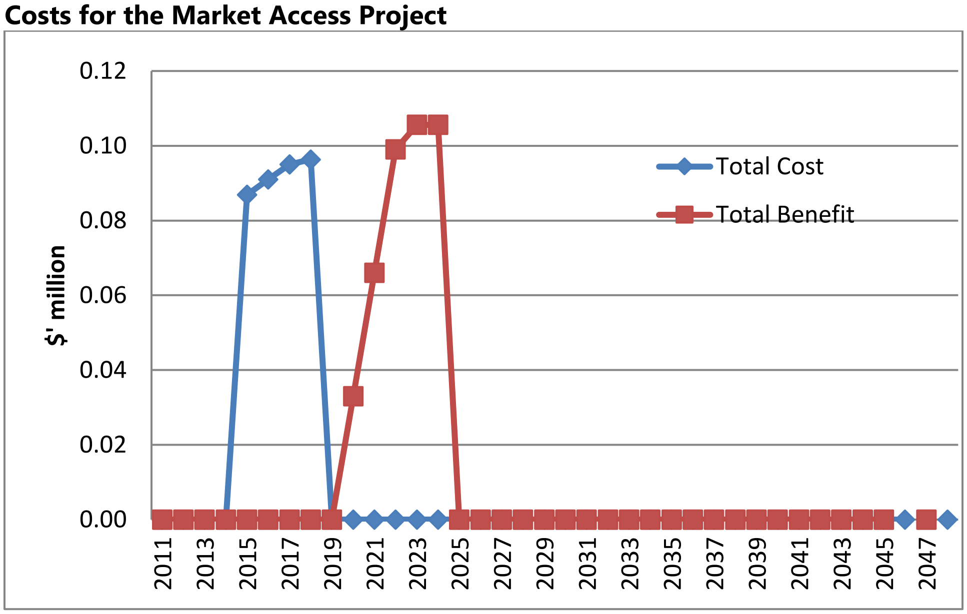
Table 6.1 shows the investment criteria estimated for the different periods of benefits for the Wine Australia investment. There was no investment by other parties in this project.

Table 6.1 Investment Criteria for Total 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 ($m)	0.00	0.16	0.31	0.31	0.31	0.31	0.31
Present value of costs ($m)	0.37	0.37	0.37	0.37	0.37	0.37	0.37
Net present value ($m)	-0.37	-0.21	-0.06	-0.06	-0.06	-0.06	-0.06
Benefit–cost ratio	0.00	0.43	0.84	0.84	0.84	0.84	0.84
Internal rate of return (%)	Negative	-13	2	2	2	2	2
Modified internal rate of return (%)	Negative	-11	3	4	4	4	4

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 Market Access 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. These indicate that only at a zero discount rate do indicators become positive.

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

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present value of benefits ($m)	0.41	0.31	0.25
Present value of costs ($m)	0.37	0.37	0.37
Net present value ($m)	0.03	-0.06	-0.13
Benefit-cost ratio	1.09	0.84	0.65

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 attribution of benefit to the AWRI project and loss of value when Australian wine destined for China is diverted to another market – Table 7.2 and Table 7.3. Results show that a 5% attribution of benefit to the AWRI project and a 10% loss in wine price is required before benefits will exceed costs.

Table 7.2 Sensitivity to Attribution of Benefit to the AWRI Project (Total investment, 30 years)

Investment Criteria	Attribution of Benefit to AWRI		
	1%	2% (base)	5%
Present value of benefits ($m)	0.16	0.31	0.79
Present value of costs ($m)	0.37	0.37	0.37
Net present value ($m)	-0.22	-0.06	0.42
Benefit-cost ratio	0.42	0.84	2.10

Table 7.3 Sensitivity to Wine Price Loss in 'Next Best' Market (Total investment, 30 years)

Investment Criteria	Loss of Wine Price		
	2%	5% (base)	10%
Present value of benefits ($m)	0.13	0.31	0.63
Present value of costs ($m)	0.37	0.37	0.37
Net present value ($m)	-0.25	-0.06	0.25
Benefit-cost ratio	0.34	0.84	1.68

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	High

9. Summary of Results

Funding for the market access project was valued at $0.37M (present value terms) and is expected to produce aggregate total benefits of approximately $0.31M (present value terms). This gives an estimated net present value of negative $0.06M, a benefit-cost ratio of approximately 0.84, an internal rate of return of 2% and a modified internal rate of return of 4%.

All investment indicators remain negative until the discount rate is reduced to zero or attribution increases to 10% or loss in wine price avoided is at least 10%.

Abbreviations

AGWA	Australian Grape and Wine Authority
AV	Australian Vignerons
AWRI	Australian Wine Research Institute
DAWR	Australian Government Department of Agriculture and Water Resources
EU	European Union
FAO	Food and Agriculture Organisation
FSANZ	Food Standards Australia New Zealand
OIV	International Organisation of Wine and Vine
PRC	People's Republic of China
WA	Wine Australia
WFA	Winemakers Federation of Australia
WHO	Would Health Organisation

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References

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