

Cost Benefit Analysis of a GWRDC Project Cluster: Vine Physiology - Flowering

A report prepared for

Grape and Wine Research and Development Corporation

Prepared by



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Contents

List of Tables	v
List of Figures	vi
Abbreviations	vi
Document History and Status	vii
1. Introduction.....	1
2. Method of Analysis	2
3. Results of the Cost Benefit Analysis for the ‘Vine Physiology - Flowering’ Project Cluster	4
4. Cost Benefit Analysis of Project Number SAR 02/05	7
4.1 Description of the Project and Research.....	7
4.2 The Scope of Costs and Benefits.....	7
4.3 Data and Assumptions Used for Quantifying Costs and Benefits	8
4.3.1 Costs of the project	8
4.3.2 Benefits of the project	9
4.3.3 Adoption rate of the research findings	11
4.3.4 The base case.....	11
4.3.5 Attribution of the net benefits of the research findings to GWRDC	12
4.4 Results of the Analysis.....	13
4.4.1 Key Indicators	13
4.4.2 Sensitivity Analysis.....	15
5. Cost Benefit Analysis of Project Numbers SAR 02/09a and 02/09b	17
5.1 Description of the Project and Research.....	17
5.2 The Scope of Costs and Benefits.....	17
5.3 Data and Assumptions Used for Quantifying Costs and Benefits	18
5.3.1 Costs of the project	19
5.3.2 Benefits of the project	20
5.3.3 Adoption rate of the research findings	21
5.3.4 The base case.....	23
5.3.5 Attribution of the net benefits of the research findings to GWRDC	23
5.4 Results of the Analysis.....	24
5.4.1 Key Indicators	24
5.4.2 Sensitivity Analysis.....	25
6. Cost Benefit Analysis of Project Number SAR 03/03	29
6.1 Description of the Project and Research.....	29
6.2 The Scope of Costs and Benefits.....	29
6.3 Data and Assumptions Used for Quantifying Costs and Benefits	30
6.3.1 Costs of the project	30
6.3.2 Benefits of the project	31
6.3.3 Adoption rate of the research findings	31
6.3.4 The base case.....	32
6.3.5 Attribution of the net benefits of the research findings to GWRDC	33

6.4	Results of the Analysis.....	33
6.4.1	Key Indicators	33
6.4.2	Sensitivity Analysis.....	35
7.	Conclusions.....	37
	References	38

List of Tables

Table 3.1	Returns to aggregate investment in the ‘vine physiology – flowering’ project cluster.....	4
Table 3.2	Returns to GWRDC investment in the ‘vine physiology – flowering’ project cluster ^a	4
Table 3.3	Attribution of net present values to Rural Research Priorities (‘vine physiology – flowering’ project cluster).....	6
Table 3.4	Sensitivity of net present values to adoption rates (‘vine physiology – flowering’ project cluster).....	6
Table 4.1	The costs of project number SAR 02/05.....	7
Table 4.2	The benefits of project number SAR 02/05.....	8
Table 4.3	Research and development costs for project number SAR 02/05 ^a	9
Table 4.4	Returns to aggregate investment in project number SAR 02/05.....	13
Table 4.5	Returns to GWRDC investment in project number SAR 02/05 ^a	14
Table 4.6	Attribution of net present values to Rural Research Priorities (SAR 02/05).....	14
Table 4.7	Sensitivity of net present values to adoption rates (SAR 02/05).....	16
Table 4.8	Sensitivity of net present values to a range of other uncertain variables (SAR 02/05) ^a	16
Table 5.1	The costs of project numbers SAR 02/09a and 02/09b.....	17
Table 5.2	The benefits of project numbers SAR 02/09a and 02/09b.....	18
Table 5.3	Research and development costs for project numbers SAR 02/09a and 02/09b ^a	19
Table 5.4	Returns to aggregate investment in project numbers SAR 02/09a and 02/09b.....	24
Table 5.5	Returns to GWRDC investment in project numbers SAR 02/09a and 02/09b ^a	24
Table 5.6	Attribution of net present values to Rural Research Priorities (SAR 02/09a and 02/09b).....	25
Table 5.7	Sensitivity of net present values to adoption rates (SAR 02/09a and 02/09b).....	26
Table 5.8	Sensitivity of net present values to a range of other uncertain variables (SAR 02/09a and 02/09b) ^a	28
Table 6.1	The costs of project number SAR 03/03.....	29
Table 6.2	The benefits of project number SAR 03/03.....	30
Table 6.3	Research and development costs for project number SAR 03/03 ^a	30
Table 6.4	Returns to aggregate investment in project number SAR 03/03.....	34
Table 6.5	Returns to GWRDC investment in project number SAR 03/03 ^a	34
Table 6.6	Attribution of net present values to Rural Research Priorities (SAR 03/03).....	35
Table 6.7	Sensitivity of net present values to adoption rates (SAR 03/03).....	36
Table 6.8	Sensitivity of net present values to a range of other uncertain variables (SAR 03/03) ^a	36

List of Figures

Figure 3.1	Net benefits of the research findings ('vine physiology – flowering' project cluster) ^a	5
Figure 4.1	Assumed adoption profile for the research findings (SAR 02/05)	12
Figure 4.2	Net benefits of the research findings (SAR 02/05) ^a	13
Figure 5.1	Assumed adoption profile for the research findings in the Merlot variety (SAR 02/09a and 02/09b)	22
Figure 5.2	Assumed adoption profile for the research findings in other susceptible varieties (SAR 02/09a and 02/09b)	22
Figure 5.3	Net benefits of the research findings (SAR 02/09a and 02/09b) ^a	23
Figure 6.1	Assumed adoption profile for the research findings (SAR 03/03)	32
Figure 6.2	Net benefits of the research findings (SAR 03/03) ^a	33

Abbreviations

ABS	Australian Bureau of Statistics
BCR	benefit cost ratio
CBA	cost benefit analysis
CRRDCC	Council of Rural Research and Development Corporation Chairs
GWRDC	Grape and Wine Research and Development Corporation
IRR	internal rate of return
NPV	net present value
PGIBSA	Phylloxera and Grape Industry Board of South Australia

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1. Introduction

Forty active project clusters, classified according to the subject matter of the research output, were identified by the Grape and Wine Research and Development Corporation (GWRDC) in their portfolio of research investments over the period 2002/03 to 2006/07. These clusters ranged in size from 1 to 13 component projects. EconSearch Pty Ltd was contracted by GWRDC to undertake cost-benefit analysis (CBA) of 3 randomly selected clusters, namely:

- vine physiology – flowering (4 component projects);
- vine physiology – water (7 projects); and
- control of measurable grape characteristics (8 projects).

This work follows on from a recently completed CBA undertaken by the consultants, the objective of which was to assess the net economic benefits generated by a 'hero project' funded by GWRDC (EconSearch 2007). The results of the analysis of the 'hero project' and the randomly selected project clusters will be used by the Council of Rural Research and Development Corporation Chairs (CRRDCC) in their broader evaluation of the impact of research and development funded by Rural Research and Development Corporations in Australia.

The results of the CBA for each project cluster have been reported separately and those for the 'vine physiology - flowering' cluster are presented in this report. This cluster was comprised of 4 GWRDC funded projects, namely:

- SAR 02/05 - *Improving vineyard productivity through assessment of bud fruitfulness and bud necrosis;*
- SAR 02/09a - *The use of molybdenum foliar sprays to improve fruit set and bunch yield of Merlot vines in the Adelaide Hills in 2002/2003;*
- SAR 02/09b - *Molybdenum foliar sprays and other nutrient strategies to improve fruit set and reduce berry asynchrony ('hen and chickens') in Australia;* and
- SAR 03/03 - *Strategic management of flowering sprays.*

As well as reporting the results of the CBA for the 'vine physiology - flowering' cluster in aggregate, a separate CBA has been prepared and reported for each component project within the cluster¹. This approach will assist GWRDC with developing a database of individual project evaluations and ACIL Tasman in fulfilling their reporting requirements to the CRRDCC.

An outline of the key characteristics of the CBA method employed in this study is provided in Section 2 of the report. The results of the CBA for the project cluster in aggregate are presented in Section 3. In Sections 4 to 6 the scope of costs and benefits, data sources/assumptions and results of the CBA, including key indicators and sensitivity analysis, are detailed for each project within the cluster.

¹ Note that project numbers SAR 02/09a and 02/09b have been treated as a single, contiguous project.

2. Method of Analysis

The CBA conducted for this project was undertaken according to the principles and method outlined in:

- the Council for Rural Research and Development Corporation Chairs *Guidelines for Evaluation* (ACIL Tasman 2007);
- the Commonwealth Government's *Introduction to Cost-Benefit Analysis and Alternative Evaluation Methodologies* (Department of Finance and Administration 2006a);
- the Commonwealth Government's *Handbook of Cost-Benefit Analysis* (Department of Finance and Administration 2006b); and
- Land and Water Australia's *Methodology for Evaluating Return on Investment from Natural Resource Management Research and Development* (Chudleigh et al. 2007).

The key characteristics of the CBA method employed in this study include the following.

- The CBA includes a base case or counterfactual scenario, that is, the benchmark against which the 'with GWRDC investment' scenario was compared. The base case was defined as what would have occurred without GWRDC investment in the technology or research.
- The CBA was conducted over a 30 year time period and results were expressed in terms of net benefits, that is, the incremental benefits and costs of the 'with GWRDC investment' scenarios relative to those generated by the base case scenario².
- Costs and benefits were specified in real terms (i.e. constant 2007 dollars). Past and future values were converted to present values by applying a discount rate of 5 per cent.
- In order to account for uncertainty, sensitivity analysis was undertaken using a range of values for key variables, including adoption profiles.
- The evaluation criteria employed in the analysis include net present value (NPV)³, benefit-cost ratio (BCR)⁴ and internal rate of return (IRR)⁵.
- Reporting requirements for the analysis were based on a Microsoft Excel® spreadsheet template developed by ACIL Tasman for the broader Rural Research and Development Corporation evaluation project (Mark Barber, pers. comm.). These requirements include:
 - reporting NPV for 5, 10, 20 and 30 year time horizons;
 - reporting on the returns to total (public and private) investment and returns to GWRDC investment in the technology or research; and

² Where incremental benefits = ('with GWRDC' benefits – 'without GWRDC' benefits) and incremental costs = ('with GWRDC' costs – 'without GWRDC' costs).

³ NPV was defined as discounted net benefits, where net benefits = (incremental benefits – incremental costs).

⁴ The BCR was defined as (discounted net benefits subsequent to the GWRDC investment phase) / (discounted net benefits during the GWRDC investment phase). This was consistent with the spreadsheet template developed by ACIL Tasman.

⁵ The discount rate at which the NPV of an investment scenario is equal to zero.

- allocation of NPVs to the Rural Research Priorities.
- For each CBA, costs and benefits for both the 'with' and 'without' GWRDC investment scenarios have been listed in tabular form and include those that can be readily identified and valued in monetary terms as well as those which cannot be easily valued in monetary terms because of the absence of market signals. The tables provide an indication of the likely distribution of the costs and benefits between stakeholder groups and the source of the information.

3. Results of the Cost Benefit Analysis for the 'Vine Physiology - Flowering' Project Cluster

In order to assist ACIL Tasman in fulfilling their reporting requirements to the CRRDCC, the results of the CBA for the 'vine physiology – flowering' project cluster are summarised below. The scope of costs and benefits, data sources/assumptions and results of the CBA for each project within the cluster, including key indicators and sensitivity analysis, are detailed in Sections 4 to 6.

The results of the CBA for the 'vine physiology – flowering' project cluster, in terms of returns to aggregate investment and GWRDC investment in the projects, are provided in Tables 3.1 and 3.2, respectively.

Table 3.1 Returns to aggregate investment in the 'vine physiology – flowering' project cluster

	Year 0	Year 5	Year 10	Year 15	Year 20	Year 30
NPV (\$m) ^a	6.6	77.6	155.7	175.5	176.5	176.5
IRR	-	-	-	-	-	150%
BCR	-	-	-	-	-	26

^a In 2007 dollars.

Source: EconSearch analysis.

Table 3.2 Returns to GWRDC investment in the 'vine physiology – flowering' project cluster^a

	Year 0	Year 5	Year 10	Year 15	Year 20	Year 30
NPV (\$m) ^b	1.9	11.2	15.3	15.9	16.0	16.0

^a Note that the IRR and BCR evaluation criteria for returns to GWRDC investment in the project are not reported as they are not directly comparable with those for aggregate investment in the project (Table 3.1).

^b In 2007 dollars.

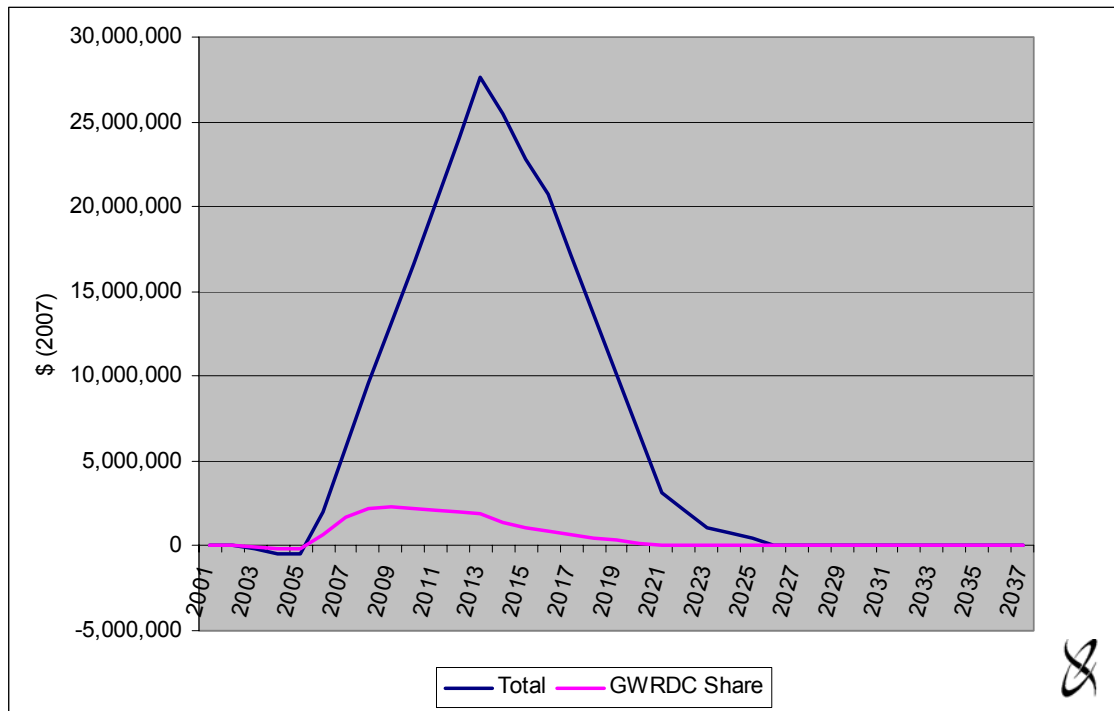
Source: EconSearch analysis.

Relative to the base case, it is apparent that the project would generate significant net benefits to the Australian community (i.e. NPV of \$177m over 30 years, IRR of 150 per cent and BCR of 26 in Table 3.1). Assuming that annual net benefits of the research findings are attributable to the GWRDC on the basis of its cumulative investment in the research relative to cumulative costs incurred by all parties, returns to GWRDC investment in the research findings would also be strongly positive (i.e. NPV of \$16m over 30 years in Table 3.2⁶). The positive NPVs in Year 0 of the analysis (Tables 3.1 and 3.2) reflect the fact that there was some commercial adoption of the research findings prior to the completion of the projects.

⁶ Unlike returns to aggregate investment, note that the NPV for returns to GWRDC investment in the project cluster is not a simple aggregate of the NPVs for individual sub-projects.

Annual net benefits⁷ of the research findings were attributed to the GWRDC on the basis of its cumulative investment in the research findings relative to cumulative costs incurred by all parties⁸. This is illustrated in Figure 3.1. The annual net benefits of the research findings reach a maximum in the year 2013 and decline thereafter, reflecting the impact of the base case.

Figure 3.1 Net benefits of the research findings ('vine physiology – flowering' project cluster)^a



^a Estimates are in 2007 dollars.

Source: EconSearch analysis.

Based on the assumptions outlined in Sections 4.3, 5.3 and 6.3, it is apparent that all of the identified monetary benefits of the research findings are attributable to the levy paying industry. As discussed above, the monetary value of net benefits that could be attributed to other industries, the environment or social impacts (i.e. spillovers) have not been included in the CBA calculations.

Attribution of the results of the analysis to the Rural Research Priorities is outlined in Table 3.3, based on information provided by Geoff Crook (GWRDC, pers. comm.).

⁷ That is, incremental benefits less incremental costs.

⁸ Including GWRDC investment, investment by research collaborators, industry adoption costs and other costs.

Table 3.3 Attribution of net present values to Rural Research Priorities ('vine physiology – flowering' project cluster)

Rural Research Priority	NPV at Year 30 (\$m) ^a	
	Total	GWRDC share
Productivity and adding value	176.5	16.0
Supply chain and markets	0.0	0.0
Natural resource management	0.0	0.0
Climate variability and climate change	0.0	0.0
Biosecurity	0.0	0.0

^a In 2007 dollars.

Source: EconSearch analysis.

The results of the analysis were re-estimated using different adoption profiles for the research findings (i.e. low, expected and high, as detailed in Sections 4.3, 5.3 and 6.3). The results of this sensitivity analysis are provided in Table 3.4. NPVs have been calculated by holding all other variables constant at their expected levels.

Table 3.4 Sensitivity of net present values to adoption rates ('vine physiology – flowering' project cluster)

Adoption rate	NPV (\$m) ^a					
	Year 0	Year 5	Year 10	Year 15	Year 20	Year 30
Low	4.8	60.8	122.0	136.9	137.5	137.5
Expected	6.6	77.6	155.7	175.5	176.5	176.5
High	8.3	94.3	189.1	213.7	215.1	215.1

^a NPVs are in 2007 dollars and relate to total investment in the project.

Source: EconSearch analysis.

4. Cost Benefit Analysis of Project Number SAR 02/05

4.1 Description of the Project and Research

The CBA described in this section of the report relates to research findings that were developed as a consequence of investment by GWRDC and collaborators in the following project:

- SAR 02/05 - *Improving vineyard productivity through assessment of bud fruitfulness and bud necrosis.*

Research conducted as part of this project has revealed the high level of incidence of primary bud necrosis (PBN) in some winegrape varieties and regions in Australia and has increased the level of awareness of the problem. It has led to the development of recommendations to undertake bud dissection analysis and modify pruning levels in appropriate circumstances in order to compensate for expected bud loss or buds with low fruitfulness.

4.2 The Scope of Costs and Benefits

Tables 4.1 and 4.2 list, in qualitative terms, the costs and benefits associated with the 'with GWRDC investment' scenario and the base case ('without GWRDC investment') scenario.

Table 4.1 The costs of project number SAR 02/05

Scenario	Cost	Bearer of the Cost	Valued in Monetary Terms	Source of Information
Base case (without GWRDC investment) scenario	Identical to the 'with GWRDC investment' scenario but with a time lag of 10 years	See below	See below	See below
With GWRDC investment scenario	Project R&D costs	GWRDC and collaborators	Yes	GWRDC and collaborators
	Adoption costs (bud dissection analysis)	Winegrape growers	Yes	See text in section 4.3.1

Table 4.2 The benefits of project number SAR 02/05

Scenario	Benefit	Beneficiary	Valued in Monetary Terms	Source of Information
Base case (without GWRDC investment) scenario	Identical to the 'with GWRDC investment' scenario but with a time lag of 10 years	See below	See below	See below
With GWRDC investment scenario	Improved winegrape yield in varieties that are susceptible to PBN	Winegrape growers and winemakers	Yes	See text in section 4.3.2
	Other industry benefits (e.g. ensuring a more consistent supply of product)	Winegrape growers and winemakers	No	See text in section 4.3.2
	Spillover benefits (e.g. flow-on impacts from an improvement in the reliability of income levels at the vineyard level)	The broader community	No	See text in section 4.3.2

4.3 Data and Assumptions Used for Quantifying Costs and Benefits

This section of the report details the method, sources of information and assumptions used to estimate the costs and benefits listed in Tables 4.1 and 4.2. For those costs and benefits which were difficult to estimate in monetary terms, some qualitative description is provided. This information was based on consultation with⁹:

- Dr Belinda Rawnsley (SARDI);
- Dr Cassandra Collins (SARDI); and
- Russell Johnstone, Group Viticulturist, Orlando Wines¹⁰.

4.3.1 Costs of the project

Research and development costs

Estimates of annual investment in the project by GWRDC and research collaborators (cash and in-kind) were provided by Geoff Crook (GWRDC, pers. comm.) and Belinda Rawnsley (SARDI, pers. comm.) and are summarised in Table 4.3.

⁹ And reference to Rawnsley and Collins (2005).

¹⁰ In order to validate some of the assumptions and data that were provided by the principal researchers for each project, an independent industry contact with relevant technical knowledge and a broad understanding of the industry was consulted.

Table 4.3 Research and development costs for project number SAR 02/05 ^a

	Cash and in-kind investment (\$)		
	GWRDC	Collaborators	Total
2002/03	\$74,587	\$62,000	\$136,587
2003/04	\$88,761	\$69,500	\$158,261
2004/05	\$39,136	\$16,500	\$55,636
2005/06	\$0	\$32,000	\$32,000
2006/07	\$0	\$0	\$0
Total	\$202,484	\$180,000	\$382,484

^a In nominal dollars and ex GST. For the purpose of the CBA these values were expressed in 2006/07 dollars using the Consumer Price Index for Adelaide (ABS 2007a).

Source: Geoff Crook (GWRDC, pers. comm.) and Belinda Rawnsley (SARDI, pers. comm.).

Adoption costs

Bud dissection analysis is undertaken on a 'block' basis. The cost of undertaking bud dissection analysis on a per hectare basis (\$57/ha) was calculated by assuming an average block size of 9 ha, an average cost per sample of \$170 and by assuming that 3 samples are taken per block (Belinda Rawnsley, SARDI, pers. comm.). Given the high level of variability in the incidence of PBN between seasons it was assumed that bud dissection analysis is undertaken on an annual basis.

4.3.2 Benefits of the project

Improvement in winegrape yield in susceptible varieties

By informing growers of the incidence and consequences of PBN in Australia, the primary benefit attributable to the research is that it is possible to increase winegrape yields in highly susceptible varieties by undertaking bud dissection analysis and modifying pruning levels to compensate for expected bud loss or buds with low fruitfulness. The following assumptions have been made with respect to these yield-related benefits.

- Based on the survey undertaken by Rawnsley and Collins (2005), the incidence of PBN was shown to exhibit a high level of variability between viticultural regions, varieties, rootstocks and between seasons. Across the surveyed regions, Shiraz, Pinot Gris, Riesling, Petit Verdot, Gewürztraminer, Chardonnay, Sauvignon Blanc, Semillon, Merlot, Pinot Noir and Cabernet Sauvignon had greater than 20 per cent PBN in some vineyards in the survey year (2003).
- Industry evidence would suggest that the incidence of severe PBN (i.e. greater than 20 per cent of buds with PBN) is restricted to the cool-climate winegrape growing regions of Australia¹¹ (Russell Johnstone, pers. comm.). To account for the high level of variability that characterises the incidence of this problem it was assumed that, in any given year, 50 per cent of the area of susceptible varieties in cool-climate regions would exhibit severe PBN.

¹¹ See page 20 for a definition of cool-climate winegrape production regions.

- By undertaking bud dissection analysis and modifying pruning levels where severe PBN is identified it is expected that yields can be increased, on average, by 15-20 per cent¹² (Belinda Rawnsley, SARDI, pers. comm.).
- The total bearing area of PBN susceptible varieties in Australia at the 2007 vintage was approximately 132,000 ha (ABS 2008), approximately 40 per cent of which was in cool-climate regions¹³. This area was assumed to remain constant for the purpose of this analysis. The average yield of susceptible varieties prior to undertaking any remedial management for PBN was assumed to be 9.3 t/ha¹⁴ and the average price was assumed to be \$1,000/t.
- Associated with the expected increase in the supply of grapes for winemaking there would be a consequent impact on the farm-gate price of these grapes. This relationship can be measured using a price flexibility coefficient, that is, the percentage change in price given a one per cent change in the quantity supplied. This can, in turn, be approximated using the reciprocal of the price elasticity of demand¹⁵. Zhao et al. (2003) in their assessment of *The Gains from Australian Wine Promotion and R&D* used price elasticities of demand for wine of -5.0 for export markets and -0.8 for the domestic market. The demand for winegrapes is a derived demand (i.e. derived from the demand for the final product) and one would expect price elasticities of demand for winegrapes to be less than those for the final product, wine. In this analysis it was assumed that price elasticities of demand for winegrapes were 20 per cent less than those for wine. Based on the assumption that 64 per cent of grapes from PBN susceptible varieties are utilised in export wines¹⁶, an estimate of the price elasticity of demand for these grapes of -2.8 was used in this analysis. The reciprocal, the price flexibility coefficient, was -0.36¹⁷.
- Whilst the research conducted as part of project number SAR 02/05 revealed the high incidence of PBN in some varieties and regions, the management solution to the problem¹⁸ was developed principally through another GRWRDC funded project (i.e. CSP 00/2)¹⁹. Thus, only a proportion of the benefits described above can be attributed to project number SAR 02/05. In the absence of other information, a proxy for this attribution was GWRDC investment in project number SAR 02/05 as a proportion of GWRDC investment in projects SAR 02/05 and CSP 00/2, in aggregate (approximately 31 per cent).

¹² The expected value used in the analysis was the mid-point (i.e. 17.5 per cent).

¹³ Based on data for SA in PGIBSA (2007).

¹⁴ Susceptible varieties account for approximately 80 per cent of total vineyard area. The yield estimate is based on the average yield nationally for all varieties from the 2005, 2006 and 2007 vintages (ABS 2008). Yield in cool-climate regions was estimated to be 80 per cent below the average for all regions.

¹⁵ The percentage change in the quantity demanded resulting from a 1 per cent increase in price (Pindyck and Rubinfeld 1995).

¹⁶ Based on the proportion of production of all varieties that was exported in 2007 (ABS 2008).

¹⁷ That is, there would be a 0.36 per cent decrease in price given a one per cent increase in the quantity supplied.

¹⁸ That is, the guidelines for growers to determine yield targets by adjusting pruning levels in accordance with bud dissection analysis.

¹⁹ Clingeffer et al. 2005, *Crop Control for Consistent Supply of Quality Wine Grapes* (GWRDC Project Number CSP 00/2).

Other industry benefits

There are a range of other benefits that could accrue to the levy paying industry (i.e. winegrape growers) and other industries within the supply chain but are difficult to quantify in monetary terms. These are listed below, in no particular order of significance and were based on consultation with Rawnsley and Collins (SARDI, pers. comm.).

- By enhancing the ability of growers to meet yield targets, the research findings assist winemakers in ensuring a more consistent supply of product and represent another tool for growers and winemakers to influence the quality of winegrapes.

Spillover benefits

Adoption of the research findings is not expected to generate any net environmental benefits. In terms of social benefits, an improvement in the reliability of income levels at the vineyard level could result in positive employment and income impacts, particularly in regional economies to which the winegrape growing sector makes a significant contribution. The net environmental and social benefits that could be attributed to the research findings have not been quantified in monetary terms.

4.3.3 Adoption rate of the research findings

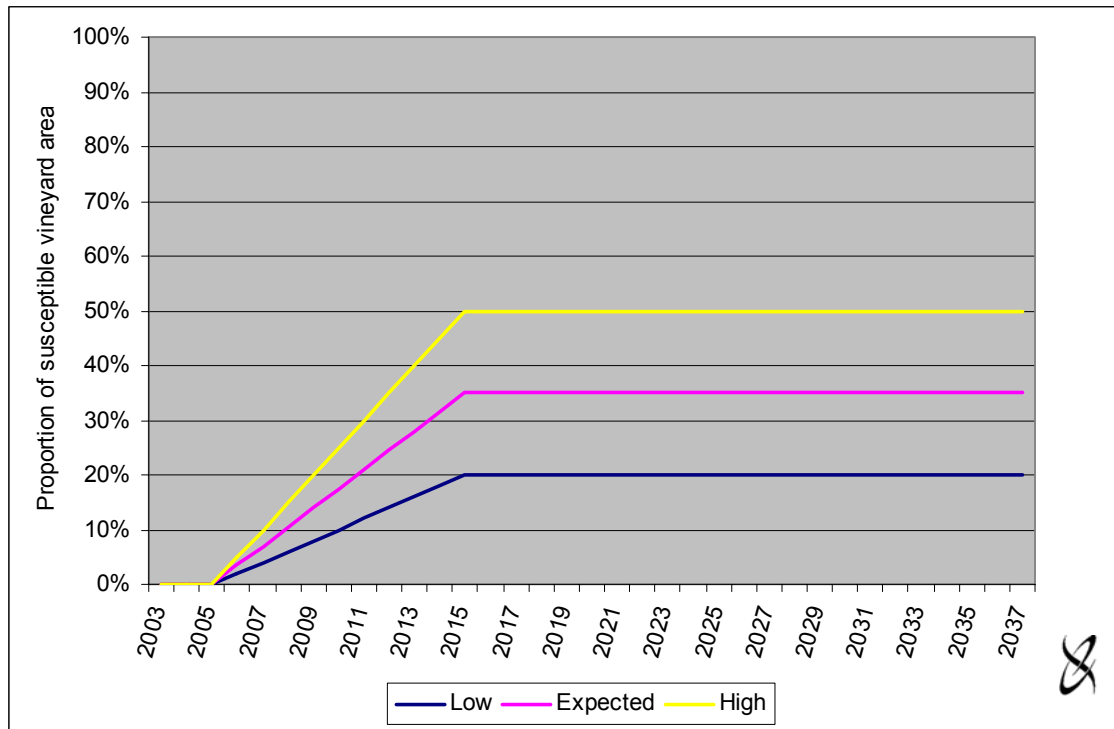
Over a period of 10 years, it is expected that the proportion of growers of susceptible varieties in cool-climate regions who will undertake bud dissection analysis and modify pruning levels in order to overcome the impact of severe PBN will grow to a maximum of approximately 35 per cent. There is a large proportion of growers who do not regard yields for susceptible varieties in cool-climate regions as being limited and are, therefore, unlikely to investigate the 'problem' or undertake remedial action (Russell Johnstone, pers. comm.). The maximum level of adoption is also based on the assumption that sufficient capacity for bud dissection analysis is developed, either in-house by winemaking firms or by relevant consulting firms. It is unlikely that this capacity currently exists.

The results of the analysis were subject to sensitivity analysis to reflect the uncertainty associated with the adoption profile, using high and low values for the maximum adoption rate of 50 per cent and 20 per cent, respectively. These adoption profiles are illustrated in Figure 4.1.

4.3.4 The base case

It is highly likely that the research described above, developed with the assistance of GWRDC investment, would eventually have been undertaken in the absence of this investment. The likely impact of the GWRDC investment has been to bring forward the development of these research findings by approximately 10 years. Thus, for the base case scenario, it was assumed that the costs of developing and adopting the research findings and the net benefits of their adoption are identical to the 'with GWRDC investment' scenario but with a lag of 10 years.

Figure 4.1 Assumed adoption profile for the research findings (SAR 02/05)



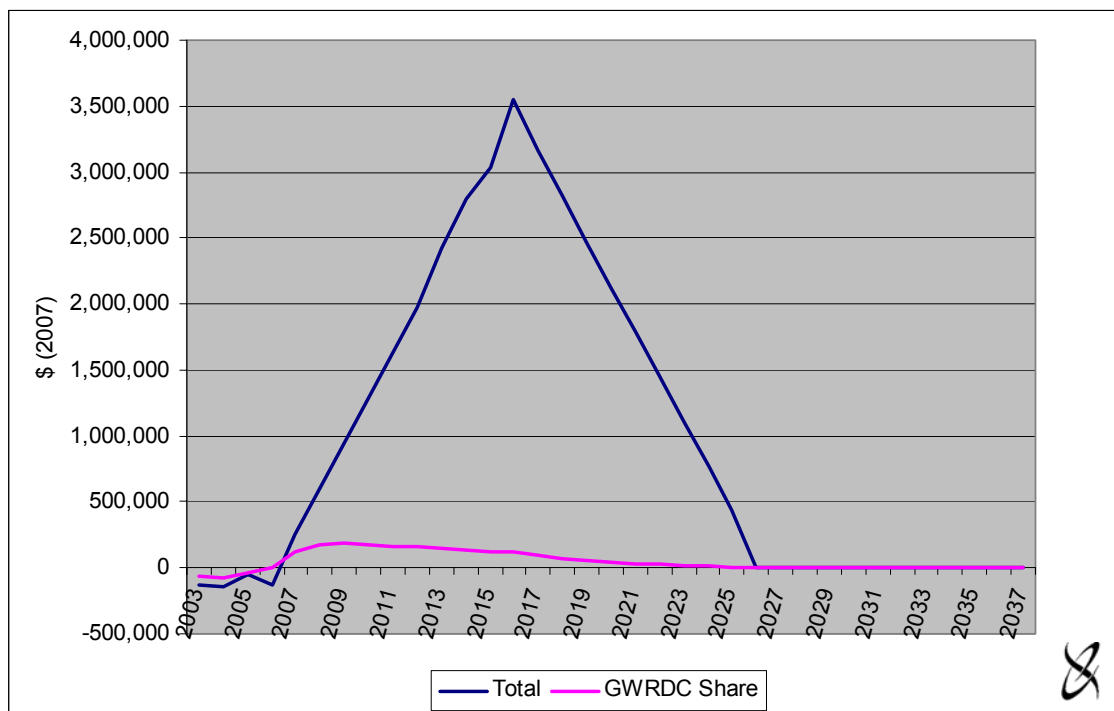
Source: Based on consultation with Belinda Rawnsley (SARDI, pers. comm.) and Russell Johnstone (Orlando Wines, pers. comm.).

4.3.5 Attribution of the net benefits of the research findings to GWRDC

Annual net benefits²⁰ of the research findings were attributed to the GWRDC on the basis of its cumulative investment in the research findings relative to cumulative costs incurred by all parties²¹. This is illustrated in Figure 4.2. The annual net benefits of the research findings reach a maximum in the year 2017 and decline thereafter, reflecting the impact of the base case.

²⁰ That is, incremental benefits less incremental costs.

²¹ Including GWRDC investment, investment by research collaborators, industry adoption costs and other costs.

Figure 4.2 Net benefits of the research findings (SAR 02/05) ^a

^a Estimates are in 2007 dollars.

Source: EconSearch analysis.

4.4 Results of the Analysis

4.4.1 Key Indicators

The results of the CBA, in terms of returns to aggregate investment and GWRDC investment in the projects, are provided in Tables 4.4 and 4.5, respectively. These results are based on the expected values for key variables, as outlined in Section 4.3.

Table 4.4 Returns to aggregate investment in project number SAR 02/05

	Year 0	Year 5	Year 10	Year 15	Year 20	Year 30
NPV (\$m) ^a	-0.3	5.2	15.2	21.0	22.0	22.0
IRR	-	-	-	-	-	65%
BCR	-	-	-	-	-	83

^a In 2007 dollars.

Source: EconSearch analysis.

Table 4.5 Returns to GWRDC investment in project number SAR 02/05 ^a

	Year 0	Year 5	Year 10	Year 15	Year 20	Year 30
NPV (\$m) ^b	-0.1	0.7	1.1	1.2	1.2	1.2

^a Note that the IRR and BCR evaluation criteria for returns to GWRDC investment in the project are not reported as they are not directly comparable with those for aggregate investment in the project (Table 4.4).

^b In 2007 dollars.

Source: EconSearch analysis.

Relative to the base case, it is apparent that the project would generate significant net benefits to the Australian community (i.e. NPV of \$22m over 30 years, IRR of 65 per cent and BCR of 83 in Table 4.4). Assuming that annual net benefits of the research findings are attributable to the GWRDC on the basis of its cumulative investment in the research relative to cumulative costs incurred by all parties, returns to GWRDC investment in the research findings would also be positive (i.e. NPV of \$1.2m over 30 years in Table 4.5).

Based on the assumptions outlined in Section 4.3, it is apparent that all of the identified monetary benefits of the research findings are attributable to the levy paying industry. As discussed above, the monetary value of net benefits that could be attributed to other industries, the environment or social impacts (i.e. spillovers) have not been included in the CBA calculations.

Attribution of the results of the analysis to the Rural Research Priorities is outlined in Table 4.6, based on the assumption that 100 per cent of the GWRDC investment in the projects was allocated to the 'productivity and adding value' priority (Geoff Crook, GWRDC, pers. comm.).

Table 4.6 Attribution of net present values to Rural Research Priorities (SAR 02/05)

Rural Research Priority	NPV at Year 30 (\$m) ^a	
	Total	GWRDC share
Productivity and adding value	22.0	1.2
Supply chain and markets	0.0	0.0
Natural resource management	0.0	0.0
Climate variability and climate change	0.0	0.0
Biosecurity	0.0	0.0

^a In 2007 dollars.

Source: EconSearch analysis.

4.4.2 Sensitivity Analysis

The results of the analysis were re-estimated using values for key variables that reflect the uncertainty of those variables. Sensitivity analyses were undertaken for different values of the following variables.

- Adoption profile for the research findings. Based on a range of assumptions for the maximum adoption rate (expected value of 35 per cent of the area of susceptible varieties). Used low and high values of 20 and 50 per cent, respectively.
- Annual incidence of severe PBN in susceptible varieties in cool-climate regions (expected value of 50 per cent of the area). Used low and high values of 25 and 75 per cent, respectively.
- Improvement in Shiraz fruitfulness with bud dissection analysis and modified pruning levels (expected value of 17.5 per cent). Used low and high values of 15 and 20 per cent, respectively.
- Average yield of Shiraz nationally (expected value of 9.3 t/ha). Used low and high values of 8.3 and 10.3 t/ha, respectively.
- Average farm-gate price of Shiraz nationally (expected value of \$1,000/t)²². Used low and high values of \$800 and \$1,200/t, respectively.
- Price flexibility coefficient (expected value of -0.36). Used low and high values of -1.56 and -0.25, respectively. The low and high values are based on the assumption that increased supply is sold in the domestic market or export markets, respectively.
- Benefits attributable to the GWRDC funded project (SAR 02/05) (expected value of 31 per cent). Used low and high values of 20 and 40 per cent, respectively.
- Time lag to development and adoption of the research findings without GWRDC investment (i.e. the base case) (expected value of 10 years). Used low and high values of 5 and 20 years, respectively.

The results of the sensitivity analyses are provided in Tables 4.7 and 4.8 below. For each sensitivity analysis, values have been calculated by holding all other variables constant at their expected levels.

The results of the analysis are somewhat sensitive to a number of the variables and assumptions used in the analysis, particularly, the maximum adoption rate, the incidence of severe PBN in susceptible varieties in cool-climate regions, the proportion of the benefits attributable to the project and the time lag to development and adoption of the research findings without the GWRDC investment (Table 4.8). It is apparent, however, that the incremental net benefits of aggregate investment in the research would be positive across a range of values for all uncertain variables.

²² Before the impact of supply-induced price decline.

Table 4.7 Sensitivity of net present values to adoption rates (SAR 02/05)

Adoption rate	NPV (\$m) ^a					
	Year 0	Year 5	Year 10	Year 15	Year 20	Year 30
Low ^b	-0.3	2.8	8.7	12.1	12.7	12.7
Expected ^c	-0.3	5.2	15.2	21.0	22.0	22.0
High ^d	-0.2	7.5	21.6	29.7	31.1	31.1

^a NPVs are in 2007 dollars and relate to total investment in the project.

^b A maximum adoption rate of 20 per cent of the area of susceptible varieties in cool-climate regions, nationally.

^c A maximum adoption rate of 35 per cent of the relevant area.

^d A maximum adoption rate of 50 per cent of the relevant area.

Source: EconSearch analysis.

Table 4.8 Sensitivity of net present values to a range of other uncertain variables (SAR 02/05)^a

	Low	Expected	High
Incidence of severe PBN in susceptible varieties in cool-climate regions			
<i>Assumed value for variable</i>	25%	50%	75%
<i>NPV (\$m) at Year 30</i>	7	22	37
Improvement in fruitfulness with bud dissection analysis and modified pruning			
<i>Assumed value for variable</i>	15.0%	17.5%	20.0%
<i>NPV (\$m) at Year 30</i>	18	22	26
Average yield of susceptible varieties nationally			
<i>Assumed value for variable (t/ha)</i>	8.3	9.3	10.3
<i>NPV (\$m) at Year 30</i>	19	22	25
Average price of susceptible varieties nationally			
<i>Assumed value for variable (\$/t)</i>	\$800	\$1,000	\$1,200
<i>NPV (\$m) at Year 30</i>	16	22	28
Price flexibility coefficient			
<i>Assumed value for variable</i>	-1.56	-0.36	-0.25
<i>NPV (\$m) at Year 30</i>	20	22	22
Benefits attributable to the GWRDC funded project			
<i>Assumed value for variable</i>	20%	31%	40%
<i>NPV (\$m) at Year 30</i>	12	22	31
Time lag to development and adoption of technology without GWRDC (base case)			
<i>Assumed value for variable (years)</i>	5	10	20
<i>NPV (\$m) at Year 30</i>	12	22	36

^a NPVs are in 2007 dollars and relate to total investment in the project. For each sensitivity analysis, values have been calculated by holding all other variables constant at their expected levels.

Source: EconSearch analysis.

5. Cost Benefit Analysis of Project Numbers SAR 02/09a and 02/09b

5.1 Description of the Project and Research

The CBA described in this section of the report relates to research findings that were developed as a consequence of investment by GWRDC and collaborators in two projects, namely:

- SAR 02/09a - *The use of molybdenum foliar sprays to improve fruit set and bunch yield of Merlot vines in the Adelaide Hills in 2002/2003; and*
- SAR 02/09b - *Molybdenum foliar sprays and other nutrient strategies to improve fruit set and reduce berry asynchrony ('hen and chickens') in Australia.*

Research conducted prior to and as part of these projects has led to the development of a corrective molybdenum (Mo) foliar spray strategy to ameliorate the impact of poor fruit set, reduced yields and fruit quality problems in some vineyards, particularly those in the cool-climate production regions of Australia.

5.2 The Scope of Costs and Benefits

Tables 5.1 and 5.2 list, in qualitative terms, the costs and benefits associated with the 'with GWRDC investment' scenario and the base case ('without GWRDC investment') scenario.

Table 5.1 The costs of project numbers SAR 02/09a and 02/09b

Scenario	Cost	Bearer of the Cost	Valued in Monetary Terms	Source of Information
Base case (without GWRDC investment) scenario	Identical to the 'with GWRDC investment' scenario but with a time lag of 10 years	See below	See below	See below
With GWRDC investment scenario	Mo foliar spray strategy R&D costs	GWRDC and collaborators	Yes	GWRDC and collaborators
	Mo foliar spray strategy adoption costs	Winegrape growers	Yes	See text in section 5.3.1
	Increased winegrape transport costs as a result of yield improvements	Winegrape growers	Yes	See text in section 5.3.1

Table 5.2 The benefits of project numbers SAR 02/09a and 02/09b

Scenario	Benefit	Beneficiary	Valued in Monetary Terms	Source of Information
Base case (without GWRDC investment) scenario	Identical to the 'with GWRDC investment' scenario but with a time lag of 10 years	See below	See below	See below
With GWRDC investment scenario	Improved winegrape yield in Merlot and other susceptible varieties with Mo foliar spray strategy	Winegrape growers and winemakers	Yes	See text in section 5.3.2
	Improved winegrape quality in Merlot and other susceptible varieties with Mo foliar spray strategy	Winegrape growers and winemakers	Yes	See text in section 5.3.2
	Other industry benefits (e.g. lifting the profile of the Merlot variety)	Winegrape growers and winemakers	No	See text in section 5.3.2
	Spillover benefits (e.g. flow-on impacts from an improvement in the reliability of income levels at the vineyard level)	The broader community	No	See text in section 5.3.2

5.3 Data and Assumptions Used for Quantifying Costs and Benefits

This section of the report details the method, sources of information and assumptions used to estimate the costs and benefits listed in Tables 5.1 and 5.2. For those costs and benefits which were difficult to estimate in monetary terms, some qualitative description is provided. This information was based on consultation with²³.

- Dr Ian Black (Principal Economist, SARDI);
- Dr Chris Williams (Senior Research Scientist - Agronomy, SARDI);
- Russell Johnstone, Group Viticulturist, Orlando Wines.

The majority of the assumptions and data utilised in this analysis were based on an unpublished, in-house CBA undertaken by SARDI. The assistance provided by Ian Black and Chris Williams, in terms of access to their modelling and consultation regarding the assumptions, is gratefully acknowledged.

²³ And reference to Williams (2007).

5.3.1 Costs of the project

Research and development costs

Estimates of annual investment in the two projects by GWRDC and research collaborators (cash and in-kind) were provided by Geoff Crook (GWRDC, pers. comm.) and Ian Black and Chris Williams (SARDI, pers. comm.) and are summarised in Table 5.3.

Table 5.3 Research and development costs for project numbers SAR 02/09a and 02/09b^a

	Cash and in-kind investment (\$)		
	GWRDC	Collaborators	Total
2000/01	\$0	\$75,000	\$75,000
2001/02	\$0	\$75,000	\$75,000
2002/03 ^b	\$11,450	\$86,450	\$97,900
2003/04	\$92,372	\$178,305	\$270,677
2004/05	\$108,294	\$199,294	\$307,588
2005/06	\$113,695	\$209,535	\$323,230
2006/07	\$0	\$48,750	\$48,750
Total	\$325,811	\$872,334	\$1,198,145

^a In nominal dollars and ex GST. For the purpose of the CBA these values were expressed in 2006/07 dollars using the Consumer Price Index for Adelaide (ABS 2007a).

^b Expenditure incurred prior to 2002/03 was fundamental to the development of the research findings but was not related to the GWRDC projects. It has been included as a sunk cost in both the 'with' and 'without' GWRDC scenarios.

Source: Geoff Crook (GWRDC, pers. comm.) and Ian Black and Chris Williams (SARDI, pers. comm.).

Adoption costs

The on-farm cost of adopting the corrective molybdenum foliar spray strategy was estimated to be \$50/ha (Black and Williams, SARDI, pers. comm.).

Increased transport costs

An improvement in winegrape yield (see details below) would result in an increase in the costs of delivering the product to the winery. For the purpose of this analysis it was assumed that the average distance between vineyards and wineries in cool climate production regions is 30km and transport costs are approximately \$0.50 per net tonne kilometre. Thus, the average transport cost was assumed to be \$15 per tonne.

5.3.2 Benefits of the project

Improvements in winegrape yields and quality

The primary benefit attributable to the research is that it is possible to increase winegrape yields and quality in the cool-climate production regions of Australia²⁴ with a corrective molybdenum foliar spray strategy. The yield and quality effects have been demonstrated in research trials on the highly-susceptible Merlot variety and there is a reasonable degree of confidence that a similar response can be achieved by applying the strategy to other susceptible varieties²⁵. The following assumptions have been made with respect to the yield and quality-related benefits.

- The national harvest of winegrapes was assumed, on average, to be 1.6 Mt²⁶, 36 per cent of which was grown in cool climate areas²⁷. Approximately 8 per cent of cool-climate production was assumed to be Merlot and 48 per cent other susceptible varieties, produced at an average price of \$900/t and an average yield of 8 t/ha (Williams, SARDI, pers. comm.).
- In a 'disaster' year (i.e. cold, wet conditions during flowering), assumed to be 1 year in 10 for Merlot and 1 in 20 for other susceptible varieties, it has been demonstrated that grape yields in cool climate areas can be increased, on average, by 5.5 t/ha (Williams, SARDI, pers. comm.). Whilst there would also be a significant improvement in the overall quality of the grapes harvested in a 'disaster' year and the possibility of associated price bonuses, it was assumed that any positive price effect would be negated by the impact of increased grape supply.
- For the balance of vintages (i.e. 9 years in 10 for Merlot and 19 in 20 for other susceptible varieties), it was assumed that yields could be increased by 26 per cent (Merlot) and 13 per cent (other susceptible varieties), respectively (Williams, SARDI, pers. comm.). It is also anticipated that the significant improvement in the overall quality of the grapes harvested would attract a price premium of 15 per cent for Merlot and 7.5 per cent for other susceptible varieties (Williams, SARDI, pers. comm.). This price premium is, however, expected to decrease over time in response to the increase in supply of winegrapes. The supply-induced impact on price has been estimated using the price flexibility coefficient (-0.36²⁸) referred to in Section 4.3.2 of the report.
- As a proxy for the cost of future extension work and the possibility that further field trials will be necessary, particularly with other susceptible varieties, it was assumed that only 80 per cent of the benefits described above can be attributed to the GWRDC funded projects (SAR 02/09a and 02/09b) and earlier research work (Black, SARDI, pers. comm.).

²⁴ Assumed to include most regions other than the Riverland (SA), Sunraysia (Victoria) and Riverina/MIA (NSW) (Black and Williams, SARDI, pers. comm.).

²⁵ Assumed to be Cabernet Sauvignon, Chardonnay, Grenache, Cabernet Franc, Pinot Noir and Sauvignon Blanc (Williams, SARDI, pers. comm.).

²⁶ Average Australian winegrape vintage over the period, 2003 to 2007 (ABS 2008).

²⁷ Based on average production for Australia less Riverland, Sunraysia and Riverina/MIA for the period, 2005 to 2007 (ABS 2008 and previous issues).

²⁸ That is, there would be a 0.36 per cent decrease in price given a one per cent increase in the quantity supplied.

Other industry benefits

There are a range of other benefits that could accrue to the levy paying industry (i.e. winegrape growers) and other industries within the supply chain but are difficult to quantify in monetary terms. These are listed below, in no particular order of significance and were based on consultation with Black and Williams (SARDI, pers. comm.).

- Given the difficulties associated with producing a reliable supply of good quality Merlot in cool climate regions in Australia, these research findings have the potential to lift the profile of this variety, in particular. For example, winemakers from these regions may not simply use the variety in blends but produce distinctive single-variety wines.
- For years in which cold, wet conditions are widespread across Australia's cool climate winegrape growing regions and yields are reduced across a wide range of varieties, there is the potential for underutilisation of winemaking and storage infrastructure. Adoption of the research findings should lead to more efficient utilisation of this infrastructure by providing a more consistent volume of grapes across vintages.

Spillover benefits

Adoption of the research findings is not expected to generate any net environmental benefits. In terms of social benefits, an improvement in the reliability of income levels at the vineyard level could result in positive employment and income impacts, particularly in regional economies to which the winegrape growing sector makes a significant contribution. The net environmental and social benefits that could be attributed to the research findings have not been quantified in monetary terms.

5.3.3 Adoption rate of the research findings

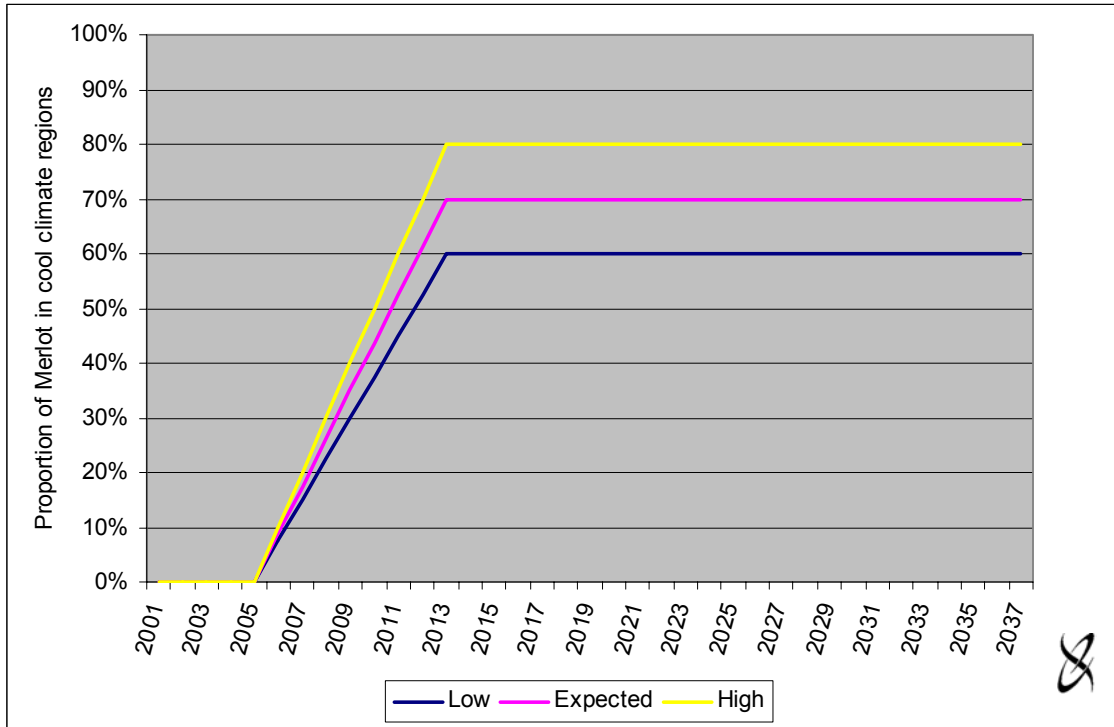
It was estimated that by 2005/06 the molybdenum foliar spray strategy had already been adopted in 10 per cent of the area devoted to Merlot production in Australia's cool climate regions (5 per cent for other susceptible varieties). It was assumed that adoption will increase to a maximum of 70 per cent (40 per cent for other susceptible varieties) of the area by 2012/13 (Black and Williams, SARDI, pers. comm.).

The results of the analysis were subject to sensitivity analysis to reflect the uncertainty associated with the adoption profiles, using:

- high and low values for the maximum adoption rate in Merlot of 80 per cent and 60 per cent, respectively; and
- high and low values for the maximum adoption rate in other susceptible varieties of 50 per cent and 30 per cent, respectively.

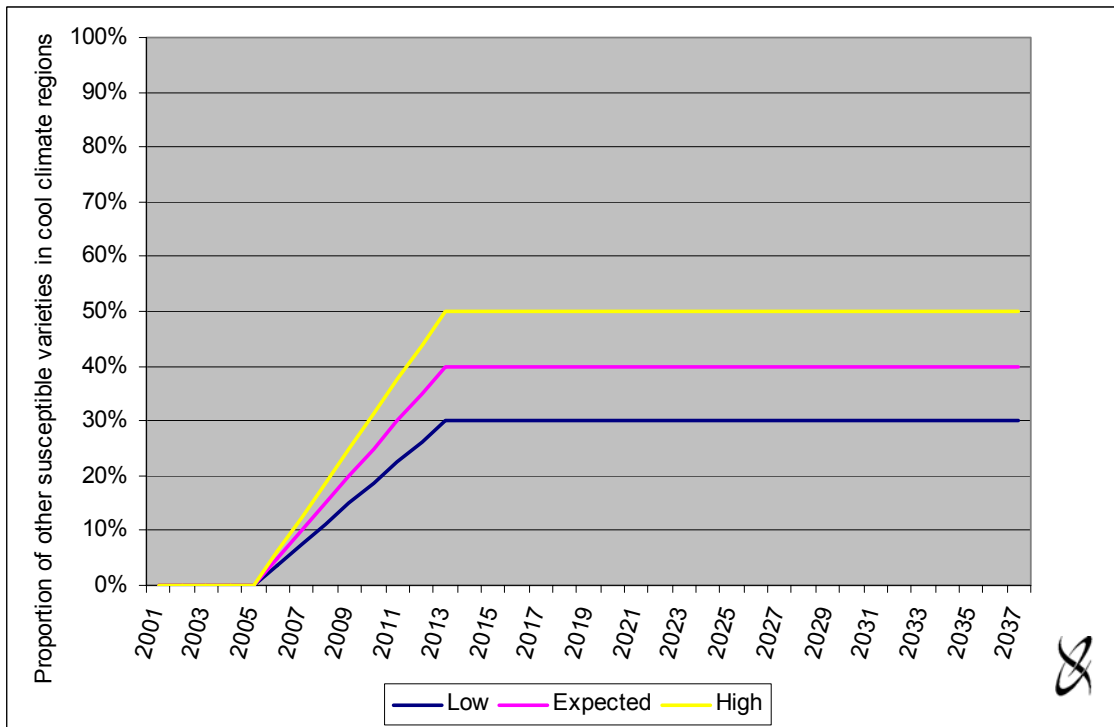
These adoption profiles are illustrated for Merlot in Figure 5.1 and other susceptible varieties in Figure 5.2.

Figure 5.1 Assumed adoption profile for the research findings in the Merlot variety (SAR 02/09a and 02/09b)



Source: Based on consultation with Black and Williams (SARDI, pers. comm.) and Russell Johnstone (Orlando Wines, pers. comm.).

Figure 5.2 Assumed adoption profile for the research findings in other susceptible varieties (SAR 02/09a and 02/09b)



Source: Based on consultation Black and Williams (SARDI, pers. comm.) and Russell Johnstone (Orlando Wines, pers. comm.).

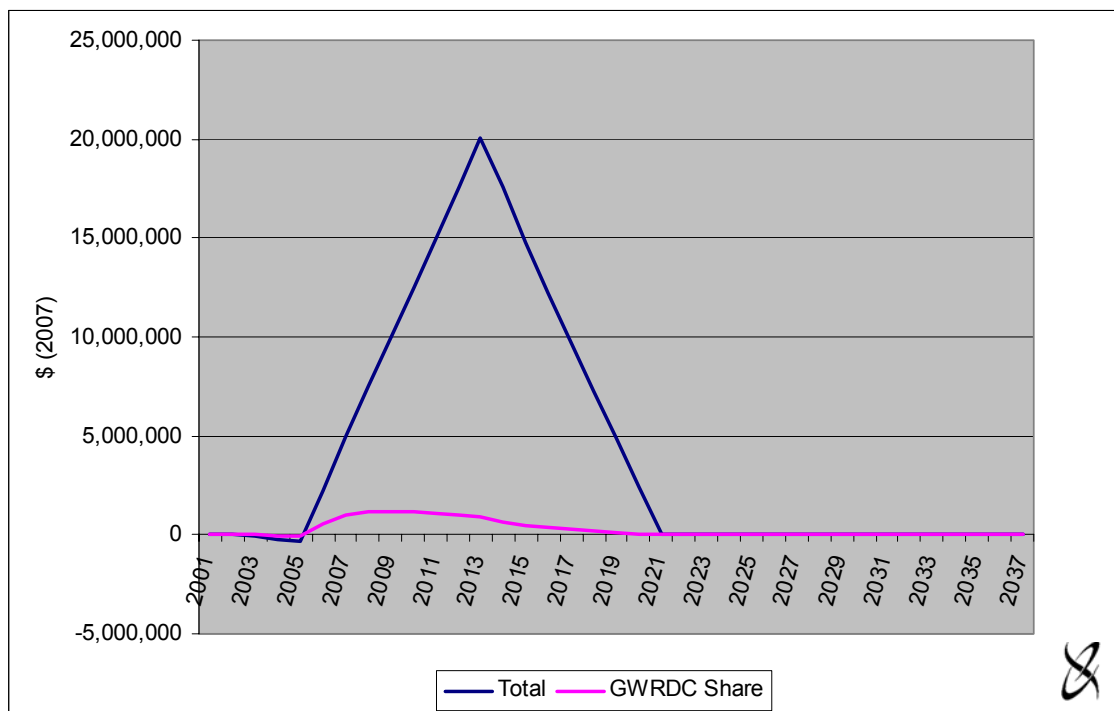
5.3.4 The base case

It is highly likely that the research described above, developed with the assistance of GWRDC investment, would eventually have been undertaken in the absence of this investment. It was assumed that the impact of the GWRDC investment has been to bring forward the development of these research findings by approximately 10 years (Black, SARDI, pers. comm.). Thus, for the base case scenario, it was assumed that the costs of developing and adopting the molybdenum foliar spray strategy and the net benefits of its adoption are identical to the 'with GWRDC investment' scenario but with a lag of 10 years.

5.3.5 Attribution of the net benefits of the research findings to GWRDC

Annual net benefits²⁹ of the research findings were attributed to the GWRDC on the basis of its cumulative investment in the research findings relative to cumulative costs incurred by all parties³⁰. This is illustrated in Figure 5.3. The annual net benefits of the research findings reach a maximum in the year 2013 and decline thereafter, reflecting the impact of the base case.

Figure 5.3 Net benefits of the research findings (SAR 02/09a and 02/09b) ^a



^a Estimates are in 2007 dollars.

Source: EconSearch analysis.

²⁹ That is, incremental benefits less incremental costs.

³⁰ Including GWRDC investment, investment by research collaborators, industry adoption costs and other costs.

5.4 Results of the Analysis

5.4.1 Key Indicators

The results of the CBA, in terms of returns to aggregate investment and GWRDC investment in the projects, are provided in Tables 5.4 and 5.5, respectively. These results are based on the expected values for key variables, as outlined in Section 5.3.

Table 5.4 Returns to aggregate investment in project numbers SAR 02/09a and 02/09b

	Year 0	Year 5	Year 10	Year 15	Year 20	Year 30
NPV (\$m) ^a	6.6	59.8	111.1	119.4	119.4	119.4
IRR	-	-	-	-	-	197%
BCR	-	-	-	-	-	17

^a In 2007 dollars.

Source: EconSearch analysis.

Table 5.5 Returns to GWRDC investment in project numbers SAR 02/09a and 02/09b^a

	Year 0	Year 5	Year 10	Year 15	Year 20	Year 30
NPV (\$m) ^b	1.4	6.2	8.1	8.3	8.3	8.3

^a Note that the IRR and BCR evaluation criteria for returns to GWRDC investment in the project are not reported as they are not directly comparable with those for aggregate investment in the project (Table 5.4).

^b In 2007 dollars.

Source: EconSearch analysis.

Relative to the base case, it is apparent that the project would generate significant net benefits to the Australian community (i.e. NPV of \$119m over 30 years, IRR of 197 per cent and BCR of 17 in Table 5.4). Assuming that annual net benefits of the research findings are attributable to the GWRDC on the basis of its cumulative investment in the research relative to cumulative costs incurred by all parties, returns to GWRDC investment in the research findings would also be strongly positive (i.e. NPV of \$8m over 30 years in Table 5.5). The positive NPVs in Year 0 of the analysis (Tables 5.4 and 5.5) reflect the fact that there was some commercial adoption of the research findings prior to the completion of the project.

Based on the assumptions outlined in Section 5.3, it is apparent that all of the identified monetary benefits of the research findings are attributable to the levy paying industry. As discussed above, the monetary value of net benefits that could be attributed to other industries, the environment or social impacts (i.e. spillovers) have not been included in the CBA calculations.

Attribution of the results of the analysis to the Rural Research Priorities is outlined in Table 5.6, based on the assumption that 100 per cent of the GWRDC investment in the projects was allocated to the 'productivity and adding value' priority (Geoff Crook, GWRDC, pers. comm.).

Table 5.6 Attribution of net present values to Rural Research Priorities (SAR 02/09a and 02/09b)

Rural Research Priority	NPV over 30 years (\$m) ^a	
	Total	GWRDC share
Productivity and adding value	119.4	8.3
Supply chain and markets	0.0	0.0
Natural resource management	0.0	0.0
Climate variability and climate change	0.0	0.0
Biosecurity	0.0	0.0

^a In 2007 dollars.

Source: EconSearch analysis.

5.4.2 Sensitivity Analysis

The results of the analysis were re-estimated using values for key variables that reflect the uncertainty of those variables. Sensitivity analyses were undertaken for different values of the following variables.

- Adoption profile for the research findings. Based on a range of assumptions for the maximum adoption rate. For details see Table 5.7 and Figures 5.1 and 5.2.
- Proportion of cool climate production assumed to be Merlot (expected value of 8 per cent). Used low and high values of 6 and 10 per cent, respectively. The low estimate was derived from PGIBSA (2007) and represents an estimate of the anticipated supply of merlot from cool climate regions in South Australia as a proportion of total anticipated supply from these regions over the period 2008 to 2012. South Australia produced almost 60 per cent of all cool climate winegrapes in Australia over the period 2005 to 2007, (ABS 2008 and previous issues). The high estimate was used by Black and Williams (SARDI, pers. comm.).
- Proportion of cool climate production assumed to be other susceptible varieties (expected value of 48 per cent). Used low and high values of 46 and 50 per cent, respectively. The low estimate was derived from PGIBSA (2007) and represents an estimate of the anticipated supply of Cabernet Sauvignon, Chardonnay, Grenache, Cabernet Franc, Pinot Noir and Sauvignon Blanc from cool climate regions in South Australia as a proportion of total anticipated supply from these regions over the period 2008 to 2012. The high estimate was used by Black and Williams (SARDI, pers. comm.).
- Average farm-gate price of cool climate grapes (expected value of \$900/t). Used low and high values of \$720 and \$1,080/t, respectively.
- Average yield of cool climate grapes (expected value of 8 t/ha). Used low and high values of 7 and 9 t/ha, respectively.

- Increase in yield in disaster years (expected value of 5.5 t/ha). Used low and high values of 4.5 and 6.5 t/ha, respectively.
- Increase in yield of Merlot in other years (expected value of 26 per cent). Used low and high values of 10 and 35 per cent, respectively.
- Increase in yield of other susceptible varieties in other years (expected value of 13 per cent). Used low and high values of 5 and 20 per cent, respectively.
- Increase in yield of other susceptible varieties in other years (expected value of 13 per cent). Used low and high values of 5 and 20 per cent, respectively.
- Quality related price premium for Merlot in non-disaster years (expected value of 15 per cent). Used low and high values of 0 and 20 per cent, respectively.
- Quality related price premium for other susceptible varieties in non-disaster years (expected value of 7.5 per cent). Used low and high values of 0 and 10 per cent, respectively.
- Frequency of disaster years for Merlot (expected value of 1 year in 10). Used low and high values of 1 year in 15 and 1 year in 7, respectively.
- Frequency of disaster years for other susceptible varieties (expected value of 1 year in 20). Used low and high values of 1 year in 30 and 1 year in 10, respectively.
- Benefits attributable to the GWRDC funded projects (SAR 02/09a and 02/09b) (expected value of 80 per cent). Used low and high values of 60 and 100 per cent, respectively.
- Time lag to development and adoption of the research findings without GWRDC investment (i.e. the base case) (expected value of 10 years). Used low and high values of 5 and 20 years, respectively.

The results of the sensitivity analyses are provided in Tables 5.7 and 5.8 below. For each sensitivity analysis, values have been calculated by holding all other variables constant at their expected levels.

Table 5.7 Sensitivity of net present values to adoption rates (SAR 02/09a and 02/09b)

Adoption rate	NPV (\$m) ^a					
	Year 0	Year 5	Year 10	Year 15	Year 20	Year 30
Low ^b	5.0	47.2	88.1	94.6	94.6	94.6
Expected ^c	6.6	59.8	111.1	119.4	119.4	119.4
High ^d	8.2	72.3	134.0	143.9	143.9	143.9

^a NPVs are in 2007 dollars and relate to total investment in the project.

^b A maximum adoption rate of 60 per cent in Merlot and 30 per cent in other susceptible varieties.

^c A maximum adoption rate of 70 per cent in Merlot and 40 per cent in other susceptible varieties.

^d A maximum adoption rate of 80 per cent in Merlot and 50 per cent in other susceptible varieties.

Source: EconSearch analysis.

The results of the analysis are somewhat sensitive to a number of the variables and assumptions used in the analysis, particularly the time lag to development and adoption of research findings without the GWRDC investment (Table 5.8). It is apparent, however, that the incremental net benefits of aggregate investment in the research would be strongly positive across a range of values for all uncertain variables.

Finally, given that there is a higher level of uncertainty associated with the benefits attributable to other susceptible varieties, the results of the analysis were calculated using 'merlot benefits only'. Holding all other variables constant at their expected values, the NPV over 30 years if benefits for merlot only are included in the analysis would be \$44m, compared with \$119m if benefits for all susceptible varieties are included.

Table 5.8 Sensitivity of net present values to a range of other uncertain variables (SAR 02/09a and 02/09b) ^a

	Low	Expected	High
Proportion of cool climate production that is Merlot			
<i>Assumed value for variable</i>	6%	8%	10%
<i>NPV (\$m) at Year 30</i>	108.3	119.4	130.5
Proportion of cool climate production that is other susceptible varieties			
<i>Assumed value for variable</i>	46%	48%	50%
<i>NPV (\$m) at Year 30</i>	116.3	119.4	122.5
Average farm gate price for cool climate winegrapes			
<i>Assumed value for variable (\$/t)</i>	720	900	1,080
<i>NPV (\$m) at Year 30</i>	93.8	119.4	144.9
Average yield for cool climate winegrapes			
<i>Assumed value for variable (t/ha)</i>	7.0	8.0	9.0
<i>NPV (\$m) at Year 30</i>	107.1	119.4	131.6
Increase in yield in disaster years			
<i>Assumed value for variable (t/ha)</i>	4.5	5.5	6.5
<i>NPV (\$m) at Year 30</i>	114.6	119.4	124.2
Increase in yield of Merlot in other years			
<i>Assumed value for variable</i>	10%	26%	35%
<i>NPV (\$m) at Year 30</i>	97.6	119.4	131.0
Increase in yield of other susceptible varieties in other years			
<i>Assumed value for variable</i>	5%	13%	20%
<i>NPV (\$m) at Year 30</i>	80.9	119.4	152.5
Quality related price premium for Merlot in non-disaster years			
<i>Assumed value for variable</i>	0%	15%	20%
<i>NPV (\$m) at Year 30</i>	114.4	119.4	121.1
Quality related price premium for other susceptible varieties in non-disaster years			
<i>Assumed value for variable</i>	0.0%	7.5%	10.0%
<i>NPV (\$m) at Year 30</i>	114.8	119.4	120.9
Frequency of disaster years for Merlot			
<i>Assumed value for variable</i>	7%	10%	13%
<i>NPV (\$m) at Year 30</i>	117.4	119.4	121.3
Frequency of disaster years for other susceptible varieties			
<i>Assumed value for variable</i>	3%	5%	10%
<i>NPV (\$m) at Year 30</i>	115.0	119.4	132.7
Benefits attributable to the GWRDC funded projects and earlier research work			
<i>Assumed value for variable</i>	60%	80%	100%
<i>NPV (\$m) at Year 30</i>	87.4	119.4	151.3
Time lag to development and adoption of technology without GWRDC (base case)			
<i>Assumed value for variable (years)</i>	5	10	20
<i>NPV (\$m) at Year 30</i>	50.3	119.4	215.9

^a NPVs are in 2007 dollars and relate to total investment in the project. For each sensitivity analysis, values have been calculated by holding all other variables constant at their expected levels.

Source: EconSearch analysis.

6. Cost Benefit Analysis of Project Number SAR 03/03

6.1 Description of the Project and Research

The CBA described in this section of the report relates to research findings that were developed as a consequence of investment by GWRDC and collaborators in the following project:

- SAR 03/03 - *Strategic management of flowering sprays.*

Research conducted as part of this project has demonstrated that the application of commonly used fungicides during the flowering period of winegrapes is unlikely to significantly inhibit fruit set. 'As flower clusters are highly susceptible to diseases such as downy mildew, powdery mildew and *Botrytis*, the potential for complete loss of fruit from these diseases as a result of not applying fungicides during flowering far outweigh the minimal impact on fruit set and yield by applying fungicides' (Wicks 2007, p.6).

6.2 The Scope of Costs and Benefits

Tables 6.1 and 6.2 list, in qualitative terms, the costs and benefits associated with the 'with GWRDC investment' scenario and the base case ('without GWRDC investment') scenario.

Table 6.1 The costs of project number SAR 03/03

Scenario	Cost	Bearer of the Cost	Valued in Monetary Terms	Source of Information
Base case (without GWRDC investment) scenario	Identical to the 'with GWRDC investment' scenario but with a time lag of 10 years	See below	See below	See below
With GWRDC investment scenario	Project R&D costs	GWRDC and collaborators	Yes	GWRDC and collaborators

Table 6.2 The benefits of project number SAR 03/03

Scenario	Benefit	Beneficiary	Valued in Monetary Terms	Source of Information
Base case (without GWRDC investment) scenario	Identical to the 'with GWRDC investment' scenario but with a time lag of 10 years	See below	See below	See below
With GWRDC investment scenario	Yield impact forgone as a result of fungicide infections at flowering	Winegrape growers and winemakers	Yes	See text in section 6.3.2
	Spillover benefits (e.g. OH & S benefits of reduced chemical applications)	The broader community	No	See text in section 6.3.2

6.3 Data and Assumptions Used for Quantifying Costs and Benefits

This section of the report details the method, sources of information and assumptions used to estimate the costs and benefits listed in Tables 6.1 and 6.2. For those costs and benefits which were difficult to estimate in monetary terms, some qualitative description is provided. This information was based on consultation with³¹:

- Dr Trevor Wicks (Principal Plant Pathologist, Horticulture Pathology, SARDI); and
- Russell Johnstone, Group Viticulturist, Orlando Wines.

6.3.1 Costs of the project

Research and development costs

Estimates of annual investment in the project by GWRDC and research collaborators (cash and in-kind) were provided by Geoff Crook (GWRDC, pers. comm.) and are summarised in Table 6.3.

Table 6.3 Research and development costs for project number SAR 03/03^a

	Cash and in-kind investment (\$)		
	GWRDC	Collaborators	Total
2003/04	\$45,189	\$52,975	\$98,164
2004/05	\$52,698	\$56,250	\$108,948
2005/06	\$71,957	\$55,000	\$126,957
2006/07	\$74,310	\$55,000	\$129,310
Total	\$244,154	\$219,225	\$463,379

^a In nominal dollars and ex GST. For the purpose of the CBA these values were expressed in 2006/07 dollars using the Consumer Price Index for Adelaide (ABS 2007a).

Source: Geoff Crook (GWRDC, pers. comm.).

³¹ And reference to Wicks (2007).

Adoption costs

Adoption of the research findings by growers who do not currently undertake fungicide spraying at flowering would most likely result in fewer applications of more expensive chemicals with no net impact on vineyard costs (Trevor Wicks, SARDI, pers. comm.).

6.3.2 Benefits of the project

Yield impact forgone as a result of fungicide infections at flowering

It was assumed that for approximately 10 per cent of the winegrape area in Australia, growers currently avoid the use of fungicides at flowering as a result of the perceived negative impact on fruit set. Whilst highly variable, it was estimated that, on average, the impact on yield for these growers of consequent fungicide infections is a loss of 5 to 10 per cent of the potential³² (Trevor Wicks, SARDI, pers. comm.). By adopting the research findings of project number SAR 03/03, yield impacts of this order of magnitude could be forgone. The following data have been used to calculate these yield-related benefits.

- The total bearing area of winegrapes in Australia at the 2007 vintage was 163,951 ha (ABS 2008) and this area was assumed to remain constant for the purpose of this analysis. The average yield of winegrapes prior to undertaking changes to spraying programs was assumed to be 11.7 t/ha³³ and the average price was assumed to be \$730/t³⁴.
- Associated with the expected increase in the supply of grapes for winemaking there would be a consequent impact on the farm-gate price of these grapes. This relationship can be measured using a price flexibility coefficient (i.e. -0.36 as detailed in Section 4.3).

Other industry benefits

There are no other benefits that are expected to accrue to the levy paying industry (i.e. winegrape growers) and other industries within the supply chain

Spillover benefits

There are expected to be some net environmental and social (i.e. OH&S) benefits associated with adoption of the research findings as a result of the need for fewer chemical applications in vineyards. However, these benefits have not been quantified in monetary terms.

6.3.3 Adoption rate of the research findings

It was estimated that, within the next 10 years, the research findings will be adopted by 70 per cent of growers (i.e. 70 per cent of the area) who currently avoid the use of fungicides at flowering. A higher rate of adoption is unlikely given the inadequacies of the extension network for this type of information and resistance amongst a proportion of growers to modifying their vineyard management practices (Russell Johnstone, Orlando Wines, pers. comm.).

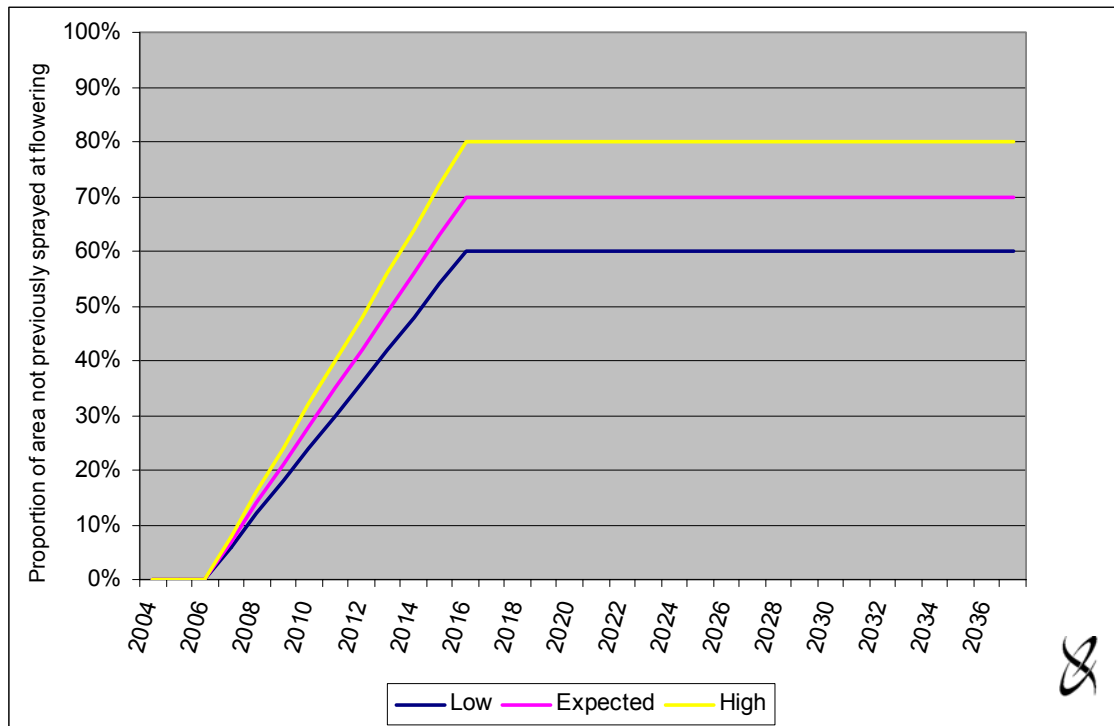
³² The expected value for this variable was the mid-point, 7.5 per cent.

³³ Average yield nationally based on the 2005, 2006 and 2007 vintages (ABS 2008).

³⁴ Average real price for all varieties in SA based on the 2005, 2006 and 2007 vintages (PGIBSA 2007).

The results of the analysis were subject to sensitivity analysis to reflect the uncertainty associated with the adoption profile, using high and low values for the maximum adoption rate of 80 per cent and 60 per cent, respectively. These adoption profiles are illustrated in Figure 6.1. The high adoption profile reflects the potential benefits associated with GWRDC's strategy of significant investment in viticultural extension in the short to medium term (Geoff Crook, GWRDC, pers. comm.).

Figure 6.1 Assumed adoption profile for the research findings (SAR 03/03)



Source: Based on consultation with Trevor Wicks (SARDI, pers. comm.) and Russell Johnstone (Orlando Wines, pers. comm.).

6.3.4 The base case

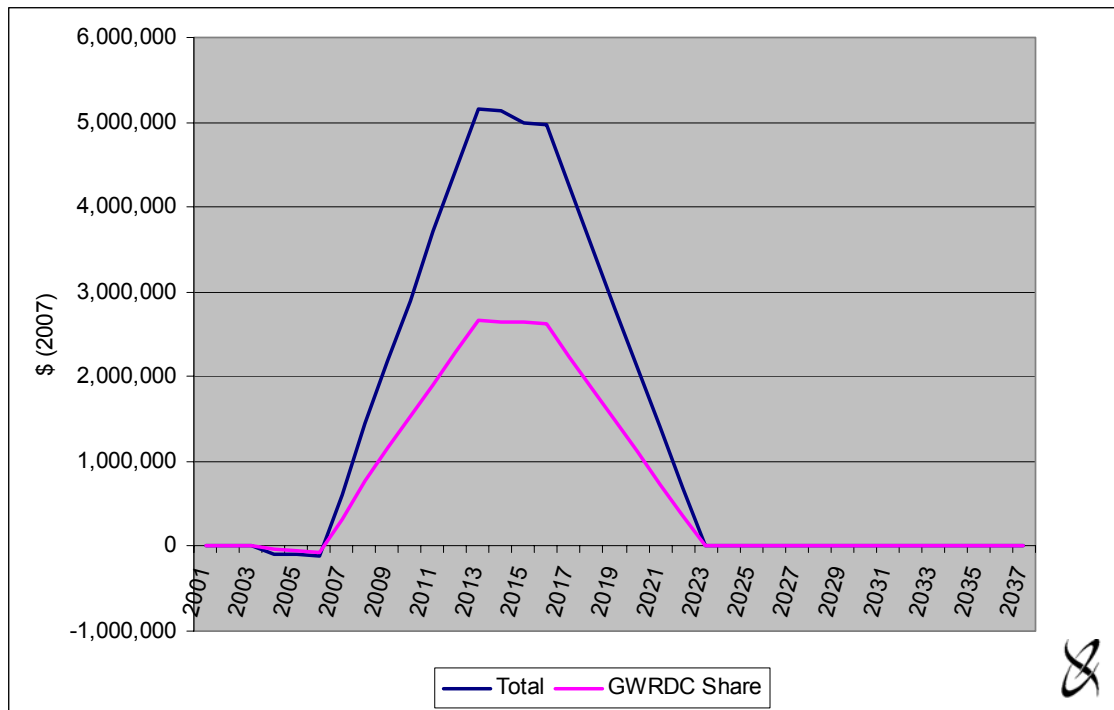
It is highly likely that the research described above, developed with the assistance of GWRDC investment, would eventually have been undertaken in the absence of this investment. The likely impact of the GWRDC investment has been to bring forward the development of these research findings by approximately 5 to 10 years (Trevor Wicks, SARDI, pers. comm.). Thus, for the base case scenario, it was assumed that the costs of developing and adopting the research findings and the net benefits of their adoption are identical to the 'with GWRDC investment' scenario but with a lag of 7 years³⁵.

³⁵ The approximate mid-point of the range of values provided by Trevor Wicks (SARDI, pers. comm.).

6.3.5 Attribution of the net benefits of the research findings to GWRDC

Annual net benefits³⁶ of the research findings were attributed to the GWRDC on the basis of its cumulative investment in the research findings relative to cumulative costs incurred by all parties³⁷. This is illustrated in Figure 6.2. The annual net benefits of the research findings reach a maximum in the year 2013 and decline thereafter, reflecting the impact of the base case.

Figure 6.2 Net benefits of the research findings (SAR 03/03)^a



^a Estimates are in 2007 dollars.

Source: EconSearch analysis.

6.4 Results of the Analysis

6.4.1 Key Indicators

The results of the CBA, in terms of returns to aggregate investment and GWRDC investment in the projects, are provided in Tables 6.4 and 6.5, respectively. These results are based on the expected values for key variables, as outlined in Section 6.3.

³⁶ That is, incremental benefits less incremental costs.

³⁷ Including GWRDC investment, investment by research collaborators, industry adoption costs and other costs.

Table 6.4 Returns to aggregate investment in project number SAR 03/03

	Year 0	Year 5	Year 10	Year 15	Year 20	Year 30
NPV (\$m) ^a	0.3	12.6	29.3	35.1	35.1	35.1
IRR	-	-	-	-	-	136%
BCR	-	-	-	-	-	139

^a In 2007 dollars.

Source: EconSearch analysis.

Table 6.5 Returns to GWRDC investment in project number SAR 03/03^a

	Year 0	Year 5	Year 10	Year 15	Year 20	Year 30
NPV (\$m) ^b	0.1	6.6	15.3	18.4	18.4	18.4

^a Note that the IRR and BCR evaluation criteria for returns to GWRDC investment in the project are not reported as they are not directly comparable with those for aggregate investment in the project (Table 6.4).

^b In 2007 dollars.

Source: EconSearch analysis.

Relative to the base case, it is apparent that the project would generate significant net benefits to the Australian community (i.e. NPV of \$35m over 30 years, IRR of 136 per cent and BCR of 139 in Table 6.4). Assuming that annual net benefits of the research findings are attributable to the GWRDC on the basis of its cumulative investment in the research relative to cumulative costs incurred by all parties, returns to GWRDC investment in the research findings would also be strongly positive (i.e. NPV of \$18m over 30 years in Table 6.5). The positive NPVs in Year 0 of the analysis (Tables 6.4 and 6.5) reflect the fact that there was some commercial adoption of the research findings prior to the completion of the project.

Based on the assumptions outlined in Section 6.3, it is apparent that all of the identified monetary benefits of the research findings are attributable to the levy paying industry. As discussed above, the monetary value of net benefits that could be attributed to other industries, the environment or social impacts (i.e. spillovers) have not been included in the CBA calculations.

Attribution of the results of the analysis to the Rural Research Priorities is outlined in Table 6.6, based on the assumption that 100 per cent of the GWRDC investment in the projects was allocated to the 'productivity and adding value' priority (Geoff Crook, GWRDC, pers. comm.).

Table 6.6 Attribution of net present values to Rural Research Priorities (SAR 03/03)

Rural Research Priority	NPV at Year 30 (\$m) ^a	
	Total	GWRDC share
Productivity and adding value	35.1	18.4
Supply chain and markets	0.0	0.0
Natural resource management	0.0	0.0
Climate variability and climate change	0.0	0.0
Biosecurity	0.0	0.0

^a In 2007 dollars.

Source: EconSearch analysis.

6.4.2 Sensitivity Analysis

The results of the analysis were re-estimated using values for key variables that reflect the uncertainty of those variables. Sensitivity analyses were undertaken for different values of the following variables.

- Adoption profile for the research findings. Based on a range of assumptions for the maximum adoption rate (expected value of 70 per cent of the area of vineyard nationally which was not previously sprayed at flowering). Used low and high values of 60 and 80 per cent, respectively.
- Proportion of growers (or area) who avoid fungicide spraying at flowering (expected value of 10 per cent). Used low and high values of 5 and 15 per cent, respectively.
- Yield potential foregone as a result of consequent fungicide infection (expected value of 7.5 per cent). Used low and high values of 5 and 10 per cent, respectively.
- Average yield of winegrapes nationally (expected value of 11.7 t/ha). Used low and high values of 10.7 and 12.7 t/ha, respectively.
- Average farm-gate price of winegrapes nationally (expected value of \$730/t)³⁸. Used low and high values of \$584 and \$876/t, respectively.
- Price flexibility coefficient (expected value of -0.36). Used low and high values of -1.56 and -0.25, respectively. The low and high values are based on the assumption that increased supply is sold in the domestic market or export markets, respectively.
- Time lag to development and adoption of the research findings without GWRDC investment (i.e. the base case) (expected value of 7 years). Used low and high values of 5 and 10 years, respectively.

The results of the sensitivity analyses are provided in Tables 6.7 and 6.8 below. For each sensitivity analysis, values have been calculated by holding all other variables constant at their expected levels.

³⁸ Before the impact of supply-induced price decline.

Table 6.7 Sensitivity of net present values to adoption rates (SAR 03/03)

Adoption rate	NPV (\$m) ^a					
	Year 0	Year 5	Year 10	Year 15	Year 20	Year 30
Low ^b	0.1	10.8	25.2	30.2	30.2	30.2
Expected ^c	0.3	12.6	29.3	35.1	35.1	35.1
High ^d	0.4	14.5	33.4	40.0	40.0	40.0

^a NPVs are in 2007 dollars and relate to total investment in the project.

^b A maximum adoption rate of 60 per cent on the relevant area.

^c A maximum adoption rate of 70 per cent on the relevant area.

^d A maximum adoption rate of 80 per cent on the relevant area.

Source: EconSearch analysis.

Table 6.8 Sensitivity of net present values to a range of other uncertain variables (SAR 03/03)^a

	Low	Expected	High
Proportion of growers (i.e. area) who avoid fungicides at flowering			
<i>Assumed value for variable (t/ha)</i>	5%	10%	15%
<i>NPV (\$m) at Year 30</i>	18	35	52
Yield potential forgone as a result of consequent fungicide infection			
<i>Assumed value for variable</i>	5.0%	7.5%	10.0%
<i>NPV (\$m) at Year 30</i>	23	35	47
Average yield nationally (t/ha)			
<i>Assumed value for variable</i>	10.7	11.7	12.7
<i>NPV (\$m) at Year 30</i>	32	35	38
Average price nationally (\$/t)			
<i>Assumed value for variable</i>	\$584	\$730	\$876
<i>NPV (\$m) at Year 30</i>	28	35	42
Price flexibility coefficient			
<i>Assumed value for variable</i>	-1.56	-0.36	-0.25
<i>NPV (\$m) at Year 30</i>	32	35	35
Time lag to development and adoption of technology without GWRDC (base case)			
<i>Assumed value for variable (years)</i>	5	7	10
<i>NPV (\$m) at Year 30</i>	26	35	47

^a NPVs are in 2007 dollars and relate to total investment in the project. For each sensitivity analysis, values have been calculated by holding all other variables constant at their expected levels.

Source: EconSearch analysis.

The results of the analysis are somewhat sensitive to a number of the variables and assumptions used in the analysis, particularly the proportion of growers who avoid fungicides at flowering, the yield potential forgone as a result of consequent fungicide infection and the time lag to development and adoption of the research findings without the GWRDC investment (Table 6.8). It is apparent, however, that the incremental net benefits of aggregate investment in the research would be strongly positive across a range of values for all uncertain variables.

7. Conclusions

Based on the data and assumptions utilised in this analysis it is apparent that there are strong positive returns to GWRDC and collaborator investment in projects grouped within the 'vine physiology – flowering' cluster. Whilst it was assumed that the research findings would eventually have been developed without GWRDC investment (i.e. the base case is based on a time lag of 7 to 10 years for all sub-projects), by bringing forward their development the GWRDC and collaborator investment will generate significant net benefits to the Australian community (i.e. estimated NPV of \$177m over 30 years in Table 3.1).

The results of the analysis were tested for sensitivity to all of the uncertain variables and assumptions used in the analysis and were found to be sensitive to some of these variables, particularly the 'time lag to development and adoption of the research findings without the GWRDC investment'. However, the incremental net benefits of aggregate investment in the research findings would be strongly positive across the likely range of values for all uncertain variables.

It is important to note that there are a range of spillover benefits of the research findings which are difficult to quantify in monetary terms and have been excluded from the CBA calculations. For example, an improvement in the reliability of income levels at the vineyard level could result in positive employment and income impacts, particularly in regional economies to which the winegrape growing sector makes a significant contribution. There is also a range of other potential (non-quantified) benefits that could accrue to the levy paying industry and other industries within the supply chain from the development of the research findings (e.g. more efficient use of winemaking and storage infrastructure).

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