Benefit Cost Analysis of Wine Australia R&D Investments 2015-16

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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 investments made in the programs. 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 Lean, the Wine Flavours Card, Rural Leaders, Varieties and Powdery Mildew all yielded positive results at a 5% discount rate, with benefit cost ratios ranging from 1.1 to 3.8. Comparisons between the cluster 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: Investment Program for five AGWA R&D Investments (discount rate 5%, 30 years from last year of investment)

Investment Criteria	Investment Program				
	Lean	**Wine Flavours Card**	**Rural Leaders**	**Varieties**	**Powdery Mildew**
Benefit–cost ratio	3.4	3.8	2.7	1.1	2.9
Benefit-cost ratio range - core assumption sensitivity	2.5 to 4.2	1.9 to 5.8	1.9 to 4.5	0.5 to 1.6	1.5 to 4.4
Potential unquantified benefits	None	Unification in marketing of Australian wines to China	Better industry decisions	Germplasm knowledge to inform the wine grape breeding program	Research outputs to assist in future development of objective assessment methods
		Increased sales to domestic tourists of Chinese descent	Additional consideration and knowledge of environmental sustainability	Lower alcohol wines with the possibility of improved health outcomes	Benefits from use of the App to score the incidence and severity of other issues
			Contributions to community initiatives in regional Australia		

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 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 of the Rural Research and Development Corporations.

Five programs identified by Wine Australia for analysis were:

- Lean;
- Wine Flavours Card;
- Rural Leaders;
- Varieties; and
- Powdery Mildew.

Documentation was assembled with assistance from Wine Australia personnel on individual projects within each program, including original project proposals, milestone reports, final reports and other relevant 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 programs may be considered conservative.

Benefit cost analysis was conducted on all five programs 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 2016/17 dollar terms. Future costs and benefits were discounted to the 2016/17 year while past costs were inflated to 2016/17 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 program. Costs for the R&D projects included the cash contributions of the Program (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 programs analysed at a 5% discount rate and expressed in 2016/17 dollar terms. Given the assumptions made for each evaluation, all of the investments are expected to produce positive net benefits over 30 years from the last year of investment.

Table 1: Investment Program for five AGWA R&D Investments (discount rate 5%, 30 years from last year of investment)

Investment Criteria	Investment Program				
	Lean	**Wine Flavours Card**	**Rural Leaders**	**Varieties**	**Powdery Mildew**
Present value of benefits ($m)	$3.4	$1.9	$2.2	$1.7	$1.7
Present value of costs ($m)	$1.0	$0.5	$0.8	$1.6	$0.6
Net present value ($m)	$2.4	$1.4	$1.4	$0.1	$1.1
Benefit–cost ratio	3.4	3.8	2.7	1.1	2.9
Internal rate of return (%)	106%	34%	275%	6%	57%
Modified internal rate of return (%)	12%	12%	14%	5%	10%
Unquantified benefits	None	Unification in marketing of Australian wines to China	Better industry decisions	Germplasm knowledge to inform the wine grape breeding program	Research outputs to assist in future development of objective assessment methods
		Increased sales to domestic tourists of Chinese descent	Additional consideration and knowledge of environmental sustainability	Lower alcohol wines with the possibility of improved health outcomes	Time saving and other benefits from use of the App to score the incidence and severity of other issues
			Contributions to community initiatives in regional Australia		

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 programs were selected by Wine Australia 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 programs. A brief conclusion is provided in Section 4. Appendices 1 to 5 provide the detailed analyses for each of the programs.

2. MATERIALS & METHODS

2.1 Projects for Evaluation

Wine Australia identified the following programs completed in 2015-16 for evaluation:

- Lean;
- Wine Flavours Card;
- Rural Leaders;
- Varieties; and
- Powdery Mildew.

2.2 Individual Analyses

Each investment was evaluated through the following steps:

1. Information from the original project schedules, and any progress reports, final reports 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. Face-to-face discussions were held with relevant Wine Australia personnel and the initial project description draft was provided to Wine Australia for perusal and comment, together with specific information requests.
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 programs 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 2016/17 dollar terms. Future costs and benefits were discounted to the 2016/17 year while past costs were inflated to 2016/17 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 program. Costs for the R&D projects included the cash contributions of the Program (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 Programs

Programs	Benefits
Lean (3 Projects)	Economic • Reduced winemaking costs Environmental • Nil Social • Nil
Wine Flavours Card (1 Project)	Economic • Increased sales of wine to China and at cellar door to Chinese tourists • Unification in marketing of Australian wines to China Environmental • Nil Social • Improve profitability and hence regional economic impacts in a number of wine regions*
Rural Leaders (2 Projects)	Economic • Improved earnings for those participating in leadership training – additional salary, or profit in their own business sooner. • Better industry decisions – more integrated, efficient and profitable supply chains, better allocation of public R&D and marketing resources, along with capacity to shape favourable public policy outcomes Environmental • Additional consideration and knowledge of environmental sustainability Social • Trained leaders are more able and willing to contribute to community initiatives in regional Australia
Varieties (1 Project)	Economic • Water use savings from commercially acceptable new varieties • Germplasm knowledge to inform the wine grape breeding program Environmental • Reduction in water use associated with new short season varieties and varieties with a high crop water use index (i.e. A fruit to leaf ratio). These new varieties will reduce pressure on the environment to supply irrigation water Social • Lower alcohol wines with the possibility of improved health outcomes • Improve profitability and hence regional economic impacts in a number of wine regions*
Powdery Mildew (1 Project)	Economic • Reduced costs of visual assessments • Reduced disputes between growers and wineries • Reduced incidence of inappropriate downgrading of grapes and use of contaminated grapes in winemaking • Research outputs to assist in future development of objective assessment methods • Benefits from use of the App to score the incidence and severity of other issues Environmental • Nil Social • Nil

* In the CBA framework regional economic impacts are distributional and hence are excluded from the analysis.

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 program investments analysed at a 5% discount rate.

Further details on each of these investments and the associated results are provided in the individual program reports (Appendices 1 to 5).

Table 3.2: Investment Criteria for Five Apple and Pear Cluster Investments (discount rate 5%, 30 years from last year of investment)

Investment Criteria	Investment Program				
	Lean	Wine Flavours Card	Rural Leaders	Varieties	Powdery Mildew
Present value of benefits ($m)	$3.4	$1.9	$2.2	$1.7	$1.7
Present value of costs ($m)	$0.9	$0.5	$0.8	$1.6	$0.6
Net present value ($m)	$2.4	$1.4	$1.4	$0.1	$1.1
Benefit–cost ratio	3.6	3.8	2.7	1.1	2.9
Internal rate of return (%)	127%	34%	275%	6%	57%
Modified internal rate of return (%)	13%	12%	14%	5%	10%

4. CONCLUSION

All the investment analyses yielded positive results at the 5% discount rate, with B/C Ratios ranging from 1.1 to 3.8. 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.

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 the cluster 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 AGWA'S INVESTMENT IN LEAN

1. Background

Lean manufacturing or lean production, often simply "lean", is a systematic method for the elimination of waste within a manufacturing system. It derives from the Toyota Production System. While information was available on Lean production principles, through engagement with stakeholders, Australian Grape and Wine Authority (AGWA) identified the need for a simple 'Lean Guide' that interprets the Lean technique in the context of the wine industry. Development and extension of the Lean Guide is intended to provide the wine industry with a resource that will allow all scales of operation to adopt and benefit from the principles of Lean manufacturing.

2. Summary of Projects

Three Projects funded by AGWA and described in Table 2.1 comprised the Lean Program. In addition, it is recognised that South Australian Wine Industry Association (SAWIA) piloted the Lean Guide in South Australia in Stage 1 of Lean Project Trials. This was not funded by AGWA. In addition, there has been a Lean workshop at the Australian Wine Industry Technical Conference (AWITC) (together with two winery visits in Barossa Valley to extend Lean) and extension will include 6 to 8 annual regional workshops from 2015/16 to 2018/19.

Table 2.1 Project Description

Project No. 2XE 1302 A simple guide to LEAN for the wine industry	
Project Details	Research Organisation: 2XE Pty Ltd Period: Completed 8/10/14 Principal Investigator: Nick Palousis
Rationale	Through previous engagement with stakeholders, AGWA identified the need for a simple 'Lean Guide' that interprets the Lean technique in the context of the wine industry. While some wineries have already sourced information about Lean production principles, primarily through consultants or other sources, and then adapted the principles to their own circumstances, there was a view that many of these existing resources focus on the methods and language (e.g. jargon) rather than the outcomes, and this is barrier to uptake. Development of the Lean Guide is intended to provide the wine industry with a resource that will allow all scales of operation to adopt and benefit from the principles of Lean manufacturing
Objectives	1. Develop a simple Lean Guide for the wine industry, in a format that uses plain and empathetic language, and contain relevant illustrative examples, in order to be approachable and readily accessible and adoptable by the wine industry 2. Recommend an appropriate extension strategy and plan for accelerating the uptake of Lean practices in the industry through the dissemination of the Guide and supporting materials.
Activities and Outputs	Key activities for this project were executed under eight key steps: 1. Confirmation of project plan and select industry performers 2. Preparation of Lean Guide concepts and structure 3. Industry engagement to test Guide concept, structure and proposed features 4. Preparation of Lean Guide extension strategy 5. Preparation of draft concepts for format and content of Lean Guide 6. Guide testing and industry participation 7. Options for extension delivery 8. Reporting and publications submitted to AGWA The project involved the development of the following deliverables:

	• The Lean Guide which offers a practical introduction to lean production concepts and techniques for Australian wineries. This guide will help wine businesses implement practices to improve their productivity, reduce their costs and improve their business resilience • Three case studies of Australian wineries successfully implementing Lean practices (accessible via the Lean Guide) • Lean Guide Extension Strategy, Delivery Plan & Risk Assessment • Final Project Report • Summary report for AGWA website • Reporting in Industry trade journals.
Outcomes	Information to assist wineries reduce production costs
Impacts	Potential for reductions in production costs

Project No. AGW 1402 Extension of Lean Production	
Project Details	Research Organisation: 2XE Pty Ltd Period: Completed 1 April 2015 to 30 June 2015 Principal Investigator: Nick Palousis
Rationale	Development of the Lean Guide provides the wine industry with a resource that will allow all scales of operation to adopt and benefit from the principles of Lean manufacturing. However, uptake is likely to be limited without the development of easy to understand tools and their extension to the wine community.
Objectives	Develop tools to educated the Australian wine community about principles and applicability o f Lean production Extension of tools and methods to wineries
Activities and Outputs	a) Identify key messaging to introduce and educate the Australian wine community about principles and applicability of lean production in winemaking and bottling processes. b) Prepare content for delivery at short sessions (approx. 20 minute) on 'introduction to lean production' suited to a general audience with winemaking and/or wine business skills c) Prepare content for delivery at half day sessions (approx. 3.5 hours) on 'practical ways to implement lean production', included a winery walk component (where possible), to a general audience with winemaking and/or wine business skills d) Prepare key messaging, concept, storyboard and other material for a short animation to introduce lean production for the Australian wine industry (to be published online and delivered at introductory workshops) e) Prepare templates, guides and other tools, as required, to be provided as collateral to workshop participants f) Be in attendance and deliver content, via webinar (in Adelaide) to at least one 'introduction to lean production' presentation. g) Be in attendance and deliver content to at least six 'introduction to lean production' workshops to be held in various locations across Australia. h) Be in attendance and deliver content to at least six 'practical ways to implement lean production' workshops to be held in various locations across Australia.
Outcomes	Information and tools for wineries to review their process efficiencies
Impacts	Potential for reductions in production costs

Project No. GWR 1405 Stage 2 of Lean Project Trials	
Project Details	Research Organisation: SAWIA Period: Completed 17 December 2014 to 30 June 2015 Principal Investigator: Mark Gishen
Rationale	Development of the Lean Guide provides the wine industry with a resource that will allow all scales of operation to adopt and benefit from the principles of Lean manufacturing. However, uptake is likely to be limited without the development of easy to understand tools and their extension to the wine community.
Objectives	Expose the wine making industry to tools and assistance to overcome barriers to implementation of Lean manufacturing techniques Evaluate the efficacy of both the implementation methodology and Lean Guide for Wineries materials as applied by wineries themselves for achieving resource efficiency improvements.
Activities and Outputs	Delivery of a series of centrally located group briefing sessions, teaching the participating wineries how to implement key Lean tools and practices into winery operations and providing the opportunity for peer-to-peer learning Evaluation of the efficacy of both the implementation methodology and Lean guide materials for achieving resource efficiency improvements One-on-one 'Lean mentoring' for each winery to assist with implementation of Lean for energy-, waste-, water- and materials- efficiency improvements as well as other indicators reflecting business productivity and sustainability as outline in the briefing sessions (192 hours of one-on-one support in total) Provisions of benchmark data on resource efficiency metrics (obtained via data collection from on-on-one Lean support)
Outcomes	Information that can be incorporated into educative material on Lean for the wine industry including cases studies, all aimed at promoting and enabling uptake by the broader wine industry.
Impacts	Potential for reductions in production costs

3. Match with National Priorities

The Australian Government's strategic science and research priorities and rural R&D priorities are reproduced in Table 3.1.

Table 3.1 Strategic Science/Research Priorities and Rural R&D 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, resources** – structure, processes governing formation/distribution. 6. **Advanced manufacturing** – high value and innovative industries in Australia. 7. **Environmental change** – mitigating, managing or adapting to changes. 8. **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 Project has addressed Strategic Science/ Research Priorities 1, 2, 3, 5 and 5. 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

4.2.1 R&D Investment

The R&D investment costs comprised:

- direct financial outlays by AGWA for the three projects (2XE1302, AGW1402 and GWR1405);
- direct financial outlays by Zero Waste Australia for the Stage 1 Lean trials;
- direct financial outlays by Zero Waste South Australia for the Stage 2 of the Lean trials (GWR1405)
- direct financial costs of wineries participating in Stage 2 of the Lean trials (GWR1405)
- In-kind contributions to the research Project, in particular time associated with the AGWA program manager, and time costs of participants in AGW1402 and GWR1405 and the Stage 1 Lean trials.

4.2.2 Extension

Extension costs associated with the Projects relate to workshops at the AWITC conference and continuing regional workshops from 2015/16 to 2018/19.

4.2.3 Administration

No additional administration costs were identified.

4.2.4 Adoption

Adoption of Lean principles by industry is primarily about changing the mindset of managers and increasing awareness of potential for cost savings. Achieving cost savings may require some labour costs associated with onsite training at the winery or some upfront labour costs as those educated in Lean principles at workshops pass on the information and methods to others. Some analysis time at wineries may also be required to determine where cost savings can be made. Implementation may also involve capital costs to change production processes, implement new technology etc.

4.2 Benefits

4.2.1 Research output and impact pathway

The output of the Project is potential reductions in production costs of wineries.

The impact pathway is:

1. Initial research into how Lean can be applied to the wine industry
2. Development of the Lean Guide and cases studies of Australian wineries
3. Development of tools to educate the Australian wine community and extension of tools and methods to wineries

4. Delivery of group briefing sessions, teaching wineries how to implement key Lean tools and practices, one-on-one mentoring for each participating winery and provision of benchmark data and case studies
5. Extension through conferences and regional workshops
6. Industry discussions and collaborations
7. Implementation by wineries

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			
1. Reduced winemaking costs	Understanding of how Lean principles can be adapted to a specific industry, thus potentially reducing industry costs	Nil	Information to aid foreign wine makers reduce costs
Environmental Benefits			
Nil	Nil	Nil	Nil
Social Benefits			
Nil	Nil	Nil	Nil

4.2.3 Public versus Private Benefits

All the benefits that will arise from Project investment will be private in nature. The private benefits will be captured by winemakers. These private benefits will in the form of production cost savings.

4.2.4 Distribution of Benefits along the Supply Chain

The benefits to the wine industry from investment in this Project will be primarily to winemakers.

4.2.5 Benefits to other Primary Industries

There are no benefits to other primary industries.

4.2.6 Benefits Overseas

Information from this Project may be able to be adapted by foreign winemakers.

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
Direct investment by AGWA, Zero Waste SA and wineries participating in the Stage 2 Lean trials	Cost savings to wineries
Time costs of program manager and participants in workshops and trials directly part of the Projects	
Extension costs associated with implementation and participation in continuing workshops	
Industry adoptions costs	

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 Projects by AGWA (Table 5.1) and for researchers and other investors (Table 5.2). Table 5.3 provides the total investment by year for both sources.

AGWA overhead costs are in addition to those shown in Table 5.1 and are estimated at 12%. Time and travel costs for participants in workshops and meeting as part of the Projects are included in Table 5.2 estimates.

Table 5.1 Investment by AGWA in the Project for Years Ending June 2014 to June 2015

Project Code	2013/14	2014/15	Total
2XE1302	$117,200	$0	$117,200
GWR1402	0	$46,918	$46,918
GWR1405	$0	$11,000	$11,000
Total	**$117,200**	**$57,918**	**$175,118**

Source: AGWA End of Project Financial Statement and Project Briefs

Table 5.2 Investment by Researchers/Others in the Project for Years Ending June 2014 to June 2015

	2013/14	2014/15	Total
2XE1302	$0	$0	$0
GWR1402	$0	$108,000	$108,000
Stage 1 Lean Trials	$20,800	$34,655	$55,455
GWR1405	$0	$90,332	$90,332
Total	**$20,800**	**$232,987**	**$253,787**

Source: AGWA Final Project Application and Consultant Estimates

Table 5.3 Annual Investment in the Project (nominal $)

Year Ending 30 June	AGWA	Researchers/Others	Total
2013/14	$131,264	$20,800	$152,064
2014/15	$64,868	$232,987	$297,855
Total	**$196,132**	**$253,787**	**$449,919**

5.1.2 Extension Costs

Extension costs are associated with time and monetary costs to implement workshops and for industry participants to attend them. They are based on an estimate of attendance numbers, financial cost of attending and opportunity cost of time.[1]

5.1.3 Adoption costs

For wineries adopting Lean principles it is assumed that it requires three two hour workshops with an external advisor plus three employee days of training. Adoption that requires capital investment is excluded from the analysis. Refer to the consideration of benefits below.

5.1.4 Additional Costs

No additional costs were identified.

5.2 Benefits

5.2.1 Cost Savings to Industry

The main potential benefit of the Projects is the identification of cost savings in the winemaking production process. Stage 2 Pilot Program of six wineries found potential cost savings via reductions in wine loss, electricity savings and improved labour efficiency. Overall potential costs savings were $0.02/L on a weighted average basis, with the major cost saving being from avoided wine loss followed by labour cost savings and electricity savings. Only labour savings were identified across all scales of winery, with wine loss savings and electricity savings mainly accruing to large producers.

However, reductions in wine losses require changing various processes throughout the winery e.g. implementing cross flow practices and altering lees management. Electricity savings require changing various processes throughout the winery such as consolidating refrigeration plant, use of new wastewater aerator technology and improving refrigeration efficiency. Even labour cost savings required changing various processes throughout the winery such as implementing of 5S principles, automated temperature controls and improved bin management. These would require some investment in capital and additional labour costs to train staff. They would only be adopted if the costs of doing so were less than the benefits. Hence all the identified benefits for the sample wineries are unlikely to be achieved.

Little information is available on the capital and labour costs required to achieving the identified cost savings per litre indicated by the Stage 2 Lean Trials. The cost savings per litre identified therefore represent an upper bound estimate.

Conservatively, this analysis focuses on labour savings benefits only as these labour changes seem least likely to require investment of capital. Instead some onsite training costs for wineries implementing Lean are assumed. Assumptions are outlined in Table 5.4.

[1] It is assumed that the opportunity cost is the wage rate (plus loading) of those attending i.e. it is assumed that attendees would otherwise be at work.

Table 5.4 Summary of Assumptions

Variable	Assumption	Source
Quantity of wine production in Australia	1,231,000,000	AGWA
% of producers by volume accessing Lean via Stage 2 Lean Trials in 2015	23%	SAWIA and 2XE Pty Ltd (2015)
% of producers by volume accessing Lean via Stage 2 Lean Trials and extension workshops by 2018/19 (last workshops)	50%	Consultant estimate
Labour cost savings per L adjusted for some onsite training and management costs	$0.001	SAWIA and 2XE Pty Ltd (2015) and AGWA/consultant estimate of training costs
% of those participating in Lean workshops who implement principles	92%	AGWA survey of participants
Period of time that participants obtain a benefit	5 years	Consultant estimate assuming that processes and production are revised periodically
Attribution of benefits to this project	100%	The project was not linked to other AGWA or non-AGWA investments

The Counterfactual

While Lean has been around for some time the uptake of Lean practices in the wine industry prior to the Projects has been minimal - primarily due to a lack of both information on the benefits of Lean (as a means of improving resource efficiency) and guidance on ways to implement Lean and sustain performance (2XE Pty Ltd, 2014). 2XE Pty Ltd identified four barriers to preventing the uptake of Lean practices and ongoing resource efficiency improvements in the wine industry:

- Lack of internal knowledge and expertise in applying Lean, and in particular how to practically implement the tools and practices into winery operations;
- lack of availability of benchmark data and peer-to-peer learning opportunities to compare resource efficiency and Lean performance;
- Lack of critical mass of the industry in adopting Lean;
- lack of availability to open-source Lean tools.

Consequently, for the base case no additional uptake of Lean is envisaged beyond those that have already implemented it.

5.2.2 Other Potential Benefits

No other potential benefits beyond cost savings were identified.

6. Results

All past costs and benefits were expressed in 2016/17 dollar terms using the Gross Domestic Product deflator (ABS 5204.0). All costs and benefits from 2016/17 onwards were discounted to 2016/17 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 initial investment period plus 30 years from the last year of the investment (2014/15) to the final year of benefits assumed.

Tables 6.1 and 6.2 show the investment criteria estimated for the different periods of benefits for both the total investment and for AGWA/industry investment, respectively. The present value of benefits (PVBs) for

the AGWA investment, shown in Table 6.2, are estimated by multiplying the total PVB by the AGWA proportion of investment.

Table 6.1 Investment Criteria for Total Investment by AGWA, Project Partners and the Wine Industry (discount rate 5%)

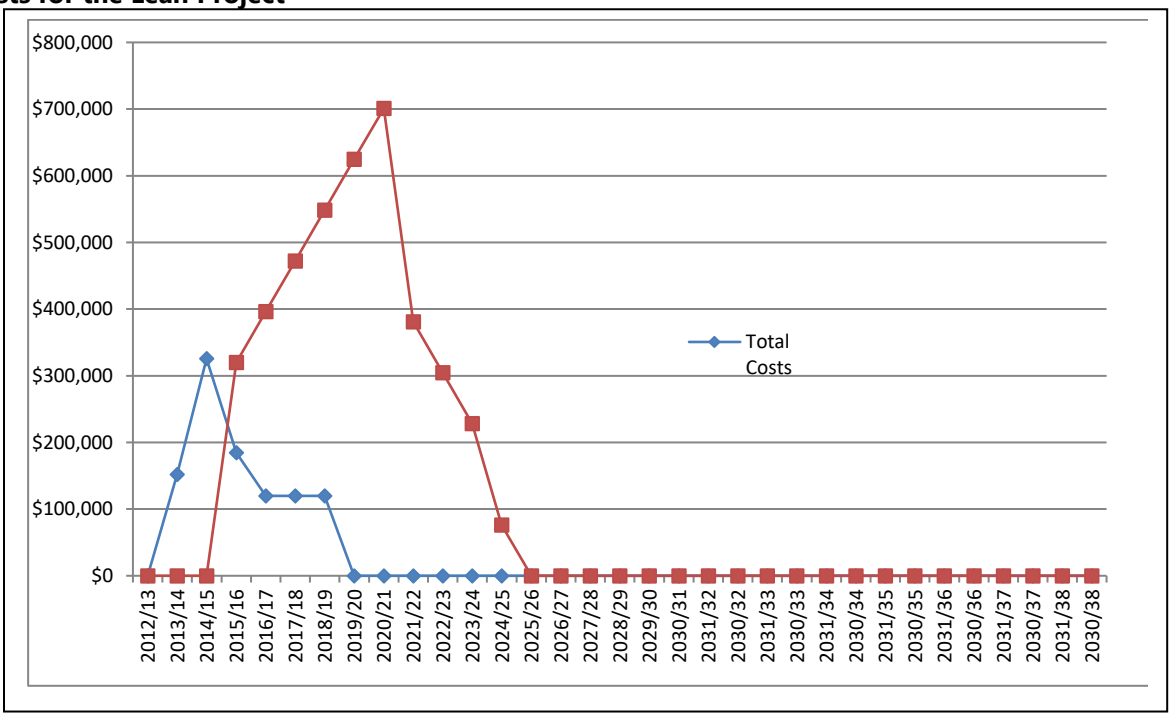
Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits ($m)	$0.0	$2.1	$3.4	$3.4	$3.4	$3.4	$3.4
Present value of costs ($m)	$0.5	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0
Net present value ($m)	-$0.5	$1.1	$2.4	$2.4	$2.4	$2.4	$2.4
Benefit–cost ratio	0.0	2.1	3.4	3.4	3.4	3.4	3.4
Internal rate of return (%)	Negative	89%	106%	106%	106%	106%	106%
Modified internal rate of return (%)	Negative	54%	33%	21%	16%	14%	12%

Table 6.2 Investment Criteria for AGWA and the Wine Industry (discount rate 5%)

Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits ($m)	$0.0	$0.6	$1.0	$1.0	$1.0	$1.0	$1.0
Present value of costs ($m)	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2
Net present value ($m)	-$0.2	$0.4	$0.8	$0.8	$0.8	$0.8	$0.8
Benefit–cost ratio	0.0	3.1	5.0	5.0	5.0	5.0	5.0
Internal rate of return (%)	Negative	172%	181%	181%	181%	181%	181%
Modified internal rate of return (%)	Negative	83%	40%	25%	19%	16%	14%

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 Lean 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)	$4.1	$3.4	$2.9
Present value of costs ($m)	$1.0	$1.0	$1.0
Net present value ($m)	$3.0	$2.4	$1.9
Benefit-cost ratio	3.9	3.4	2.9

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 level of adoption of Lean principles and the level of cost saving per L for those implementing Lean. The analysis assumed a maximum of 50% penetration of Lean principles into Australian production and a cost saving only in relation to labour costs at $0.001/L. The results for an assumed 40% and 60% penetration and 25% higher and lower savings at varying discount rates are provided in Tables 7.2 and 7.3, respectively. These indicate that all indicators remain positive for all discount rate assumptions.

Table 7.2 Sensitivity to Change in Penetration (Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5% (base)	10%
40% Penetration			
Present value of benefits ($m)	$3.3	$2.8	$2.4
Present value of costs ($m)	$1.0	$1.0	$1.0
Net present value ($m)	$2.2	$1.8	$1.4
Benefit-cost ratio	3.2	2.8	2.4
60% Penetration			
Present value of benefits ($m)	$4.8	$4.0	$3.3
Present value of costs ($m)	$1.0	$1.0	$1.0
Net present value ($m)	$3.8	$3.0	$2.4
Benefit-cost ratio	4.7	4.0	3.4

Table 7.3 Sensitivity to Change in Level of Cost Saving (Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5% (base)	10%
25% Higher			
Present value of benefits ($m)	$5.1	$4.2	$3.6
Present value of costs ($m)	$1.0	$1.0	$1.0
Net present value ($m)	$4.0	$3.2	$2.6
Benefit-cost ratio	4.9	4.2	3.7
25% Lower			
Present value of benefits ($m)	$3.0	$2.5	$2.1
Present value of costs ($m)	$1.0	$1.0	$1.0
Net present value ($m)	$2.0	$1.5	$1.2
Benefit-cost ratio	2.9	2.5	2.2

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 Lean Project, including expected future costs, are valued at $1.0M (present value terms) and are expected to produce aggregate total benefits of approximately $3.4M (present value terms). This gives an estimated net present value of $2.4M, a benefit-cost ratio of approximately 3.4, an internal rate of return of 106% and a modified internal rate of return of 12%.

The estimated net benefits to AGWA and the Wine Industry are estimated at $0.8M with a benefit-cost ratio of approximately 5.0, an internal rate of return of 181% and a modified internal rate of return of 14%.

All investment indicators remain positive for different discount rate assumptions and different assumptions around market penetration of Lean and the level of cost saving.

10. References

2XE Pty Ltd (2014) *SAWIA Efficient Wineries Program: Stage 1 Final Report*, prepared for South Australian Wine Industry Association (SAWIA) and Zero Waste SA.

2XE Pty Ltd and SAWI (2015) *Efficient Wineries (Lean) Program - Stage 2 Pilot Program, Confidential Summary Report - 30 June 2015, prepared for AGWA*.

Abbreviations

ABS	Australian Bureau of Statistics
AGWA	Australian Grape and Wine Authority
AWITC	Australian Wine Industry Technical Conference
EOPFS	End of Project Financial Statement
GDP	Gross Domestic Product
MIRR	Modified Internal Rate of Return
SAWIA	South Australian Wine Industry Association

APPENDIX 2: ECONOMIC ANALYSIS AGWA'S INVESTMENT IN THE WINE FLAVOURS CARD

1. Background

China is relatively new to wine consumption but with a population of over 1.3 billion people and a large middle class interested in prestige products, it has enormous potential as a market for Australian wine exports. However, the language used by Chinese consumers to describe wine is poorly understood by Australian wine marketers and taste descriptors, packaging information and even varietal names used by Australian wine makers may have no resonance with Chinese consumers. Effective communication and marketing strategies require recognition of language used by Chinese consumers for wine and its concordance with Australian descriptors.

2. Summary of Projects

A single Project was supported as described in Table 2.1. In addition, the information gained from the Project was extended via the development and supply of Mash Design card (Wine Flavours Card) summarising the results of the Project.

Table 2.1 Project Description

Project No. USA 1201 Understanding Chinese sensory preferences for varied wine styles and the language used to describe them	
Project Details	Research Organisation: University of South Australia Period: 01-January-2013to 31-December-2013 Principal Investigator: Larry Lockshin
Rationale	China is the number one destination for Australian bottled wine exports in Asia and is the third largest market for Australian global bottled wine exports by value (Wine Australia, 2012), with strong growth in recent years. While per capita consumption has doubled over the last five years, it is from a low base and is currently 1.0 L compared to the world average of 7 L. As a relatively new to wine, highly diverse market with cultural and language issues for Australian wine producers, there is very limited information available on consumer behaviour. Taste preferences for this diverse market are not clear, with only anecdotal information available regarding any products apart from red wine, and with a wide range of possible styles and product types able to be produced in Australia, knowledge of preferred wine styles is required. Importantly, language used by Chinese consumers regarding wine is little understood, and it is not known how consumers respond to taste descriptors, packaging information or even varietal names, meaning communication and marketing strategies are hindered. Chinese use the term 'wine' loosely, often including spirits and rice-based beverages. Commonly used terms to describe wine flavours such as 'blackcurrant' may have no resonance with Chinese at all, as they may be completely unfamiliar with such fruits or not concerned about specific taste descriptions in any way. Also, different name for the same grape variety may hinder communication and uptake in the Chinese market. This Project aimed to understand both the Chinese consumer use of language to describe wines, grape varieties and flavours, and to measure the preferences existing Chinese wine drinkers have for the above. The outcome will be a much clearer understanding of how to communicate a range of information about Australian wines to Chinese consumers. Previous research in China has reported multiple names for some regions and grape varieties and a growing use of Western terms for flavours and styles by wine producers, which are not understood by Chinese wine consumers.
Objectives	The Project had two main objectives: 1) Understand the way Chinese consumers describe Australian wines, grape varieties and flavours: a. What is the language and lexicon that Chinese consumers use to describe the taste of wine and grape varieties? b. What language do Chinese consumers use to describe the following wine styles: i. Red wine? ii. White wine? iii. Fortified wine? iv. Sparkling wine?

	c. What are the common terms that resonate with consumers and should be used in further sensory analysis and to describe Australian wine styles in the future? d. What occasions do Chinese consumers associate with the different styles and flavours of the wines being tasted? 2) Understand what Australian wine styles Chinese consumers prefer? a. What intrinsic wine sensory attributes do Chinese consumers most prefer for sparkling, white, red and dessert wines? b. What extrinsic wine attributes do Chinese consumers most prefer for sparkling, white, red and dessert wines?
Activities and Outputs	This research was divided in two phases: 1) Qualitative component: 12 x 1-hour focus groups with Chinese consumers in 3 cities Four participants took part in each focus group for a total of 48 respondents, socio-demographically representative of the population of Chinese regular wine drinkers. The focus group moderator facilitated the elicitation of Chinese terms using a collection stimulus materials 2) Quantitative research: a. Sensory characterisation of the wines: the research team selected from a pool of approximately 40 red wines, 40 white wines, 10 sparkling and 10 dessert wines at least 15 wines (6 red wines, 5 white wines, 2 sparkling wines and 2 dessert wines) to be sensorially characterised by a trained panel. These wines were shipped to Beijing, Shanghai and Wuhan for part 2b of the research. b. Wine tasting and packaging evaluation: 300 consumers (100 per city) were recruited to taste the wines under blind and informed conditions. Consumers were asked overall liking of each wine, plus specific style questions. The pick-any methodology was applied, with meaningful terms from the qualitative research describing wine region, grape varieties and sensory descriptors to find the terms most associated with best and least liked wines. The same for the wine packaging. Consumer liking was related with sensory data to find the preferred sensory attributes and styles by Chinese consumers. From questionnaires completed by the participants, information was also obtained on wine attitudes, usage and involvement with wine.
Outcomes	New knowledge regarding sensory attributes, together with chemical attributes, that drive consumer liking in the form of a preference map covering a wide range of wine styles. Knowledge of how these preferences change with information on the actual wine (extrinsic packaging attributes) A list of terms, phrases or descriptors that are meaningful to Chinese consumers, in English and Chinese. Production of a Wine Flavours Card linking an Australian wine desriptor with an equivalent taste identified by Chinese consumers
Impacts	Clearer understanding of how to communicate a range of information about Australian wines to Chinese consumers Increased demand for Australian wine from Chinese consumers

3. Match with National Priorities

The Australian Government's strategic science and research priorities and rural R&D priorities are reproduced in Table 3.1.

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, resources** – structure, processes governing formation/distribution. 6. **Advanced manufacturing** – high value and innovative industries in Australia. 7. **Environmental change** – mitigating, managing or adapting to changes. 8. **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 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

4.2.1 R&D Investment

The R&D investment costs comprised:

- direct financial outlays by collaborators and participants in the R&D Project, namely AGWA, University of South Australia and AWRI.
- In-kind contributions to the research Project, in particular time associated with meeting of the Project Reference Group and the AGWA program manager.
- Cost of developing the Wine Flavours card.

AGWA advise that the Project will likely be repeated in 2017/18 to update the Wine Flavours Card, albeit at less cost than the original Project.

4.2.2 Extension

Extension costs to AGWA relate to the printing and distribution of the Wine Flavours Cards to wineries/exporters, education/media/research organisations and retailers. This is undertaken on a request basis.

4.2.3 Administration

No additional administration costs were identified.

4.2.4 Adoption

Adoption costs by industry relate to distribution of the Wine Flavour Cards to staff and distributors etc. Adoption does not require label changes etc but simply making the cards available to potential Chinese purchasers of Australian wine, those involved in developing tasting notes for Australian wine and those responsible for making Australian wine accessible to Chinese consumers.

4.2 Benefits

4.2.1 Research output and impact pathway

The output of the Project is a product to help Chinese consumers understand the nomenclature used in the description and marketing of Australian wine.

The primary potential benefit of the research output is increased demand by Chinese consumers for Australian wine. The impact pathway is:

1. Initial research
2. Development of Wine Flavours Card
3. Distribution of the Wine Flavours Card to winemakers and others who request it
4. Distribution of the Wine Flavours Card by winemakers, sales persons, marketers and distributors
5. Education/explanation of Australian descriptors to potential Chinese consumers
6. Increased demand

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			
1. Increased sales of wine to China and at cellar door to Chinese tourists 2. Unification in marketing of Australian wines to China	Better understanding of the importance of understanding Chinese terminologies and descriptors etc in boosting sales.	Nil	Information to aid foreign wine exporters understand the Chinese wine market
Environmental Benefits			
Nil	Nil	Nil	Nil
Social Benefits			
Improve profitability and hence regional economic impacts in a number of wine regions.*	Nil	Nil	Nil

* In the CBA framework regional economic impacts are distributional and hence are excluded from the analysis.

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 and wine making sectors. These private benefits will focus on an increase in wine sales to Chinese consumers.

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 in some of the benefits.

4.2.5 Benefits to other Primary Industries

Benefits to other primary industries include a better understanding of the importance of Chinese terminologies and descriptors etc in boosting sales.

4.2.6 Benefits Overseas

Information from this Project may be able to be adapted by other wine exporters to China.

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
Investment by AGWA, University of SA and AWRI	Increased demand for Australian wines from China and at cellar door to Chinese tourists
Time allocated by Project Reference Group and AGWA program manager	Unification of marketing of Australian Wines to China - leading to increased demand
AGWA cost of developing and distributing the Wine Flavours Card to wine makers who export to China	
Cost to winemakers of distributing the Wine Flavours Card to their outlets	
Cost of updating the Project	

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 AGWA, including for the development of the Wine Flavours Card (Table 5.1) and for researchers and other investors (Table 5.2). Table 5.3 provides the total investment by year for both sources.

AGWA overhead costs are in addition to those shown in Table 5.1 and are estimated at 12%. Time and travel costs for the Project reference group are included in Table 5.2 estimates.

Table 5.1 Investment by AGWA in the Project for Years Ending June 2013 to June 2015

Project Code	2012/13	2013/14	2014/15	Total
USA 1201	$84,453	$123,237	$10,000	**$217,690**
Total	**$84,453**	**$123,237**	**$10,000**	**$217,690**

Source: AGWA End of Project Financial Statement

Table 5.2 Investment by Researchers/Others in the Project for Years Ending June 2013 to June 2015

Project Code	2012/13	2013/14	Total
CSP 0902	$15,988	$73,292	**$89,280**
Total	**$15,988**	**$73,292**	**$89,280**

Source: AGWA Final Project Application

Table 5.3 Annual Investment in the Project (nominal $)

Year Ending 30 June	AGWA	Researchers/Others	Total
2012/13	$84,453	$15,988	**$100,441**
2013/14	$123,237	$73,292	**$196,530**
2014/15	$10,000		**$10,000**
Total	**$217,690**	**$89,280**	**$306,971**

5.1.2 Extension Costs

Extension costs to AGWA of printing and distributing Wine Flavours Cards to winemakers who request them is estimated at $1,000 pa from 2015. These costs are assumed continue over the evaluation period.

5.1.3 Adoption costs

Wine makers requesting the cards may also incur costs in distributing the cards to importers, distributors, staff and consumers. These costs are estimated at $1,000 per annum over the evaluation period.

5.1.4 Additional Costs

AGWA advised that the Project would need to be repeated in say 2017/18 to update the Wine Flavours Card content. The costs are assumed at 2/3 of the original cost.

5.2 Benefits

5.2.1 Increased Demand by Chinese Consumers for Australian Wine

The Counterfactual

China is the 5th largest wine market in the world and the 4th largest market for Australian exports. Export of Australian wines to China has been growing rapidly. Between 2015 and 2016 exports to China by quantity and value have grown, 45% and 40% respectively, to 99ML and $520M.

Demand for Australia's exports to China are expected to continue to grow strongly "without" the Wine Flavours Card. Those marketing to Chinese consumers, both at the cellar door and in China, are likely to engage Chinese sales and marketing resources to aid in marketing.

Increased Demand from the Wine Flavours Card

The main potential benefit of the Wine Flavours Card is increased demand for Australian wine by Chinese consumers resulting in increased exports, including indirectly via orders from Chinese tourists at the cellar door. However, there is a myriad of demand and supply factors that contribute to this increase exports and

the Wine Flavours Card is likely to have only a very small influence. Wine exporters contacted considered that the Wine Flavours Card will assist businesses as it helps translate terms and expressions that people may not be familiar with and will increase the understanding of Australian wines and assist in educating consumers in general and provide information on official terms and expressions. However, Wine Exporters were unsure of the level of any resulting increase in demand.

This suggests a minor role for the Wine Flavours Card. However, given the potential market size even a small influence will yield significant benefits.

The impact of any growth in demand for Australian exports depends on the price elasticity of supply and demand. Zhao et al. (2003) suggest elastic demand for Australian exports (-5) and relatively inelastic supply (0.4). On this basis the main benefit of any increase in demand is a price effect on existing sales with only a small benefit from an increase in quantity demanded (all other things being equal).

A starting point for assessing the benefit from an increase in demand as a result of the Wine Flavours Card is price and quantity of export sales in 2015 and the above assumed elasticities of supply and demand. In 2015, 15% of exporters to China (by volume) had requested Wine Flavour Cards, and hence the cards could only be of potential benefit to these exporters. This level grew by 5% between 2015 and 2016. Assuming a 0.05% increase in the exports of firms as a result of the Wine Flavours Card gives an increase in exports of 7,400L. Shifting the demand curve to achieve this level of additional exports results in annual benefits of $100,000, largely via a small increase in price for all wine exports to China. This is assumed to grow each year as the percentage of the wine exporters to China who access the Wine Flavours Card increases over time. The potential influence of the Wine Flavours Card is likely to be ongoing as the numbers of Chinese consumers who can benefit from the information it provides is large.

Table 5.4 Summary of Assumptions

Variable	Assumption	Source
Quantity of Australian exports to China 2015	68ML	AGWA
Value of Australian exports to China 2015	$370M	AGWA
% of Exporters to China by volume with cards in 2015	15%	AGWA
Increase per annum in % of exporter to China (by volume) with Wine Flavours Card	5% pa increase up to a max. of 20%	AGWA data 2015 to 2016, and consultant assumption
% cards aided in demand for these exporters	0.05%	Consultant estimate based on discussions with exporters
Elasticity of demand for Australian exports	-5.0	Zhao et al. (2003)
Elasticity of supply for Australian exports	0.4	Zhao et al. (2003)
Increased demand volume from cards per annum 2015	7,398L	Consultant calculation based on supply and demand and above assumptions
Year in which benefits commence	2015	AGWA data on distribution and consultant estimate
Year in which benefits cease	Ongoing	AGWA and consultant estimate - new wine consumers in China will continue to grow over time with the flavours card able to continue influencing new consumers
Attribution of benefits to this project	100%	The project was not linked to other AGWA or non-AGWA investments

5.2.2 Other Potential Benefits

The Wine Flavours Card is also being used to influence sales at the cellar door to Chinese tourists. However, any substantive sales are registered as exports to China and hence are included in the estimation of benefits above.

Benefits not valued included:

- potential benefits associated with sales to domestic tourists of Chinese descent.

6. Results

All past costs and benefits were expressed in 2016/17 dollar terms using the GDP deflator. All costs and benefits from 2016/17 onwards were discounted to 2016/17 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 (2014/15) to the final year of benefits assumed.

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

Table 6.1 Investment Criteria for Total Investment by AGWA, Project Partners and the Wine Industry (discount rate 5%)

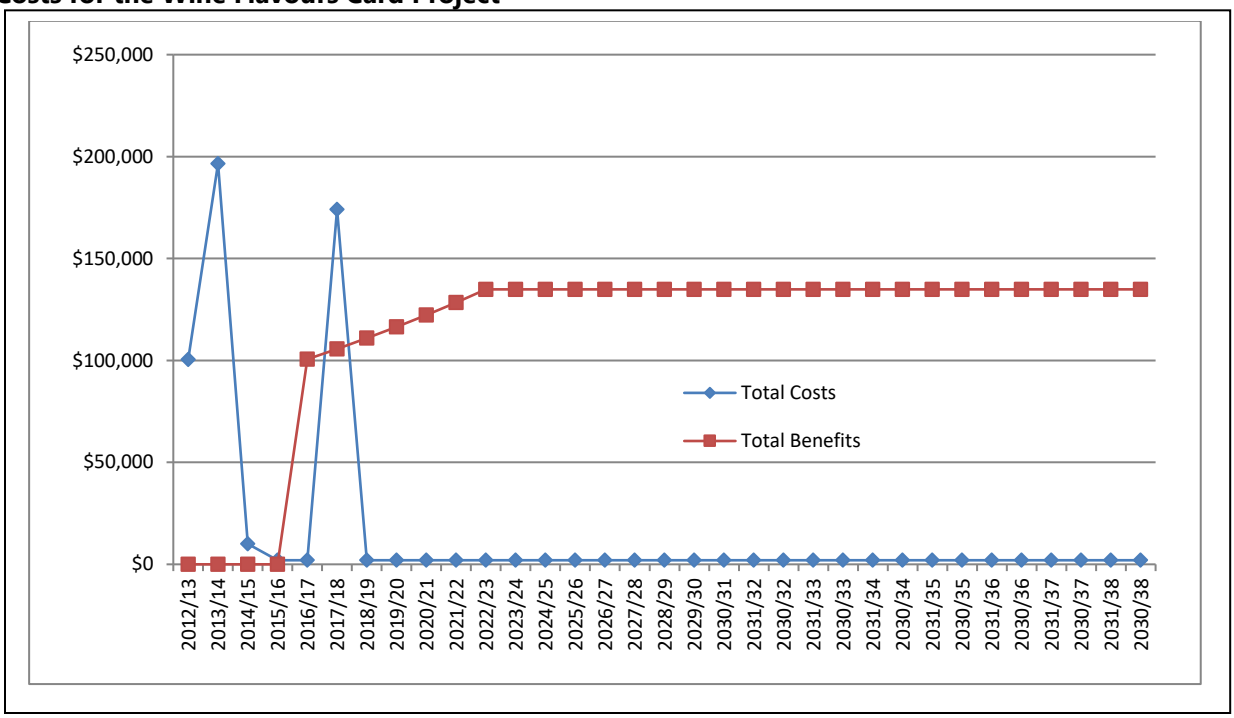
Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits ($m)	$0.0	$0.4	$0.8	$1.2	$1.5	$1.8	$1.9
Present value of costs ($m)	$0.3	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5
Net present value ($m)	-$0.3	-$0.1	$0.4	$0.7	$1.0	$1.3	$1.4
Benefit–cost ratio	0.0	0.8	1.7	2.5	3.1	3.5	3.8
Internal rate of return (%)	Negative	-10%	28%	33%	33%	33%	34%
Modified internal rate of return (%)	Negative	-7%	17%	16%	15%	13%	12%

Table 6.2 Investment Criteria for AGWA and the Wine Industry (discount rate 5%)

Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits ($m)	$0.0	$0.3	$0.6	$0.9	$1.1	$1.2	$1.4
Present value of costs ($m)	$0.2	$0.3	$0.4	$0.4	$0.4	$0.4	$0.4
Net present value ($m)	-$0.2	-$0.1	$0.3	$0.5	$0.7	$0.9	$1.0
Benefit–cost ratio	0.0	0.8	1.7	2.5	3.0	3.5	3.8
Internal rate of return (%)	Negative	-12%	28%	32%	33%	33%	33%
Modified internal rate of return (%)	Negative	-8%	17%	16%	14%	13%	12%

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 Wine Flavours Card 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)	$3.8	$1.9	$1.2
Present value of costs ($m)	$0.5	$0.5	$0.5
Net present value ($m)	$3.2	$1.4	$0.7
Benefit-cost ratio	6.9	3.8	2.4

Sensitivity analyses was 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 level of demand shift as a result of the development and distribution of the Wine Flavours Card. The analysis assumed a 0.05% export growth for those wine exporters accessing the Wine Flavours Card. The results for an assumed 0.025% export growth and 0.075% export growth at varying discount rates is provided in Tables 7.2 and 7.3, respectively. These indicate that all indicators remain positive for all discount rate assumptions.

Table 7.2 Sensitivity to Change in Export Growth (0.025%) (Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present value of benefits ($m)	$1.9	$1.0	$0.6
Present value of costs ($m)	$0.5	$0.5	$0.5
Net present value ($m)	$1.4	$0.5	$0.1
Benefit-cost ratio	3.5	1.9	1.2

Table 7.32 Sensitivity to Change in Export Growth (0.075%) (Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present value of benefits ($m)	$5.7	$2.9	$1.7
Present value of costs ($m)	$0.5	$0.5	$0.5
Net present value ($m)	$5.1	$2.4	$1.3
Benefit-cost ratio	10.5	5.8	3.7

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	Low/Medium

9. Summary of Results

Funding for the Wine Flavours Card Project, including expected future costs, are valued at $0.5M (present value terms) and are expected to produce aggregate total benefits of approximately $1.9M (present value terms). This gives an estimated net present value of $1.4M, a benefit-cost ratio of approximately 3.8, an internal rate of return of 34% and a modified internal rate of return of 12%.

The estimated net benefits to AGWA and the Wine Industry are estimated at $1.0M with a benefit-cost ratio of approximately 3.8, an internal rate of return of 33% and a modified internal rate of return of 12%.

All investment indicators remain positive for different discount rate assumptions and different assumptions around the level of demand shift as a result of the development and distribution of the Wine Flavours Card. However, there is considerable uncertainty around that latter variable.

10. References

Zhao, X., Anderson, K. and Wittwer, G. (2003) Who gains from Australian generic wine promotion and R&D?, *The Australian Journal of Agricultural and Resource Economics,* 47:2, pp. 181–209.

Abbreviations

ABS	Australian Bureau of Statistics
AGWA	Australian Grape and Wine Authority
AWRI	Australian Wine Research Institute
EOPFS	End of Project Financial Statement
GDP	Gross Domestic Product
MIRR	Modified Internal Rate of Return

APPENDIX 3: ECONOMIC ANALYSIS AGWA'S INVESTMENT IN LEADERSHIP DEVELOPMENT IN THE WINE INDUSTRY (FUTURE LEADERS)

1. Background

There is an increasing shortage of high quality, skilled candidates for senior industry representation roles in the Australian wine industry. The shortage of future leaders undermines the industry's collaborative structure and culture. A greater degree of corporate self-interest and international ownership is also undermining this culture. In addition, the wine industry has had no facility in place for the formal capture and transfer of knowledge held by experienced industry 'veterans'. Both the Winemakers Federation of Australia (WFA) and Wine Australia Boards have recognised that the decline in leadership capacity is set to hasten without a process to foster a 'next generation' of skilled and committed industry leaders. While there are numerous generic courses in leadership available none, outside of these projects, is tailored for the Australian wine industry.

2. Summary of Projects

Two Future Leaders projects funded by AWGA were assessed: WFA 1101 and FL 2015. Descriptions of both projects are provided in Table 2.1.

Table 2.1 Project Description

Project No. WFA 1101 Leadership Development in the Wine Industry (Future Leaders)	
Project Details	WFA 1101 Research Organisation: Winemaker's Federation of Australia contracted to Australian Rural Leadership Foundation Period: July 2011 to June 2014 Principal Investigator: Yvonne McClaren
Rationale	While a range of 'generic' (non-industry specific) courses exist that cater for leadership development there is a need to tailor the offering to the wine industry and capture and transfer industry wisdom to the next generation.
Objectives	• To develop future leaders to strengthen / develop the capacity of existing collaborative structures including R&D • To provide a qualification 'benchmark' for nominees to industry organisations • To boost the skills base of individual businesses and regions • To encourage broader professional development ('pull-through') within the industry by creating a recognised 'model' leader profile to aspiring candidates • To capture and utilise the industry's knowledge assets from the last 50 years – aiding continuity, and improving decision-making • To harness and build on the participants' own experience, networks etc. to benefit broader industry • To reinforce the industry's international credibility, competitiveness and influence.
Activities and Outputs	Activities included: • Development of the program for 2012 • Determination of selection criteria • Advertise the new program • Select 15 participants for 2012 • Running of training programs - the project was delivered in five sessions on 14 days over the year in various regions around Australia. • Evaluation of the program • Alumni group meetings. Outputs for WFA 1101 included: • 15 trained candidates • Graduate case studies, publicly presented • Appointment of graduates to a nominated industry body • Additions to the alumni association
Outcomes	Additional 15 graduates to take on key industry roles.
Impacts	Strengthening of the industry's human resource capacity at the highest levels.

Project No. FL 2015 Future Leaders	
Project Details	FL 2015 Research Organisation: Australian Rural Leadership Foundation Period: April 2015 to June 2016 Principal Investigator: Australian Rural Leadership Foundation
Rationale	Continue to address the increasing shortage of high quality, skilled candidates for senior industry representation roles and the formal capture and transfer of knowledge held by a number of highly experienced and successful industry 'veterans'
Objectives	• Future leaders to strengthen / develop the capacity of existing collaborative structures including R&D • Provide a qualification 'benchmark' for nominees to industry organisations • Boost the skills base of individual businesses and regions • Encourage broader professional development ('pull-through') within the industry by creating a recognised 'model' leader profile to aspiring candidates • Capture and utilise the industry's knowledge assets from the last 50 years – aiding continuity, and improving decision-making • Harness and build on the participants' own experience, networks etc to benefit the broader industry • Reinforce the industry's international credibility, competitiveness and influence
Activities and Outputs	Activities included: • Selection of 15 participants for 2015 • Running of training programs - delivered through five sessions in various Australian regions. Outputs for FL 2015: • 15 trained candidates • Graduate case studies, publicly presented • Appointment of graduates to a nominated industry body • Additions to the alumni association
Outcomes	15 additional graduates to take on key industry roles.
Impacts	Strengthening of the industry's human resource capacity at the highest levels

3. Match with National Priorities

The Australian Government's strategic science and research priorities and rural R&D priorities are reproduced in Table 3.1.

Table 3.1 Strategic Science/Research Priorities and Rural R&D 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, resources** – structure, processes governing formation/distribution. 6. **Advanced manufacturing** – high value and innovative industries in Australia. 7. **Environmental change** – mitigating, managing or adapting to changes. 8. **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 project has addressed Strategic Science/ Research Priority 1 and Rural R&D Priority 4.

4. Identification of Potential Costs and Benefits

4.1 Costs

4.2.1 R&D Investment

The R&D investment costs comprised:

- Direct financial outlays by AGWA and collaborators.
- In-kind contributions to the research projects, in particular time costs associated with the three person steering committee required to review leadership training candidates plus the AGWA program manager's time.

4.2.2 Administration

No additional R&D overhead or administration costs were identified.

4.2.3 Student Participation Costs

Costs were incurred by participating students who forwent work and or leisure time to undertake leadership training. Students did not pay course feeds but were asked to meet some of their travel costs.

4.2.4 Extension

No extension costs incurred. Minor costs associated with publicising both the opportunity and the graduates are included in R&D investment costs.

4.2.5 Adoption

No adoption costs were incurred.

4.2 Benefits

4.2.1 Research output and impact pathway

The output from the projects is trained industry leaders – 15 from each of WFA 1101 and FL 2015. The principle benefits from this investment are improved earnings for those participating in leadership training and better decision making for the Australian wine industry. Better industry decisions will result in more integrated, efficient and profitable supply chains, better allocation of public R&D and marketing resources, along with capacity to shape favourable public policy outcomes.

The impact pathway is:

1. Initial R&D investment in training leaders
2. Trained leaders rise more rapidly through the organisations they work for or their own businesses, earning additional income sooner
3. Trained leaders take on industry representative roles where they prove to be more resilient, emotionally intelligent and make better decisions for the Australian wine industry

4. Better industry decisions result in more integrated, efficient and profitable supply chains, better allocation of public R&D and marketing resources along with capacity to shape favourable public policy outcomes.

4.2.2 Triple Bottom Line Benefits

A summary of the potential benefits from the two Future Leaders projects 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			
Improved earnings for those participating in leadership training – additional salary, or profit in their own business sooner. Better industry decisions – more integrated, efficient and profitable supply chains, better allocation of public R&D and marketing resources, along with capacity to shape favourable public policy outcomes.	A small number of graduates from wine industry future leader training, leave the industry taking up positions in other sectors and benefiting these industries with the skills they have developed.	Nil	Trained leaders may work in overseas wine industries or facilitate the development of the overseas parts of Australian supply chains.
Environmental Benefits			
Additional consideration of, and knowledge pertaining to, environmental sustainability.	Nil	Nil	Nil
Social Benefits			
Trained leaders are more able and willing to contribute to community initiatives in regional Australia.	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 future leaders trained by the projects. These private benefits will include improved earnings for those participating in leadership training as well as better decision making in the Australian wine industry. Public benefits will include gains from improved understanding and commitment to environmental sustainability and leaders more able and willing to contribute to regional Australia.

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, exporters and industry representative bodies all sharing in some of the benefits created. Candidates for future leader training are drawn from all facets of the Australian wine and allied industries e.g. viticulturists, wine makers, yeast manufacturers, sommeliers and restaurateurs.

4.2.5 Benefits to Other Industries

Benefits to other industries include the addition of the small number of graduates from wine industry future leader training who leave the wine industry and take up positons in other sectors.

4.2.6 Benefits Overseas

Trained leaders may choose to work in overseas wine industries or in the overseas parts of Australian supply chains – benefiting both foreign industries and the Australian wine industry.

4.3 Summary of Costs and Benefits

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

Table 4.2 Incremental Cost and Benefit Categories

Costs	Benefits
R&D investment costs including administration incurred by AGWA	Improved earning for those participating in leadership training – additional salary, or profit in their own business, sooner.
Time allocated by the project steering committees and AGWA program manager	Better industry decisions – more integrated, efficient and profitable supply chains, better allocation of public R&D and marketing resources, along with capacity to shape favourable public policy outcomes.
Student participation costs including foregone work and leisure time and some out of pocket expenses for travel	Industry spillovers – a small number of trained future leaders take up positions in other industries (approximately 8%).
	Community spillover – individuals with leadership training are more able and willing to contribute to community initiatives in regional Australia.
	Environmental spillover – leadership training has a strong emphasis on environmental management and sustainability and will result in improved environmental outcomes.
	Foreign spillovers – a number of graduates will find themselves working in overseas wine industries or international supply chains

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 both projects by AGWA (Table 5.1) and for 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 2015

Project Code	2012	2013	2014	2015	Total
WFA 1101	74,460	83,050	16,185	0	**173,695**
FL 2015	0	0	0	199,155	**199,155**
Total	**74,460**	**83,050**	**16,185**	**199,155**	**372,850**

Source: AGWA data (AGWA estimates include contributions from GWRDC and Wine Australia)

Table 5.2 Investment by Other Investors in the Project for Years Ending June 2012 to June 2015

Project Code	2012	2013	2014	2015	Total

WFA 1101	12,500	20,000	0	0	**32,500**
FL 2015	0	0	0	0	**0**
Total	**12,500**	**20,000**	**0**	**0**	**32,500**

Source: AGWA data

Table 5.3 Annual Investment in the Project (nominal $)

Year Ending 30 June	AGWA	Other Investors	Total
2012	74,460	12,500	86,960
2013	83,050	20,000	103,050
2014	16,185	0	16,185
2015	199,155	0	199,155
Total	**372,850**	**32,500**	**405,350**

5.1.2 Time Allocated to Project Steering Committees and AGWA Program Manager

AGWA overhead costs are in addition to those shown in Table 5.1 and are estimated at 12%. They include AGWA Program Manager time allocated to the future leaders projects. Time costs for the project steering committees are estimated assuming three people on each project committee meeting twice every year, 2012 to 2015 for one full day at an average daily salary cost of $1,000 per person.

5.1.3 Student Participation Costs

Student participation in leadership training has an opportunity cost – foregone work and or leisure. Each student is required to commit 14 days to their leadership training and a further 6 days is assumed for application, preparation, travel, reading and learning course material. Average daily salary cost is estimated at $500 per person. The time and salary cost estimate is assumed to cover any out of pocket expenses incurred by the student.

5.2 Benefits

The Counterfactual

If this project had not been funded the gap in wine industry specific leadership training would have persisted and there would be a continued shortage of leaders willing to take up voluntary positions within the industry.

5.2.1 Better Industry Decisions

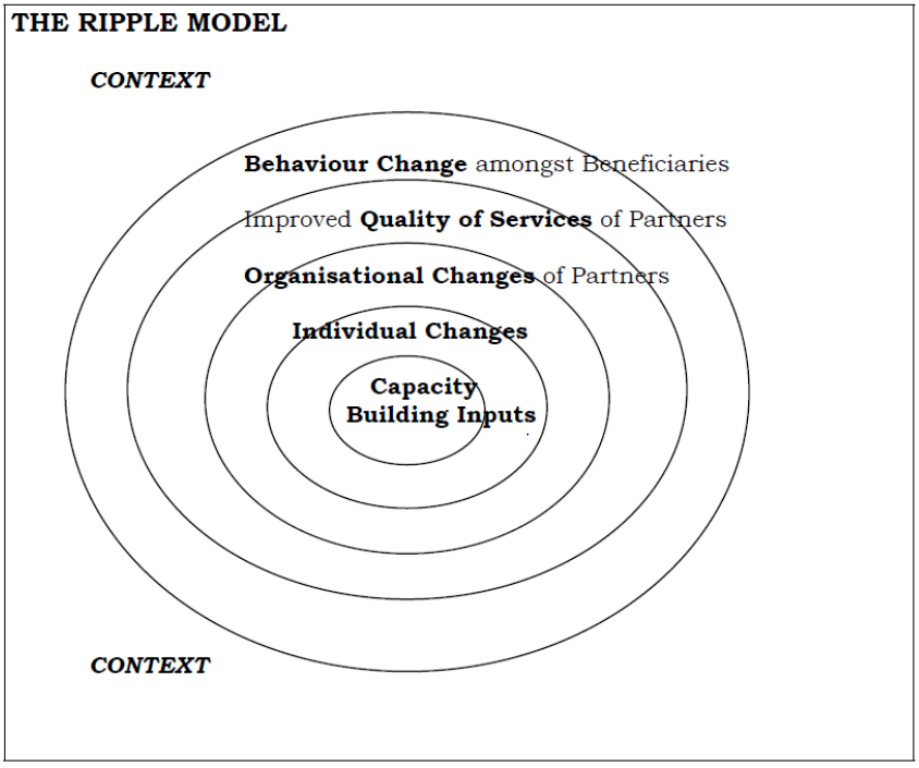
Testimonials provided by graduates of the Future Leaders program provide insight into capacity built, industry roles filled and how better industry decisions might be made:

- '*I wouldn't be where I am without the Future Leaders program*' – Tom Ward, Chair of the NSW Wine Industry Association
- *'Having been an active participant in boards and committees on a regional level in the Barossa, I was interested to see what the picture looked like from a national level*' – Allister Ashmead, Co-managing Director, Elderton Wines
- '*I was a Vineyard Manager on a reasonable sized vineyard, but that position can be pretty insulated from the rest of the sector and I enjoyed how challenging the program was to my way of thinking and working at the time. For all of us – throughout the program there was constant challenging of beliefs'* - Andrew Weeks, Executive Director, Australian Vignerons

- *'The program made me feel more responsible for the direction of our future and showed me paths to get on and actually help shape that future'* – Rebekah Richardson, Irvine Wines
- *I wanted to ensure I could contribute to decision making processes in an effective way* – Mary Retallack, Viticultural Consultant
- *I wanted to 'put back' into the industry that was helping me earn my living, and the best way I saw of doing this was through becoming involved in industry associations* – James Omond, Omond & Co

The experience of graduates in the Future Leaders program is consistent with the literature on the evaluation of capacity building investments. The ripple model shows how improved decision making might be brought about by capacity building (leadership training) - Figure 5.1.

Figure 5.1 Ripple Model Showing Impact of Capacity Building Inputs (Leadership Training)



Source: Hailey and James 2003 in Bath and Chudleigh 2015

The literature on evaluating capacity building investments suggests that quantification of returns from leadership training might be achieved by measuring both the improved earnings of those participating in the training and improvement in industry outcomes through the value of voluntary work undertaken. Stiefelmeyer et al (2013) used this approach to evaluate investment in the Canadian Advanced Agricultural Leadership Program and calculated the value of voluntary work by determining the number of additional hours undertaken by graduates and applying wage equivalents. This approach is adopted in valuing returns to the wine industry from leadership training.

5.2.2 Improved Earnings for Leadership Training Graduates

In addition to industry returns, individuals participating in leadership training receive a private benefit. This private benefit can be measured as additional salary earned sooner than if no leadership training was undertaken.

Stiefelmeyer et al (2013) found that career progression and salary benefits were greatest immediately after training and diminished over time. Typically graduates of AGWA's Future Leaders program are tertiary trained middle managers aged between 25 and 35 years earning a total salary of $120,000. When alumni become senior managers they might reasonably expect a total salary package of $250,000 (Liz Waters, pers. comm. February 2017). Assumed salary progression 'with' and 'without' Future Leaders training is shown in Table 5.4.

Table 5.4 Assumed Salary Progression 'with' and 'without' Future Leaders Training

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Salary 'with' leadership training	$120,000	$140,000	$150,000	$160,000	$165,000	$180,000	$190,000	$210,000	$232,000	$250,000
Salary 'without' leadership training	$120,000	$130,000	$140,000	$150,000	$100,000	$175,000	$185,000	$205,000	$230,000	$250,000
Annual benefit of training	**$0**	**$10,000**	**$10,000**	**$10,000**	**$5,000**	**$5,000**	**$5,000**	**$5,000**	**$2,000**	**$0**

Source: Consultant estimate

A summary of the key assumptions used to value industry and individual benefits of Future Leaders training is shown in Table 5.5.

Table 5.5 Summary of Assumptions

Variable	Assumption	Source
Better industry decisions		
Number of graduates trained in 2012 and 2015 less number lost to other industries	14 graduates gained 2012 14 graduates gained 2015	Project records that indicate 15 trainees in 2012 and again in 2015 and advice from AGWA that approximately 8% of graduates leave the wine industry after graduation
Additional voluntary days worked per graduate on industry committees and representative organisations after completion of Future Leaders training	6 days/graduate/year	Consultant estimate assuming each graduate fills a single additional industry role in an organisation that meets 3 times per year with one day's preparation and travel and one day of sitting required for each meeting.
Salary equivalent of each day volunteered to the Australian wine industry	$500/day	Consultant estimate assuming a salary of $120,000, 1,800 hours worked per annum and a 7.5 hour work day
Number of years until number of days volunteered for industry committees and representative organisations is equivalent to non-trained individuals	10 years	Consultant assumption based on literature that concludes benefit of training is greatest immediately after training and diminishes over time
Improved earnings for graduates		
Current salary of Future Leader candidates	$120,000	AGWA advice

Salary when Future Leader alumni become senior managers	$250,000	AGWA advice
Difference in salary between Future Leader graduates and their peers	Table 5.4	Consultant estimate

5.2.3 Other Potential Benefits

Other potential benefits identified but not valued include:

- Industry spillovers – a small number of trained future leaders take up positions in other industries
- Community spillover – individuals with leadership training are more able and willing to contribute to community initiatives in regional Australia
- Environmental spillover – leadership training has a strong emphasis on environmental management and sustainability and will result in improved environmental outcomes
- Foreign spillovers – a number of graduates will find themselves working in overseas wine industries or international supply chains.

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 and benefits were expressed in 2017 dollar terms using the GDP deflator. All costs and benefits from 2017 onwards were discounted to 2017 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 (2015) to the final year of benefits assumed.

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

Table 6.1 Investment Criteria for Total Investment by AGWA, Project Partners and the Wine Industry (discount rate 5%)

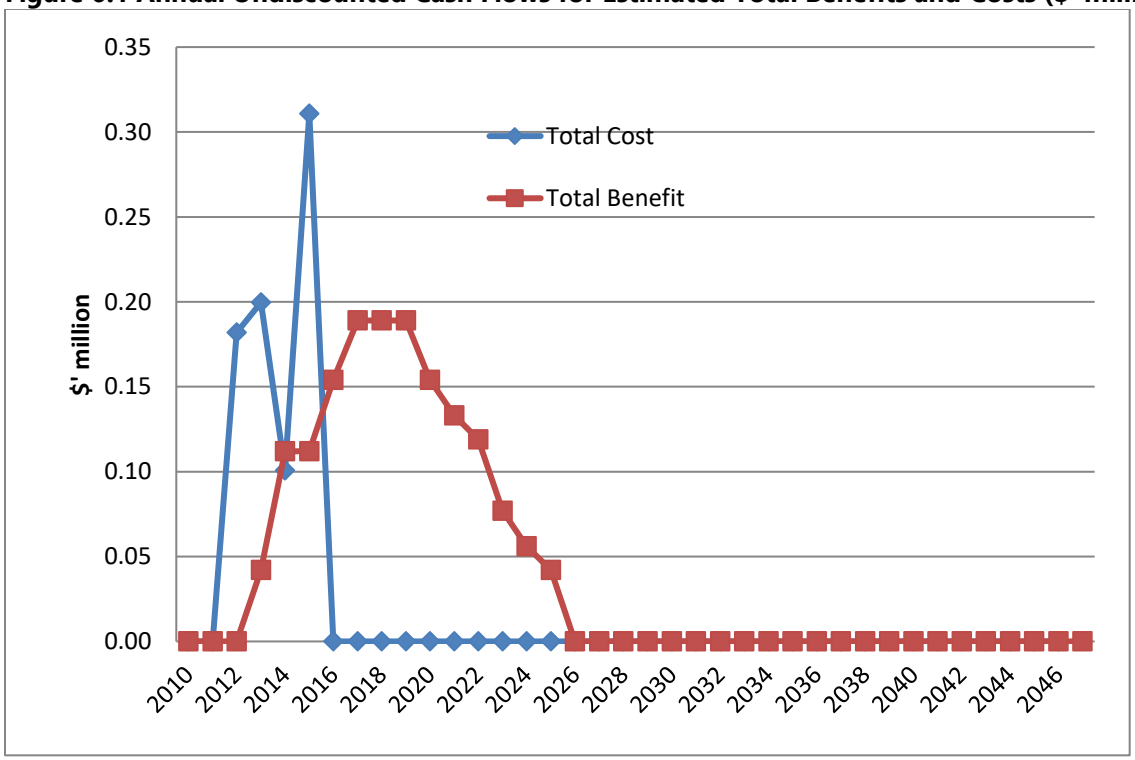
Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits ($m)	1.0	2.0	2.2	2.2	2.2	2.2	2.2
Present value of costs ($m)	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Net present value ($m)	0.2	1.2	1.4	1.4	1.4	1.4	1.4
Benefit–cost ratio	1.3	2.5	2.7	2.7	2.7	2.7	2.7
Internal rate of return (%)	176	274	275	275	275	275	275
Modified internal rate of return (%)	176	58	33	23	19	14	14

Table 6.2 Investment Criteria for AGWA and the Wine Industry (discount rate 5%)

Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits ($m)	0.5	1.1	1.2	1.2	1.2	1.2	1.2
Present value of costs ($m)	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Net present value ($m)	0.1	0.7	0.8	0.8	0.8	0.8	0.8
Benefit–cost ratio	1.3	2.5	2.7	2.7	2.7	2.7	2.7
Internal rate of return (%)	176	274	275	275	275	275	275
Modified internal rate of return (%)	176	58	33	23	19	16	14

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 Costs ($' million)



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 for the discount rate sensitivity test and shows that the analysis is not sensitive to the discount rate used.

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

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present value of benefits ($m)	2.3	2.2	2.1
Present value of costs ($m)	0.8	0.8	0.8
Net present value ($m)	1.5	1.4	1.3
Benefit-cost ratio	2.9	2.7	2.6

Sensitivity analyses were also 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 uncertainties related to voluntary days contributed to industry organisations and increased earnings attributable to Future Leader training – Table 7.2 and Table 7.3. Results show that at half the number of days contributed to industry, investment benefits still exceed costs. They also show that if the increase in graduate earnings attributable to Future Leader training is halved, then benefits still exceed costs.

Table 7.2: Sensitivity to Change in Voluntary Hours Contributed by Graduates to Industry Organisations (Total investment, 30 years)

Investment Criteria	Days Contributed to Industry by Graduates		
	3 days/year	6 days/year (base)	9 days/year
Present value of benefits ($m)	1.8	2.2	2.6
Present value of costs ($m)	0.8	0.8	0.8
Net present value ($m)	1.0	1.4	1.8
Benefit-cost ratio	2.2	2.7	3.2

Table 7.3: Sensitivity to Change in Increased Earnings by Graduates (Total investment, 30 years)

Investment Criteria	Increase in Graduate Earnings		
	Half base	(base)	Two times base
Present value of benefits ($m)	1.5	2.2	3.6
Present value of costs ($m)	0.8	0.8	0.8
Net present value ($m)	0.7	1.4	2.8
Benefit-cost ratio	1.9	2.7	4.5

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 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 two 'rounds' of Future Leader training, including student costs, were valued at $0.8M (present value terms) and are expected to produce aggregate total benefits of approximately $2.2M (present value terms). This gives an estimated net present value of $1.4M, a benefit-cost ratio of approximately 2.7, an internal rate of return of 275% and a modified internal rate of return of 14%.

Analysis results are dependent on assumptions made and results remain positive for both core assumptions and sensitivity tests.

10. References

Bath, A and Chudleigh, P (2015) 'A Framework for Evaluating Leadership and Capacity Investment by the Rural Industries Research and Development Corporation'. RIRDC Publication No 14/123

Stiefelmeyer, K., Rajcan, I. Mussell, A. (2013) *'Social and Economic Return on Investment of the Advanced Agricultural Leadership Program'* George Morris Centre, Ontario

Wine Future Leaders http://www.winefutureleaders.com/testimonials

Abbreviations

ABS	Australian Bureau of Statistics
AGWA	Australian Grape and Wine Authority
CPI	Consumer Price Index (measure of inflation)
EOPFS	End of Project Financial Statement
GNP	Gross National Product
GWRDC	Grape and Wine Research and Development Corporation (now AGWA)
PVB	Present Value of Benefits
MIRR	Modified Internal Rate of Return
WFA	Winemakers Federation of Australia

APPENDIX 4: ECONOMIC ANALYSIS AGWA'S INVESTMENT IN ENHANCED VARIETIES AND CLONES FOR A MORE VARIABLE CLIMATE AND THE PRODUCTION OF LOWER ALCOHOL WINES

1. Background

The Australian wine industry is reliant on a small number of varieties. A systematic review of the industry's germplasm repository was required to identify grape varieties and clones better suited to a hotter and more variable climate further constrained by limited water supply. Varieties and clones were also sought that meet stated consumer preferences for lower alcohol wines that do not compromise flavour, colour and mouth feel. Higher alcohol content is associated with hotter growing conditions.

2. Summary of Projects

A single grape variety/clone project was supported and Table 2.1 provides a description.

Table 2.1 Project Description

Project No. CSP 0902 Enhanced varieties / clones to meet the challenges of climate change and deliver lower alcohol wines	
Project Details	Research Organisation: CSIRO Plant Industry Period: 1 July 2009 to 30 June 2012 Principal Investigator: Peter Clingeleffer
Rationale	The industry is faced with new and evolving challenges surrounding production in a changing and variable climate with limited water supply and a requirement to reduce alcohol content in Australian wines. There is widespread industry concern that current varieties and their clones may limit the potential of the industry to adapt to these challenges. For the Australian wine grape industry to be economically sustainable it must address: • the need for product consistency (and supply) in a variable climate, which will be compounded by the impacts of climate change (i.e. temperature effects on fruit composition and wine attributes and a compression of season, leading to an inability to process fruit at optimum maturity) • the impacts of drought on production and fruit composition with a requirement to survive with less available water • the requirement to reduce alcohol levels in Australian wines without negative impacts on flavour, colour and mouth feel Industry adoption of varieties and clones suited to hot conditions offers significant potential to address these issues.
Objectives	The project has the following objectives. 1. Phenotype varieties, clones and mutants and advanced breeding lines under hot conditions in the CSIRO wine grape germplasm collection for key phenological, growth and compositional characteristics relevant to meeting future industry challenges. 2. Use the phenotypic information together with detailed targeted assessment of fruit and wine composition of the promising types (i.e. for organic acid composition and anthocyanins) to: • identify varieties and clones suited to hot climate wine grape production which will allow the industry to meet the challenges of wine production in a changing and variable climate including higher temperatures • identify varieties and clones with high water use efficiency based on short seasonality and/or high fruit to leaf ratios as a surrogate for crop water use index (crop yield to water transpired) • identify varieties suited to production of wines with lower alcohol contents. 3. Provide underpinning research knowledge for ongoing genetic diversity research and future varietal enhancement based on flavour, aroma, colour, phenolics and tannin analysis incorporating the advanced scientific fields of molecular physiology, genomics and metabolomics.

Activities and Outputs	The diverse range of CSIRO germplasm was phenotyped for key characteristics to enable identification of varieties to meet future industry specifications and provide underpinning research knowledge for future varietal enhancement. These included: • Key phenological developmental stages (i.e. budburst, flowering, veraison and harvest date at 22 Brix, a moderate sugar level). • Key growth characteristics such as fruitfulness (bunches/shoot), maximum canopy size (using a leaf area meter), berry weight, bunch weight and yield. • Key aspects of fruit composition such as total soluble solids, titratable acidity, pH, free run 'juice colour', total anthocyanins and phenolics and berry flavour. • For most promising types, targeted measurement in fruit and wine (i.e. mini-ferments or small scale-wine lots produced by Provisor) of organic acid composition and anthocyanin profiles by HPLC. A weighted ranking process, against key selection criteria, was used to identify genotypes with most potential. The genotypes were categorised with respect to their suitability for hot climate wine production, water use efficiency and low alcohol wine production. The ranking/sorting processes were facilitated by the development of a detailed data base. This included not only the phenotypic information collected but also background information from the literature on origins, regional use and wine style; vine health status and data from previous CSIRO small-scale winemaking evaluations. Genotypes for winemaking were selected based on the background information together with the preliminary phenotying data (i.e. phenology, fruitfulness, canopy size, potential yield and berry flavour characteristics). This selection was refined as more information on yield components and fruit composition was included. Project outputs included: • A document with the complete characterisation of potential genotypes; and • a detailed database and documentation of information which characterises the existing varieties, clones and advanced breeding lines.
Outcomes	Identification of varieties, clones and advanced breeding lines that meet key criteria that will assist the industry to meet future production and marketing challenges.
Impacts	New varieties to enable industry to improve productivity and profitability.

3. Match with National Priorities

The Australian Government's strategic science and research priorities and rural R&D priorities are reproduced in Table 3.1.

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, resources** – structure, processes governing formation/distribution. 6. **Advanced manufacturing** – high value and innovative industries in Australia.	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

7. **Environmental change** – mitigating, managing or adapting to changes. 8. **Health** – improving health outcomes for all Australians.	and recognising the growing role of private service delivery.

The project has addressed Strategic Science/ Research Priorities 1, 2, 7 and 8. The major focus of the project has been on the first and third of the Rural R&D Priorities.

4. Identification of Potential Costs and Benefits

4.1 Costs

4.2.1 R&D Investment

The R&D investment costs comprised:

- Direct financial outlays by collaborators and participants in the research project, namely AGWA and CSIRO.
- In-kind contributions to the research project, in particular time associated with meeting of the Project Reference Group and the AGWA program manager.

4.2.2 Administration

No additional administration costs were identified.

4.2.3 Extension

Extension costs will be incurred communicating project outputs, a report and database, and making them available as an online searchable resource.

4.2.4 Adoption

Adoption costs will be incurred by growers when new varieties and clones identified by this project are planted.

4.2 Benefits

4.2.1 Research output and impact pathway

The output of the project is new varieties, clones and advanced breeding lines that will assist the industry to improve productivity (increase output and/or reduce cost) in a more variable climate. New varieties may also have a role in meeting marketing challenges – lower alcohol wine, new and interesting wine styles.

The primary potential benefit of the research output is likely to be productivity gain – varieties that are acceptable to the market that can be grown with less irrigation water.

The impact pathway is:

1. Initial research on germplasm and identification of new varieties

2. Development of an online tool to allow growers and their advisors to easily identify new varieties
3. Growers request nursery sector production of new varieties
4. New varieties grown and water savings realised without loss of yield – lower production costs for wine grape growers

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			
Water use savings from commercially acceptable new varieties. Germplasm knowledge to inform the wine grape breeding program (see https://csiropedia.csiro.au/ grapevine-breeding/for program details).	Assessment of germplasm that may be relevant to table grape and dried grape breeding	Nil	New wine grape varieties may be applicable to other warm wine growing areas e.g. Spain, South Africa
Environmental Benefits			
Reduction in water use associated with new short season varieties and varieties with a high crop water use index (i.e. A fruit to leaf ratio). These new varieties will reduce pressure on the environment to supply irrigation water.	Nil	Nil	Nil
Social Benefits			
Lower alcohol wines with the possibility of improved health outcomes Improve profitability and hence regional economic impacts in a number of wine regions.*	Nil	Nil	Nil

* In the CBA framework regional economic impacts are distributional and hence are excluded from the analysis.
Note: A mooted benefit of this program was the industry avoiding the economic costs of re-positioning and developing in new regions. However, it is considered that industry would not relocate or develop in new regions unless it was equally or more profitable to do so, including accounting for the cost of relocation and development. Hence, there are no savings from helping industry to not relocate.

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 and wine making sectors. These private benefits will focus on reduced production costs in the form of irrigation water savings. Public benefits include reduced use of irrigation water with the potential for additional water to be made available for the environment.

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 in some of the benefits.

4.2.5 Benefits to other Primary Industries

Benefits to other primary industries include a better understanding of germplasm that may be relevant to table grape and dried grape breeding.

4.2.6 Benefits Overseas

Varieties and clones identified through this project may be applicable to other warm wine growing areas e.g. Spain, South Africa. There will also be benefits for overseas consumers of Australian wine e.g. lower cost supply.

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 including administration incurred by AGWA and CSIRO	Water use savings from commercially acceptable new varieties
Time allocated by Project Reference Group and AGWA program manager	Germplasm knowledge to inform the wine grape breeding program
Extension costs incurred communicating project outputs, a report and database, and making them available as an online searchable resource	Assessment of germplasm that may be relevant to table grape and dried grape breeding
Adoption costs incurred by growers when new varieties and clones identified by this project are planted	Environmental benefits that may be associated with an overall reduction in water use
	Savings associated with the forced relocation of wineries due to climate change impacts
	Lower alcohol wines with the possibility of improved health outcomes
	Improve profitability and hence regional economic impacts in a number of wine regions
	Germplasm that may be relevant to overseas warm wine growing areas

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 AGWA (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 2010 to June 2015

Project Code	2010	2011	2012	2013	2014	2015	Total
CSP 0902	142,381	228,583	152,548	144,873	160,599	62,048	**891,032**
Total	**142,381**	**228,583**	**152,548**	**144,873**	**160,599**	**62,048**	**891,032**

Source: AGWA End of Project Financial Statement

Table 5.2 Investment by Researchers/Others in the Project for Years Ending June 2010 to June 2015

Project Code	2010	2011	2012	2013	2014	2015	Total
CSP 0902	189,042	198,536	172,888	0	0	0	**560,466**
Total	**189,042**	**198,536**	**172,888**	**0**	**0**	**0**	**560,466**

Source: AGWA Final Project Application

Table 5.3 Annual Investment in the Project (nominal $)

Year Ending 30 June	AGWA	Researchers/Others	Total
2010	142,381	189,042	331,423
2011	228,583	198,536	427,119
2012	152,548	172,888	325,436
2013	144,873	0	144,873
2014	160,599	0	160,599
2015	62,048	0	62,048
Total	**891,032**	**560,466**	**1,451,498**

5.1.2 Time Allocated to Project Reference Group and AGWA Program Manager

AGWA overhead costs are in addition to those shown in Table 5.1 and are estimated at 12%. Time and travel costs for the Project Reference Group are included in Table 5.2 estimates.

5.1.3 Extension Costs

Communication costs will be incurred taking existing project outputs, a report and database, and making them available as an online searchable resource. AGWA advise that website development work will require an investment of $17,000.

5.1.4 Adoption costs

Investment will be required by wine grape growers adopting new grape varieties originating from this project and time will elapse before benefits are realised. For the purposes of this analysis it is assumed that the cost of growing new grape varieties is the same as existing varieties i.e. new grape varieties will be purchased from nurseries for the same costs as existing varieties (Shiraz, Chardonnay, etc.) and grower cost is incurred when existing vines require replacement or new areas of vine are being developed.

5.2 Benefits

5.2.1 Water Use Savings from New Commercially Acceptable Varieties

The Counterfactual

If this project had not been funded adaptation by wine grape growers to a hotter drier and more variable climate would have occurred. Irrigation infrastructure efficiencies would have been identified and implemented, management solutions developed and so on. Outputs from this project provide one solution in a range of options available to growers. This solution – adoption of new commercially acceptable varieties that offer water use savings - will be preferred by a small number of growers where this solution addresses their particular business needs.

Water Use Savings from New Commercially Acceptable Varieties

The project is expected to result in the adoption of new wine grape varieties that are acceptable to wine makers and can be grown without yield or quality loss using less irrigation water.

A non-standard variety identified through this project has the potential to be high yielding, have great colour, require less irrigation water and be suitable for blending with recognised varieties at a rate of up to 15% of final product volume without loss of an all-important recognised variety based label (e.g. Shiraz).

Consumers are familiar with, and make purchasing decisions based on, a small number of recognised varieties – Shiraz, Chardonnay, Cabernet Sauvignon, Merlot, Semillon, Pinot Noir, Riesling and Sauvignon Blanc. Wine makers are reluctant to purchase new varieties given the investment needed to establish a new named variety. However, if a new variety has significantly lower production costs (water cost savings) and some of these cost savings are passed on to the wine maker in the form of lower grape costs, wine makers will make use of the new variety as a minor component of an established product range.

For the purposes of this analysis, it is assumed that the new variety is able to offer a 20% water cost saving over existing varieties. This assumption is tested in the sensitivity analysis.

New commercially acceptable varieties targeting water cost savings will be most relevant to warm inland production areas. Warm inland (irrigated) regions produce 64% of Australia's wine grapes (CSIRO project proposal 2009 and Anderson et al 2010).

In 2017 when website development work is complete, growers will be in a position to identify new varieties evaluated as part of this project and these new varieties will require production in a nursery. Nurseries will grow a suitable supply of the new varieties and these vines will be planted in growers' vineyards and in time will start to supply fruit. Initial production from the new varieties will not be available until 2025.

A summary of the key assumptions made is shown in Table 5.4.

Table 5.4 Summary of Assumptions

Variable	Assumption	Source
Water use savings from new commercially acceptable varieties		
Wine grape growing area – Australia	135,178 ha	ABS Vineyards Australia 2014-15, Cat No. 1329.0.55.002
Percentage of Australian wine grape growing area classified as a 'warm inland' region	64%	CSIRO project proposal 2009 and Anderson et al 2010
Percentage of 'warm inland' area replanted or new greenfield production 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 'warm inland' region replanting or new planting each year likely to adopt new varieties	15%	Consultant assumption based on a maximum of 15% of volume from unnamed variety permissible in a known varietal wine
Irrigation water cost saving associated with new varieties	20%	Consultant estimate after review of project documentation and discussions with AGWA February 2017
Cost of irrigation water for wine grape growing	$1,395/ha	Wine Grape Growing Revenue and Expenditure Profile in AgEconPlus and Gillespie Economics 2015
Year in which first new varieties are planted in 'warm inland' growing regions	2025	Consultant estimate

Year in which maximum adoption of new varieties is reached	2030	Consultant estimate
Year in which new varieties are removed and replaced with an alternative	2055	Consultant estimate and based on an industry average vineyard life of 25 years
Attribution of benefits to this project	100%	The project was not linked to other AGWA or non-AGWA investments

5.2.2 Other Potential Benefits

Other potential benefits identified but not valued include:

- Environmental benefits associated with an overall reduction in water use
- Germplasm knowledge to inform the wine grape breeding program
- Assessment of germplasm that may be relevant to table grape and dried grape breeding
- Germplasm that may be relevant to overseas wine producing areas
- Savings associated with the forced relocation of wineries due to climate change impacts
- Lower alcohol wines that may have health benefits for consumers
- Positive regional economic impacts in wine regions due to improved grape grower profitability

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 and benefits were expressed in 2017 dollar terms using the GNP deflator. All costs and benefits from 2017 onwards were discounted to 2017 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 (2015) to the final year of benefits assumed.

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

Table 6.1 Investment Criteria for Total Investment by AGWA, Project Partners and the Wine Industry (discount rate 5%)

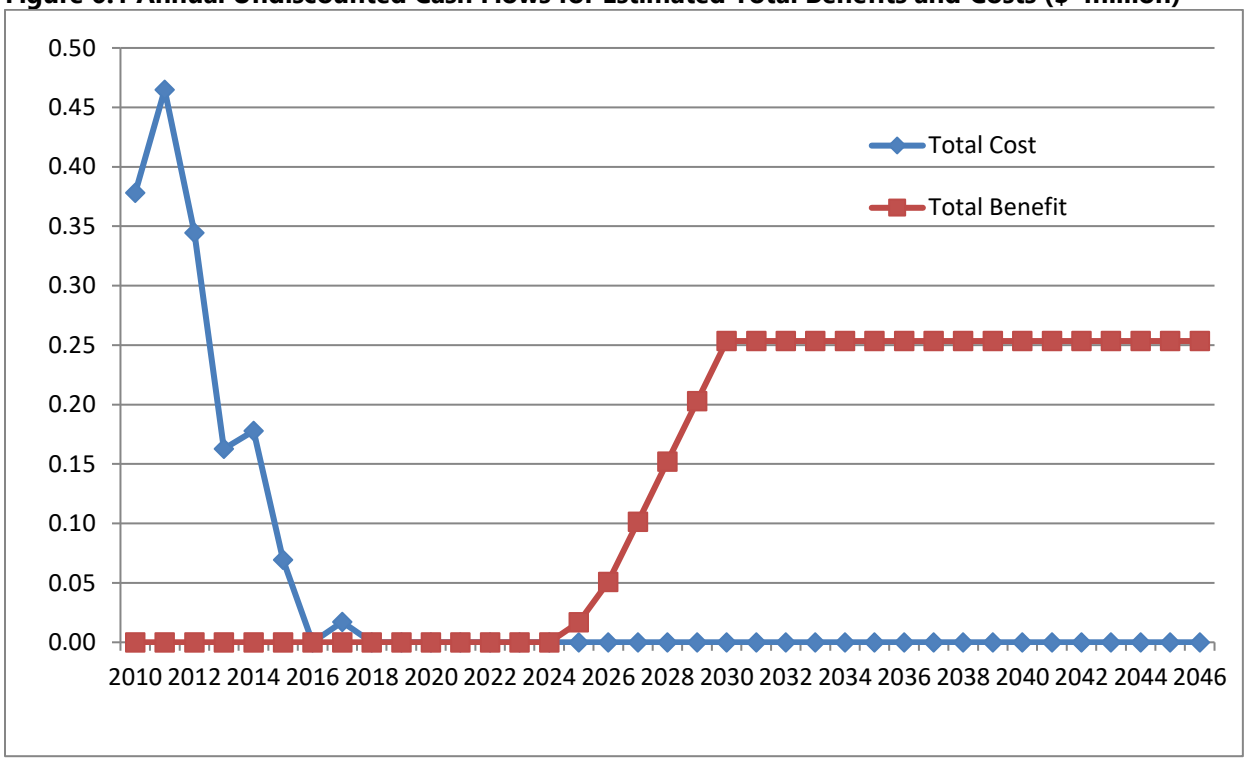
Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits ($m)	0.0	0.0	0.0	0.5	1.0	1.4	1.7
Present value of costs ($m)	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Net present value ($m)	-1.6	-1.6	-1.6	-1.1	-0.6	-0.2	0.1
Benefit–cost ratio	0.0	0.0	0.0	0.3	0.6	0.9	1.1
Internal rate of return (%)	Negative	Negative	Negative	Negative	2	5	6
Modified internal rate of return (%)	Negative	Negative	Negative	Negative	3	5	5

Table 6.2 Investment Criteria for AGWA and the Wine Industry (discount rate 5%)

Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits ($m)	0.0	0.0	0.0	0.3	0.7	0.9	1.1
Present value of costs ($m)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Net present value ($m)	-1.0	-1.0	-1.0	-0.7	-0.3	-0.1	0.1
Benefit–cost ratio	0.0	0.0	0.0	0.3	0.6	0.9	1.1
Internal rate of return (%)	Negative	Negative	Negative	Negative	2	5	6
Modified internal rate of return (%)	Negative	Negative	Negative	Negative	3	5	5

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

Figure 6.1 Annual Undiscounted Cash Flows for Estimated Total Benefits and Costs ($' million)



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 for the discount rate sensitivity test and shows that at a 10% discount rate total costs exceed total benefits.

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

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present value of benefits ($m)	4.8	1.7	0.7
Present value of costs ($m)	1.6	1.6	1.6
Net present value ($m)	3.2	0.1	0.9
Benefit-cost ratio	3.0	1.1	0.4

Sensitivity analyses were also 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 uncertainties related to irrigation water savings associated with new varieties and grower adoption of new varieties – Table 7.2 and Table 7.3. Results show that at half the water use saving total costs exceed total benefits. They also show that if grower adoption is reduced to 10% of replant area then benefits will also exceed costs.

Table 7.2: Sensitivity to Change in Irrigation Water Use Savings (Total investment, 30 years)

Investment Criteria	Water Use Saving		
	10%	20% (base)	30%
Present value of benefits ($m)	0.9	1.7	2.6
Present value of costs ($m)	1.6	1.6	1.6
Net present value ($m)	-0.7	0.1	1.0
Benefit-cost ratio	0.5	1.1	1.6

Table 7.2: Sensitivity to Change in Grower Adoption of New Varieties (Total investment, 30 years)

Investment Criteria	Grower Adoption of New Varieties		
	10%	15% (base)	20%
Present value of benefits ($m)	1.2	1.7	2.3
Present value of costs ($m)	1.6	1.6	1.6
Net present value ($m)	-0.4	0.1	0.7
Benefit-cost ratio	0.7	1.1	1.4

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 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 new varieties project, including expected future costs, were valued at $1.6M (present value terms) and are expected to produce aggregate total benefits of approximately $1.7M (present value terms). This gives an estimated net present value of $0.1M, a benefit-cost ratio of approximately 1.1, an internal rate of return of 6% and a modified internal rate of return of 5%.

Analysis results are dependent on assumptions made and while results are positive for core assumptions, sensitivity testing results in investment costs exceeding project benefits.

10. References

ABS (2015) – Vineyards, Australia, 2014-15 , Catalogue number 1329.0.55.002 accessed 2 Nov 2015 http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/1329.0.55.0022014-15?OpenDocument

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Abbreviations

ABS	Australian Bureau of Statistics
AGWA	Australian Grape and Wine Authority
CPI	Consumer Price Index (measure of inflation)
EOPFS	End of Project Financial Statement
GNP	Gross National Product
PVB	Present Value of Benefits
MIRR	Modified Internal Rate of Return

APPENDIX 5: ECONOMIC ANALYSIS AGWA'S INVESTMENT IN POWDERY MILDEW ASSESSMENT

1. Background

Powdery Mildew is a fungal disease that grows well in environments with high humidity and moderate temperatures. While the pathogen can be controlled using chemical methods, genetic resistance, and careful farming methods, occurrences can significantly reduce crop yields. Scholefield Robinson and Econsearch (2010) estimated that Powdery mildew has a mean annual national economic impact of $76 million from the costs of preventative spray programs and yield losses from infestations.

Powdery Mildew causes serious quality issues in wines, notably bad flavours and aromas. The wine industry therefore has a very low tolerance of powdery mildew on grapes with downgrading at 3-6% or rejection when the disease is more severe.

Grapes are therefore inspected in the field, and sometimes also at the winery, for presence and extent of Powdery Mildew. Uncertainty about assessments, and even which estimate is used (incidence or severity), can lead to confusion and disputes about quality and pricing, so objective, quantitative measures are required. While the goal is eventually to develop objective molecular and spectroscopic measures for Powdery Mildew, inspections are currently and for the foreseeable future undertaken visually.

2. Summary of Projects

A single Project was supported as described in Table 2.1.

Table 2.1 Project Description

Project No. UA 1202 Objective Measures for Powdery Mildew	
Project Details	Research Organisation: University of Adelaide Period: 1 December 2012 to 30 November 2015 Principal Investigator: Eileen Scott

Rationale	Powdery mildew occurs in all viticultural regions of Australia and causes significant yield (quantity) and quality (price) loss when conditions are conducive. Powdery mildew has a mean national economic impact of $76 million (Scholefield and Morison, 2010, GWR08-04), and was particularly problematic in the wet 2010-11 season. It causes off-flavours and aromas in wines. The project team detected an oily/viscous mouth-feel in wine when powdery mildew severity on Chardonnay was >1-5% (CRCV-1.5.2) Wineries set tolerance thresholds for powdery mildew because contamination can compromise wine quality. Current methods for disease assessment are largely subjective. This can lead to tension between growers and winemakers and uncertainty about quality and best use of parcels of grapes after receival. Assessment of powdery mildew in-field and at the weighbridge is often difficult, particularly for red varieties. Specifications in contracts sometimes use the terms incidence and severity interchangeably or not at all. Universal standards for in-field sampling and disease assessment are lacking. Some wineries use pictorial disease assessment keys e.g. based on Emmett and colleagues, but interpretations is not standard. NIR was validated by comparison with pictorial keys and DNA-slot-blot assay in GWRDC-UA05/08, and offered potential to deliver a rapid, objective measurement of powdery mildew at the weighbridge. The DNA assay was robust but technically demanding, whereas visual disease assessment by industry personnel varied amongst assessors. A qualitative-PCR assay was developed via the Australian Genome Research Facility for calibration of NIR, but degradation of fungal DNA during processing made adaptation for use in an industry setting difficult. Other means of calibration need to be investigated. MIR offers better resolution and reliability than NIR and may allow identification of fungal chemical components. This project builds on previous research to standardise in-field assessment develop a robust spectroscopic assay, with a practical calibration method, as an objective measure for disease severity on bunches.
Objectives	The primary aim of the research was to develop objective methods for measuring powdery mildew severity on grapes close to harvest. Recognising that visual assessment is the current practice in the wine sector and widespread adoption of any objective measures would be some time off, a secondary aim was to improve methods for visual assessment of powdery mildew in the interim. During the course of the project, the secondary aim was expanded from the initial concept of improving diagrammatic keys and developing a user-friendly iPhone application (app) to include modification of the app for use with iPads and android hand-held devices, and to develop a suite of online resources to support the app.
Activities and Outputs	Pictorial keys for disease assessment • review literature on sampling strategies for in-field disease assessment • compile pictorial keys for quantifying powdery mildew severity, and literature on training practitioners • in workshops with IRG early-and post-vintage in years 1 and 2 (i) evaluate pictorial keys using freshly-harvested white and red grapes with a range of disease severity, and photographs, (ii) review sampling strategies and training options and develop and adoption strategy in consultations with IRG and GWRDC Program Managers • use assessment keys in participatory vineyard trials Develop NIR/MIR for objective quantification • collect grapes of two white and red varieties with powdery mildew and other diseases where possible. Sort into disease categories using pictorial keys, assess Baume and pH • Develop reference method to calibrate NIR/MIR: prepare standards comprising healthy grapes and batches spiked with 1% increments of powdery mildew affected grapes; quantify fungal components (e.g. chitin, ergosterol) and conduct qPCR on standards based on methods developed by AGRF • involve SRDI diagnostic services if none of the above measures is suitable as a reference method • subject subsamples to MIR and NIR, compare spectra with results from visual assessment, spiked standards and references methods to evaluate specificity to, and quantification of, powdery mildew

	• examine relationships between variety, Baume, pH, reference method and NIR/MIR spectra • validate NIR/MIR based assessment and sampling strategy
Outcomes	• Pictorial key for infield assessment of severity of powdery mildew and training resources for deployment of the key and interpretation of assessment data • iPhone application for powdery mildew severity assessment • suite of online resources to support the app. • Consideration of future NIR and MIR methods for objective measurement of severity of powdery mildew in-field and at weighbridge
Impacts	• Reduced cost of assessments • Reduced disputes between growers and wineries (time and stress and expert determination and litigation costs) • Reduced incidence of inappropriate downgrading of grapes and use of contaminated grapes in winemaking • Research to contribute to the future development of objective measures to assess powdery mildew

3. Match with National Priorities

The Australian Government's strategic science and research priorities and rural R&D priorities are reproduced in Table 3.1.

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, resources** – structure, processes governing formation/distribution. 6. **Advanced manufacturing** – high value and innovative industries in Australia. 7. **Environmental change** – mitigating, managing or adapting to changes. 8. **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 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

4.2.1 R&D Investment

The R&D investment costs comprised:

- Direct financial outlays for the R&D Project by AGWA;
- In-kind contributions to the research Project by collaborators i.e. University of Adelaide, AWRI and University of Tasmania.
- In-kind contributions to the research Project, in particular time, associated with meeting of the Project Reference Group and the AGWA program manager.

4.2.2 Extension

The main product of the Project is a free App that can be downloaded from the Web. Extension costs are there negligible.

4.2.3 Administration

No additional administration costs were identified.

4.2.4 Adoption

Adoption costs by industry relate to downloading the fee App and becoming familiar with the App's operations. The App includes training components. An image bank containing a mix of photos and computer generated images helps users familiarise themselves with various disease patterns and severities, while a self testing tool marks their assessment of a range of provided scenarios and indicates whether their tendency is to over- or under-estimate infection severity.

4.2 Benefits

4.2.1 Research output and impact pathway

The key output of the Project is an App that can be used to assess the incidence of Powdery Mildew on grapes. The primary potential benefit of the research output is reduced costs associated with undertaking Powdery Mildew assessments. The impact pathway is:

1. Initial research
2. Development of a new Powdery Mildew diagrammatic key, a smartphone application (app) and a supporting online resource to provide training in field assessment of powdery mildew
3. Download of App by industry participants
4. Familiarisation with App by industry participants
5. Use of App for visual assessments of Powdery Mildew

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			
1. Reduced costs of visual assessments 2. Reduced disputes between growers and wineries 3. Reduced incidence of inappropriate downgrading of grapes and use of contaminated grapes in winemaking 4. Research outputs to assist in future development of objective assessment methods 5. Benefits from application to the incidence and severity of other issues including bunch rot, sooty moulds, downy mildew and sunburn	Ni	Nil	An App that can also be used by foreign grape and wine industry.
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 and wine making sectors. These private benefits will focus on time cost savings, reduction in disputes and reduced incidence of inappropriate downgrading of grapes and use of contaminated grapes in winemaking.

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 mainly between wine grape growers and wine makers.

4.2.5 Benefits to other Primary Industries

No benefits to other primary industries are identified.

4.2.6 Benefits Overseas

The App has been downloaded by those in the overseas grape and wine industry and has application for those areas that experience Powdery Mildew.

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
Investment by AGWA	Reduced cost of visual assessments
In-kind investment by University of Adelaide, AWRI and University of Tasmania	Reduced disputes between growers and wineries
Time allocated by Project Reference Group, industry participants and AGWA program manager	Reduced incidence of inappropriate downgrading of grapes and use of contaminated grapes in winemaking
Download of App and familiarisation time	Research outputs to assist in future development of objective assessment methods
	Benefits from application to the incidence and severity of other issues including bunch rot, sooty moulds, downy mildew and sunburn

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 AGWA (Table 5.1) and for researchers and other investors (Table 5.2). Table 5.3 provides the total investment by year for both sources.

AGWA overhead costs are in addition to those shown in Table 5.1 and are estimated at 12%. Time and travel costs for the Project reference group are included in Table 5.2 estimates.

Table 5.1 Investment by AGWA in the Project for Years Ending June 2013 to June 2016

Project Code	2012/13	2013/14	2014/15	2015/16	Total
UA1202	$103,588	$185,724	$162,581	$67,255	**$519,148**
Total	**$103,588**	**$185,724**	**$162,581**	**$67,255**	**$519,148**

Source: AGWA Final Project Application

Table 5.2 Investment by Researchers/Others in the Project for Years Ending June 2013 to June 2016

Project Code	2012/13	2013/14	2014/15	2015/16	Total
UA1202	$163,607	$318,435	$329,734	$157,428	**$969,205**
Total	**$163,607**	**$318,435**	**$329,734**	**$157,428**	**$969,205**

Source: AGWA Final Project Application

Table 5.3 Annual Investment in the Project (nominal $)

Year	AGWA	Researchers/Others	Total
2012/13	$116,019	$163,607	**$279,626**
2013/14	$208,011	$318,435	**$526,446**
2014/15	$182,091	$329,734	**$511,825**
2015/16	$75,326	$157,428	**$232,754**
Total	**$581,446**	**$969,205**	**$1,550,651**

5.1.2 Extension Costs

Extension costs are considered negligible.

5.1.3 Adoption costs

Adoptions costs are considered negligible.

5.1.4 Additional Costs

No additional costs were identified.

5.2 Benefits

5.2.1 Reduced Costs of Visual Assessments

The Counterfactual

Formal assessments of incidence and severity are mainly undertaken by wineries prior to harvest of grapes. Following walk through inspections of individual patches, assessments of incidence and severity are undertaken where the presence of Powdery Mildew is at a level that is of concern to the winery. In bad Powdery Mildew years it is estimated that there are in the order of 3,800 incidence and severity assessments undertaken by wineries (scaled up from data from Accolade) and 1,260 undertaken by growers (scaled up from data from CWW). These years are assumed to occur every three years following Scholefield Robinson Horticultural Services Pty Ltd and EconSearch Pty Ltd (2010). In areas of concern a 200 bunch sample i.e. 50 times along 4 rows, would be assessed. This may take in the order of 45 minutes.

Reduced Cost of Visual Assessments

The Powdery Mildew App has the potential to reduce the cost of incidence and severity assessments by in the order of 20% (Andrew Weeks, pers. comms). However, while the App has been downloaded over 1,500 times, data on the extent of its use is limited. A number of large corporate wineries already have their own systems in place for assessing Powdery Mildew (Mary Retallick pers comms) and are assumed not to use the App. In addition, some assessors of Powdery Mildew, have identified limitations[2] with the App that mean that they have a preference for alternative methods (Mary Retallick pers comms). Non-corporate wineries e.g. in the Hunter Valley, may not have PM specifications in contracts and hence don't undertake formal assessments of incidence and severity (Liz Riley pers comms). Conservatively, it is assumed that the App has been adopted by 20% of the industry by volume[3] and that this will grow by 5% pa over the next 10 years, after which some objective means of assessment will have been developed.

5.2.2 Reduced Disputes

The Counterfactual

Assessments by wineries that result in downgrading of grapes can lead to disputes between grape growers and wineries. These can then require an independent assessment that may cost around $200 per hour plus travel costs i.e. around $250 in total. It is assumed that there are around 200 disputes per year in a bad Powdery Mildew year and these occur every three years.

Reduced Cost of Disputes

It is assumed that App avoids disputes in proportion to its adoption by the industry and that for the remainder there is a time saving in undertaking the assessments in proportion to its adoption in the industry.

[2] E.g. limitations with the reporting function and a focus on bunches when sometimes other assessments are required.
[3] Accolade which represents around 16% of wine production in Australia is known to use the App.

5.2.3 Reduced incidence of inappropriate downgrading of grapes and use of contaminated grapes in winemaking

The Counterfactual

Visual subjective measurement of Powdery Mildew can lead to some level of inappropriate downgrading of grapes and some level of wineries using grapes with Powdery Mildew levels that impact wine quality. Inappropriate downgrading of grapes results in vineyards not being paid the correct economic value for the grapes. The lower value reflects the winery's perceived marginal value product of the grapes in winemaking. That is, wineries use the grapes in production of a lower value product and hence are only willing to pay a lower amount for them. For the purpose of this analysis, where inappropriate downgrading occurs it is conservatively assumed to result in a 20% reduction in grape value.

Inadvertent use of impacted grapes in winemaking has two potential impacts:

- overpayment by winemakers for grapes - a benefit to grape growers. Where this occurs it is assumed that grape growers receive the average market price rather than a 20% reduction in grape value that would have reflected its true marginal value product; and
- reduction in value of wine produced (assumed to be 20%).

On the assumptions made in this analysis, there is a net cost to society of inadvertent use of impacted grapes in winemaking.

Reduced Cost of Inappropriate Grading

Use of the App can improve the accuracy of Powdery Mildew assessments (Alex Sass, pers. comms). It is assumed that for 10% of visual assessments undertaken using the App (instead of alternative paper based approaches) there is an improvement in accuracy that for 50% of these results in avoidance of inappropriate grape downgrading and for 50% results in avoidance of use of impacted grapes (above the threshold) in winemaking.

Table 5.4 Summary of Assumptions

Variable	Assumption	Source
Patches per year requiring walk through visual inspection	1 patch per 45,000L of wine production	Consultant calculation based on Warren Burchmore, pers comms
% of patches requiring incidence and severity assessment by Wineries in a bad Powdery Mildew year	13%	Based on data provided by Warren Burchmore, pers comms
% of patches assessed by Wineries that are also assessed by growers	33%	Based on data provided by Warren Burchmore, pers comms
Winery assessments in bad Powdery Mildew year	3,800	Scaled up from Accolade data
Grower assessments in bad Powdery Mildew year	1,264	Scaled up from CWW data
% of years with bad Powdery Mildew	33%	Scholefield Robinson and Morison, 2010
Standard time for incidence and severity assessment	45 mins	Mary Retallick, pers coms.
Time saving from using PM App	20%	Andrew Weeks, pers comms
App Adoption in industry by Volume	20%	Consultant estimate
Annual growth in App adoption in industry by volume	5%	Consultant estimate

Length of time that benefits are obtained i.e. before objective measure developed	10 years	Consultant estimate
Average number of disputes in a bad PM year requiring independent assessment	200	Consultant calculation based on advice from Mary Retallick, and Warren Burchmore
Cost of independent assessment	$250	Mary Retallick, pers comms, and Ian McCrae, pers comms
Avoided disputes as a result of the App	Proportional to industry adoption	Consultant estimate
Cost saving for remaining disputes	20% for remaining independent assessment in proportion to industry adoption	Consultant estimate
Impact of an inappropriate patch downgrade		
Grape value $/patch	$27,194	Derived from AgEconPlus and Gillespie Economics (2015) and imputed number of patches from Warren Burchmore, pers comms
Reduction in price	20%	Consultant estimate
Impact per patch	$5,438	Derived from above two figures
Impact of an inappropriate patch upgrade		
Wine price per litre	$4.86	AgEconPlus and Gillespie Economics (2015)
Value of wine per patch	$210,413	Derived from AgEconPlus and Gillespie Economics (2015) and imputed number of patches from Warren Burchmore, pers comms
Decrease in price of wine if inappropriately upgraded	20%	Consultant estimate
Cost to winery if upgraded inappropriately	$42,083	Derived from above two figures
Net effect (net of benefit to grape grower)	$36,644	Calculated from cost to winery if upgraded inappropriately less benefit to grape growers if upgraded inappropriately
Application of Avoided Downgrading and Upgrading Benefits		
Frequency (%) of App use that accuracy improves and has an impact	10%	Consultant estimate
% where accuracy improves and has an impact and grapes would have been downgraded wrongly	50%	Consultant estimate
% where accuracy improves and has an impact and grapes would have been upgraded wrongly	50%	Consultant estimate
Attribution of benefits to this project	100%	The project was not linked to other AGWA or non-AGWA investments

5.2.2 Other Potential Benefits

Benefits not valued included:

- benefits of the research in contributing to future development of an objective measure for Powdery Mildew
- time savings and other benefits from use of the App to score the incidence and severity of other issues including bunch rot, sooty moulds, downy mildew and sunburn.

Consideration was given to any potential benefits in informing better disease management and hence resulting in reduced spray costs and/or increased yields. However, any link was considered tenuous.

6. Results

All past costs and benefits were expressed in 2016/17 dollar terms using the GDP deflator. All costs and benefits from 2016/17 onwards were discounted to 2016/17 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 (2015/16) to the final year of benefits assumed.

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

Table 6.1 Investment Criteria for Total Investment by AGWA, Project Partners and the Wine Industry (discount rate 5%)

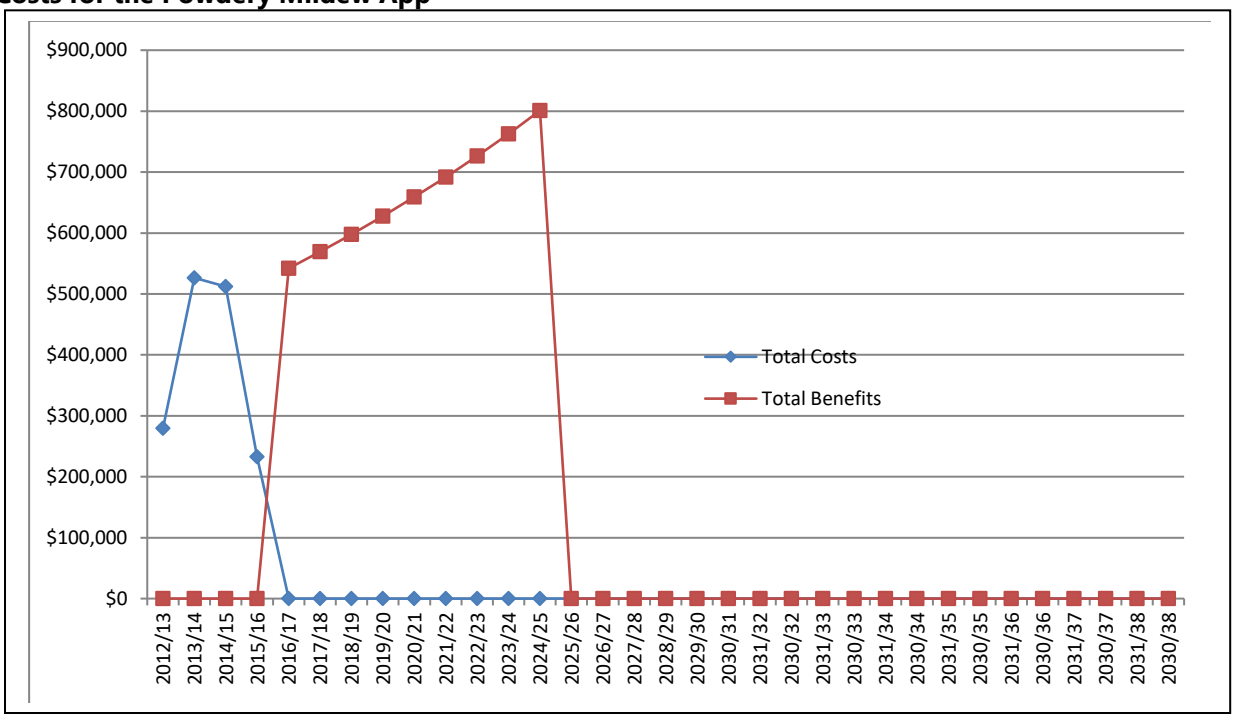
Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits ($m)	$0.0	$2.6	$4.6	$4.6	$4.6	$4.6	$4.6
Present value of costs ($m)	$1.6	$1.6	$1.6	$1.6	$1.6	$1.6	$1.6
Net present value ($m)	-$1.3	$1.0	$3.1	$3.1	$3.1	$3.1	$3.1
Benefit–cost ratio	0.00	1.63	2.93	2.93	2.93	2.93	2.93
Internal rate of return (%)	Negative	44%	57%	57%	57%	57%	57%
Modified internal rate of return (%)	Negative	26%	23%	16%	13%	11%	10%

Table 6.2 Investment Criteria for AGWA and the Wine Industry (discount rate 5%)

Years	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits ($m)	$0.0	$1.0	$1.7	$1.7	$1.7	$1.7	$1.7
Present value of costs ($m)	$0.5	$0.6	$0.6	$0.6	$0.6	$0.6	$0.6
Net present value ($m)	-$0.5	$0.4	$1.1	$1.1	$1.1	$1.1	$1.1
Benefit–cost ratio	0.00	1.63	2.93	2.93	2.93	2.93	2.93
Internal rate of return (%)	Negative	44%	57%	57%	57%	57%	57%
Modified internal rate of return (%)	Negative	26%	23%	16%	13%	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 Powdery Mildew App



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 negative 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)	$6.0	$4.6	$3.7
Present value of costs ($m)	$1.6	$1.6	$1.6
Net present value ($m)	$4.4	$3.1	$2.1
Benefit-cost ratio	3.77	2.93	2.34

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 visual assessments by wineries (who adopt the App), where an improvement in accuracy might avoided inappropriate downgrading or upgrading of grapes (assumed at 10%); and
- the percentage of these where grapes are inappropriately downgraded (assumed at 50%) as opposed to inappropriately upgraded (assumed at 50%).

The results for changes in these assumptions are provided in Table 7.2. This indicates that under all scenarios the economic indicators remain positive.

Table 7.2 Sensitivity to Change in Visual Assessment Accuracy and Impact

Investment Criteria	Discount rate		
	0%	5% (base)	10%
15% Where Accuracy is Improved and Impacts Outcome			
Present value of benefits ($m)	$8.9	$6.9	$5.5
Present value of costs ($m)	$1.6	$1.6	$1.6
Net present value ($m)	$7.4	$5.4	$4.0
Benefit-cost ratio	5.63	4.38	3.50
5% Where Accuracy is Improved and Impacts Outcome			
Present value of benefits ($m)	$3.0	$2.3	$1.9
Present value of costs ($m)	$1.6	$1.6	$1.6
Net present value ($m)	$1.4	$0.8	$0.3
Benefit-cost ratio	1.90	1.48	1.18
10% Where Accuracy Improved 70% Avoided Downgrading			
Present value of benefits ($m)	$4.2	$3.3	$2.6
Present value of costs ($m)	$1.6	$1.6	$1.6
Net present value ($m)	$2.6	$1.7	$1.0
Benefit-cost ratio	2.66	2.07	1.65
10% Where Accuracy Improved 70% Avoided Upgrading			
Present value of benefits ($m)	$7.7	$6.0	$4.8
Present value of costs ($m)	$1.6	$1.6	$1.6
Net present value ($m)	$6.1	$4.4	$3.2
Benefit-cost ratio	4.88	3.79	3.02

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	Low

9. Summary of Results

Funding for the Powdery Mildew Project, including expected future costs, are valued at $1.6M (present value terms) and are expected to produce aggregate total benefits of approximately $4.6M (present value terms). This gives an estimated net present value of $3.1M, a benefit-cost ratio of approximately 2.93 and a modified internal rate of return of 10%.

The estimated net benefits to AGWA and the Wine Industry are estimated at $1.1M with a benefit-cost ratio of approximately 2.93 and a modified internal rate of return of 10%.

All investment indicators remain positive for different discount rate assumptions and different assumptions around the changes in visual assessment accuracy and impact.

10. References

AgEconPlus and Gillespie Economics (2015) *Economic Contribution of the Australian Wine Sector,* prepared for Wine Australia.

Scholefield Robinson and EconSearch Pty Ltd (2010) *Assessment of Economic Cost of Endemic Pests and Diseases on the Australian Grape and Wine Industry*, GRWC Project GWR 08/04

Abbreviations

ABS	Australian Bureau of Statistics
AGWA	Australian Grape and Wine Authority
AWRI	Australian Wine Research Institute
EOPFS	End of Project Financial Statement
GDP	Gross Domestic Product
MIRR	Modified Internal Rate of Return
NIR	Near Infrared
MIR	Mid-Infrared