Grape and Wine Research and Development Corporation



Economic Evaluation of GWRDC Portfolio

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EVALUATION SUMMARY

What we did?

- eSYS Development and the BDA Group were contracted by the GWRDC to carry out an economic evaluation of 27 research themes in the current portfolio to support research strategic planning efforts in the wine and grape industry. Following consultation with key GWRDC staff, the following themes were selected:

  1. Rootstocks
  2. Phylloxera
  3. Vineyard floor management
  4. Virus
  5. Powdery mildew management
  6. Botrytis management
  7. Soil health management
  8. Tannin
  9. Grape Composition and Flavours
  10. Near infrared spectroscopy
  11. Wine microbiology
  12. Grape berry physiology
  13. Industry data
  14. Environmental management
  15. Hot water treatment
  16. Technical information
  17. Quality Management
  18. Spray Application
  19. Participatory on-farm trials
  20. Genetic improvement of grapevines
  21. Precision agriculture
  22. Crop control
  23. Yellows management strategy
  24. Haze formation
  25. Oxidation
  26. Oak
  27. Novel bacteria and by-products

- Benefit cost analysis was used to derive estimates of each themes expected economic pay off – as measured by a project's net present value (the difference between project benefits and costs over a 20 year period) and benefit cost ratio (the ratio of all project benefits to all project costs).

How we did it?

- Project benefits were determined in consultation with the Principal Investigators and during a workshop with wine-makers and viticulturists. Project costs were obtained from project documents and consultant estimates of possible additional R&D expenditure required for commercial development.

Summary

- In estimating project benefits, an assessment was first made on what the R&D would produce and what additional investment would be required to produce an application ready outcome or technology (product, process or information).

- Industry benefits considered included lower production costs, increased consumer demand (which leads to higher prices), higher quality production, and increased yields.

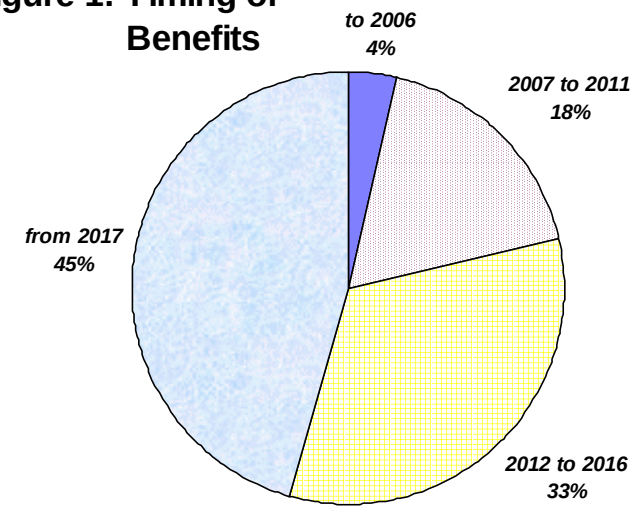
- A one page summary of each evaluation was prepared and is included in this report. Each summary makes explicit the assumptions regarding industry outcomes, benefits to individual technology users, technology adoption through time and risk or chance of achieving a successful outcome. Research lead time has been built into adoption assumptions or appropriation of benefits where appropriate (details provided in appendix).

What we found?

- 27 research themes were assessed – with GWRDC and other industry partner investment having an annual cost some $12 million. The highest cost projects included wine microbiology and Genetic improvement of grapevines, with funding levels of $1.3 and $1.1 million per annum respectively. Lower cost projects included spray application in vineyards and novel fungicide investigations. Spray applications in vineyards has an annual budget of $0.04 million.

- A large number of projects had a high expected pay off (more than $10 of benefit for every $1 invested). Smaller projects tended to have higher benefit-cost ratios as they are at the applied end of the research and development pipeline. Projects such as spray application is applied and low cost. The competitive position of GWRDC (or other public sector bodies) to private industry in the provision of these technologies needs to be considered in order to ensure the most cost-effective transfer. A lead time parameter, or number of years before private industry would deliver a similar technology is incorporated into relevant projects to account for the competitive advantage of extension or accelerated product development time frames as a result of GWRDC financing.

Figure 1: Timing of Benefits



- The majority of investment benefits were estimated to accrue beyond 2011, with only 4% being generated within the next five years. The proposed R&D portfolio considered in this report was estimated to deliver 78% of all generated benefits beyond 2011.

- The investment cost, risk and reward, by investment theme are provided in the Table 1. Note: Reward is expressed as the benefit cost ratio at 100% chance of success. Benefit cost ratio was calculated on all project costs (which include GWRDC and partner contributions). Project cost is only is reported for 2001/02. Total risk and reward have been weighted by individual theme reward and cost (lifetime of project) respectively.

TABLE 1: INVESTMENT COST, RISK AND POTENTIAL REWARD

Theme	Project Title	Annual Project Cost ($'000)	Risk (%)	Reward (BCR)
1	**Breeding and Developing Rootstocks**	831	25	24
2	**Phylloxera**	327	50	25
3	**Vineyard Floor Management**	300	20	22
4	**Grapevine Viruses**	744	25	22
5	**Management of new fungicides - control of powdery mildew and other diseases**	65	50	23
6	**Botrytis Management**	236	50	9
7	**Soil Health Management**	365	50	13
8	**Tannin**	841	10	131
9	**Grape Composition and Flavours**	739	Na	Na
10	**Near Infrared Spectroscopy**	293	50	10
11	**Wine Microbiology**	1,331	10	29
12	**Grape Berry Physiology**	520	25	18
13	**Industry Data**	130	Na	Na
14	**Environmental Management**	401	35	25
15	**Hot Water Treatment**	372	60	36

Summary

Theme	Project Title	Annual Project Cost ($'000)	Risk (%)	Reward (BCR)
16	**Technical Information**	751	80	10
17	**Quality Management**	150	95	9
18	**Spray Application in Vineyards**	41	40	162
19	**Participatory Farm Trials**	525	50	3
20	**Genetic improvement of grapevines**	1,130	20	6
21	**Precision Agriculture**	263	35	35
22	**Crop Control for Consistent Supply of Quality Wine Grapes**	583	40	47
23	**Yellows Management Strategy**	123	10	14
24	**Characterization of Unstable Proteins Involved in Haze Formation**	263	30	49
25	**Random Oxidation**	154	25	89
26	**The Influence of Oak Cooperage on Wine Composition**	181	30	95
27	**Novel Bacteria and By-Products**	198	15	4
Total		**$11.9m**	**21%**	**41:1**
Expected Portfolio Pay off				***9:1***

Key points

- The overall expected portfolio economic return is attractive and estimated to be 9:1. A ratio of this order suggests that each dollar invested by GWRDC in research is forecast to deliver 9 dollars of industry benefits. This return is attractive when considered in relation to other RDCs in Australia. Chudleigh and Simpson (2001*) Report on the Performance of Rural Research and Development Corporations and Options for Future Performance Measures of the RDCs,* Agtrans Research, Brisbane found the following returns for RDCs:

  - Dairy Research and Development Corporation – benefit cost ratio for portfolio of projects 3.2:1
  - Land & Water Australia – benefit cost ratio for portfolio of projects 20:1

- Pig Research and Development Corporation – benefit cost ratio for portfolio of projects 8:1
- Sugar Research and Development Corporation – benefit cost ratio for portfolio of projects 3:1
- Australian Wool Innovation – benefit cost ratio for portfolio of projects 6:1

- A weighted average benefit-cost ratio for RDCs in the Chudleigh and Simpson analysis was calculated and found to be 7.2:1. Based on this analysis the GWRDC portfolio is forecast to deliver above average returns, given a ratio of 9:1 was estimated for grape and wine research. A recent survey of wine and grape industry stakeholders indicated that 90% of respondents are in favour of increasing R&D spending by 50% or more. Benchmark data from other industries supports the view that grape and wine industry is underspending on R&D. Favourable calculated economic returns on research support an increase in funding levels.

- It should be noted that it was not possible to derive monetary estimates for potential environmental impacts within this consultancy time frame. Potential environmental threats to the wine industry should, however, be quantified and individual projects assessed on the basis of their contribution to reducing any environmental risks or consequences. In the absence of this data, it is extremely difficult to determine the magnitude of environmental benefits that could be attributed to individual projects.

- A moderate to high risk profile of 21% was calculated for the portfolio of current projects. Higher risk projects included vineyard floor management, tannin, wine microbiology, yellows strategy, genetic improvement of grapevines and novel bacteria; whereas lower risk projects included extension projects transferring known practices and products. As a general comment, risk is largely considered in terms of the technical aspects associated with each project throughout project proposals. In many cases there will be considerable downstream risks in commercialising technologies including scale-up, marketing and distribution. These risks should be considered to a greater extent within project design.

- The relationship between R&D output and commercial outcome was not readily apparent in some project documents and following discussions with principal investigators. Consequently, project needs and planned outcomes tend to address general issues facing the industry rather than specific industry benefits that can be attributed to the project. The collation and synthesis of grape/wine industry value chain data, along with costs of major diseases and other industry constraints into a journal article or readily available report may help researchers focus scientific efforts on key industry problems. Much of the information for this is available (through the WFA, CIES, ABARE and GWRDC reports).

- As a final comment on project impact estimates, it is noted that economic evaluations have been carried out on current project funding levels, and hence serve only to provide an indicator of relative “value for money”. Prospective evaluations of this type also have value when used in an iterative process to focus project design and output. The potential for repositioning or restructuring projects within each nominated theme is outlined in the strategic issues section.

STRATEGIC PLANNING ISSUES

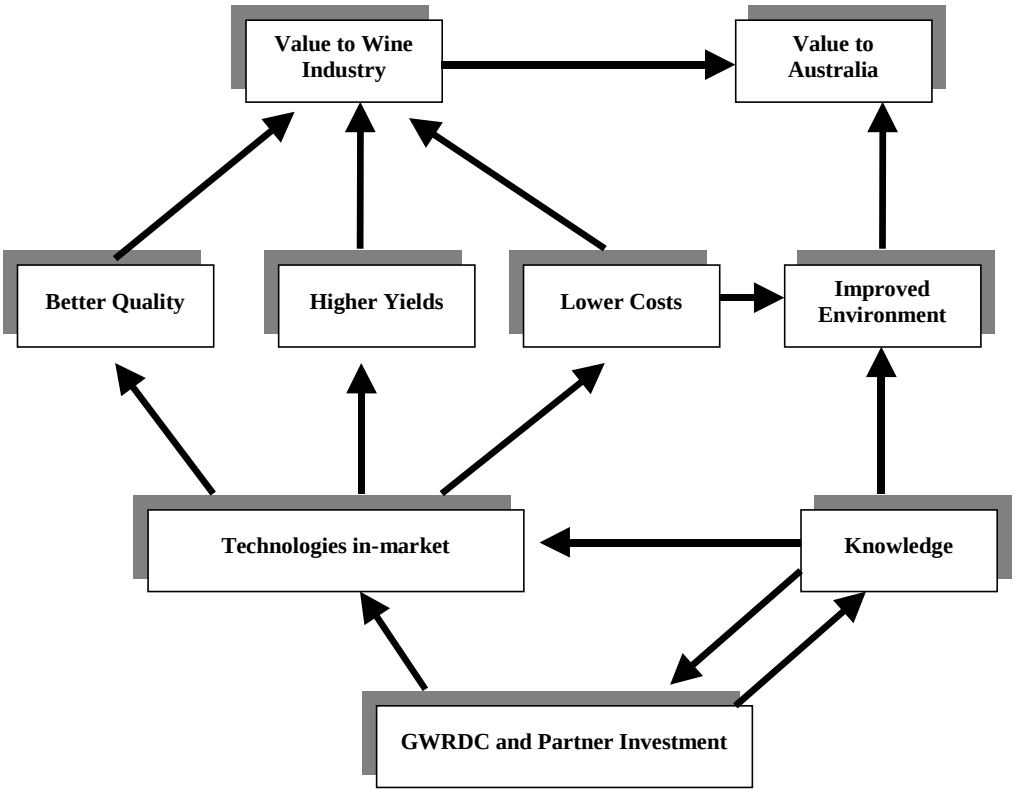
Recent GWRDC strategic planning consultation with industry has identified the following research fields as being of major importance to the wine and grape industry.

- grape and wine quality measurement methods/products;
- methods for improving grape and wine quality and flavour;
- soil and water management strategies;
- water use efficiency methods; and
- market relevant grape and wine quality parameters.

To better define the potential impact of these, and other fields of research, potential research impacts were specified in terms of the type of value created for industry within a cost-benefit framework. Such an approach, where impact assumptions are made explicit, enables debate to focus on key drivers of industry benefit.

Value drivers quantified in the cost-benefit analysis framework include better product quality, higher yields and lower costs. Some projects are not designed to deliver a commercial outcome – they often just contribute to knowledge and subsequent R&D is typically needed before a commercial outcome is achieved. These projects should be assessed from a wider portfolio perspective and be considered on the cost effectiveness of their contribution to generating knowledge.

FIGURE 2: VALUE DRIVERS FOR THE WINE & WINE GRAPE INDUSTRY



Each of the research themes (or clusters) assessed in this report can be classified into broad areas based on how they contribute to industry value. These areas include quality enhancement, yield improvement, cost reduction or knowledge. Many of the research themes contribute in two or more areas, but are classified by the area of maximum economic value realised. The assumptions used to quantify each of the research themes are made explicit in each one-page summary.

TABLE 2: GWRDC INVESTMENT AREAS

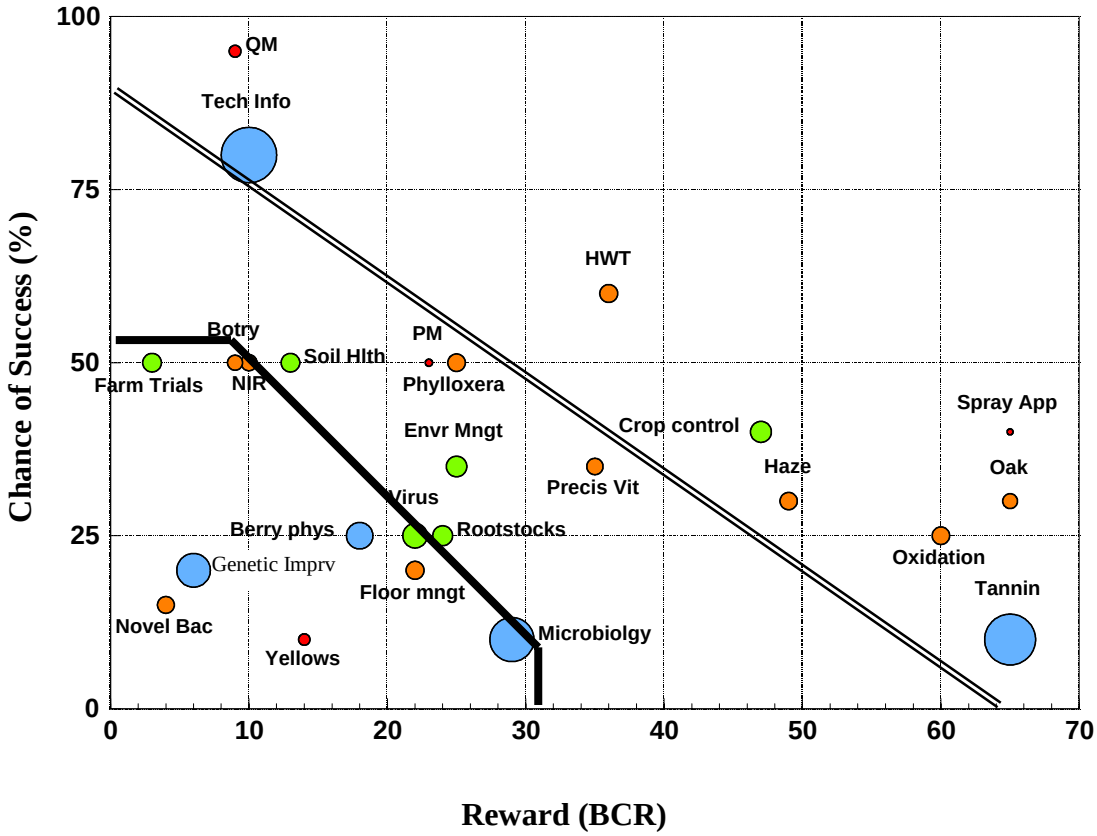
Target	Grape Production	Wine Production
1. Quality	• Genetic improvement of grapevines • Spray Application • Powdery Mildew • Botrytis	• Tannin • Environmental Mgt • Oak Cooperage
2. Yield	• Phylloxera • Viruses	
3. Costs	• Rootstock Breeding • Floor Management • Soil health • Hot water treatments • Precision Viticulture • Yellows	• Near infrared spectroscopy • Microbiology • Technical Info • Haze formation • Oxidation • Novel Bacteria
4. Knowledge	• Industry data • Farm Trials • Quality Management • Grape Composition	

From the table it is evident that most research themes fall into the classification of enhancing quality or reducing industry costs. Under knowledge, the broad thrust of investment is to stimulate technology adoption across the industry. However, some themes included in other areas might more appropriately fall into the knowledge area. For example, wine microbiology and genetic improvement of grapevines.

Portfolio Matrix: Risk / Reward Tradeoff

Each of the 27 research themes are plotted on the following matrix (by economic impact (reward) and respective level of risk) to gain an appreciation for portfolio balance and the relative importance of differing research fields in the delivery of industry value. The size of the circle reflects the relative size of the investment in each theme. (Red <$0.5m, brown $0.5m to $1m, green $1m to $2m and blue >$2m.)

FIGURE 3: GWRDC PROPOSED INVESTMENT PORTFOLIO: RISK VERSUS REWARD



Key points

- Generally, the portfolio is well balanced for risk versus reward. Research devoted to improving the tannin profile of wines and extending technical information are large investments, but risk balance is appropriate and both are economically attractive. Some relatively high risk projects such as oak cooperage, haze and oxidation have significant economic attractiveness due to the large potential industry benefits of research outcomes. (In Figure 3 the Reward from these projects are understated to enable a better graphically representation of all investments. The estimated rewards from these investments are substantially higher, as reported in Table 1.)

- Investments underneath the double line, but outside the bottom left hand box could be re-positioned to address or to achieve greater reward for the risk taken or lower risk for the potential reward. Re-positioning may entail reducing project costs, or leveraging off overseas research efforts at a later date to achieve desired industry outcomes.

- Investments in the left hand area underneath the solid black line have a poor risk / reward trade-off, and should be re-structured. Many of the research projects in this section of the matrix have low potential industry adoption, or high risk. Greater effort should be focused on achieving adoption. This shift need not occur at the expense of strategic research if greater resources can be attracted.

- In Table 3 investments are summarised by their risk / reward trade-off. It is evident that the majority of projects could be repositioned or restructured as discussed above. This would enable the potential expected portfolio return to be significantly increased. Apart from the higher pay off to stakeholders, it would enable more strategic or fundamental work to be undertaken without compromising portfolio pay off.

- One final comment is that there appears to be no clear area (see Table 2) where the expected pay off is greatest. Often there is a tendency to look at potentially high benefit areas and allocate funds accordingly. We would stress the need to look at each prospective investment and assess its contribution to the portfolio objective, in terms of risk and reward. Ex-ante evaluation of investments provides a useful tool for this purpose. Further, making explicit evaluation assumptions enables robust performance indicators to be developed, and more important, to be used to actively manage investments through time.

TABLE 3: IMPROVING PORTFOLIO PAYOFF: INVESTMENTS WHERE RISK / REWARD BALANCE COULD BE IMPROVED.

Theme	Project Title	Expected Reward (BCR)	Risk (%)	Reward (BCR)
Appropriate risk / reward balance				
18	**Spray Application in Vineyards**	64	40	162
26	**The Influence of Oak Cooperage on Wine Composition**	43	30	95
25	**Random Oxidation**	22	25	89
22	**Crop Control for Consistent Supply of Quality Wine Grapes**	22	40	47
15	**Hot Water Treatment**	22	60	36
24	**Characterization of Unstable Proteins Involved in Haze Formation**	20	30	49
8	**Tannin**	13	10	131
17	**Quality Management**	8	95	9
16	**Technical Information**	8	80	10

Theme	Project Title	Expected Reward (BCR)	Risk (%)	Reward (BCR)
Need to Be Better Positioned for Risk or Reward				
2	**Phylloxera**	12	50	25
21	**Precision Agriculture**	12	35	35
5	**Management of new fungicides - control of powdery mildew and other diseases**	11	50	23
1	**Breeding and Developing Rootstocks**	10	25	24
4	**Grapevine Viruses**	9	25	22
7	**Soil Health Management**	7	50	13
14	**Environmental Management**	7	35	25
Need to be re-structured				
10	**Near Infrared Spectroscopy**	6	50	10
3	**Vineyard Floor Management**	5	20	22
12	**Grape Berry Physiology**	5	25	18
6	**Botrytis Management**	5	50	9
11	**Wine Microbiology**	3	10	29
20	**Genetic improvement of grapevines**	3	20	6
19	**Participatory Farm Trials**	1	50	3
23	**Yellows Management Strategy**	1	10	14
27	**Novel Bacteria and By-Products**	1	15	4

ECONOMIC EVALUATION OF INVESTMENT AREAS

In this section economic evaluation parameters for future investments supported by GWRDC are discussed. Each evaluation has been reported in a consistent manner with key assumptions made explicit. The format used is described in some detail in the box below.

BOX 1: REPORTING FORMAT FOR INDIVIDUAL EVALUATIONS

R&D Output:

- What will be produced at the completion of the GWRDC supported project?
- Output will typically be a technology – be it a product, process or information.

Industry Outcome :

- What further steps will be required before the technology has a commercial application across the industry?
- When will the technology be commercially available?
- What type of gain or benefit will be realised by the industry?

Benefit in Use :

- For the typical technology user, what is the estimated benefit in dollar terms?
- Derivation of monetary benefits is shown.

Benefits through time

The distribution of estimated benefits over a 20 year period is shown graphically.

Adoption:

- Size of market
  How large is the target market where the technology could potentially be used?
- Max adoption (as % of market)
  What is the anticipated level of take-up or adoption within the target market?
- Rate of adoption %
  Over what period of time will the technology be taken up within the target market?

Risk: Risk level: (likelihood that industry outcome achieved)

- Is the commercial outcome guaranteed or is there an element of risk?
- What are the major determinants of project risk?

Conclusion:

- Is the project attractive from an economic perspective?
- What is key driver of pay off and at what point would the project break even?

R&D Output:

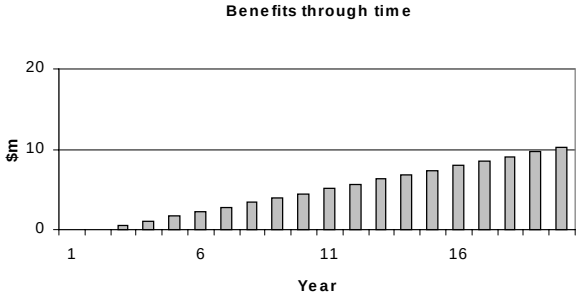
- To collect and analyse data of essential rootstock characteristics and determine modes of inheritance
- Characterise stress response of major varieties and relate to Water Use Efficiency (WUE) and develop biochemical markers for rapid selection
- Identify scion and rootstock combinations with high water use efficiencies and other desirable characteristics
- Characterise genotype differences that impact upon transpiration efficiency, water use efficiency and crop-water relationships
- Recommend most efficient irrigation strategies (scheduling) and system design for specific varieties and scion/rootstock combinations

Industry Outcome:

- Initially, more efficient use of irrigation water – increase in crop productivity per ML, or decreased vineyard production costs.
- Enhanced fruit quality through improved water use.
- Smarter, more focused breeding and selection of rootstocks (targeting soil borne pest resistance, high vigour, reduced salt uptake & improved fruit)
- Reduced off-site impacts from irrigation (less salinity, and enhanced flows)

Benefit in Use:

- Decreased use of irrigated water per bearing area of vineyard to support current yields and enhance fruit quality
  - Assume decrease in water use of 2ML/ha per adopting hectare, average cost of water (@$80/ML)
  - Assume grape price increase @$20/t
  - Target area 25% of industry
  - Assume adoption of improved timing has no additional labour cost.
- Annual total benefit across target segment of industry = $14.3 million
- Additional on-going research costs would be required to extension of project recommendations (@$0.1m per annum)



Adoption:

- Max adoption - 25% of industry.
- Rate of adoption 1% per annum within target area. Adoption may be limited in near-time with slow down in expansion.
- Year of initial adoption = 2004 (improved irrigation recommendations extended)

Risk: Medium risk because (25% chance of success):

- Demonstration that different scion-rootstock combinations and varieties have differing WUEs that could be exploited
- Dissemination of WUE enhanced planting material would utilise existing distribution infrastructure and networks.

Conclusion:

- Investment attractive with NPV = $10.6 million and BCR = 10

R&D Output:

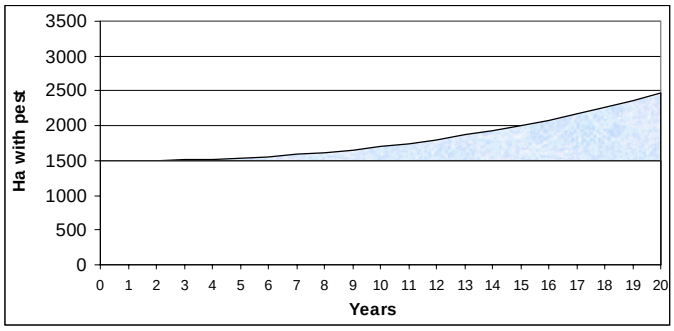
- R&D on phylloxera is being undertaken across State and federal organisations, with some support provided by GWRDC.
- GWRDC investment is aimed at developing revised guidelines for phylloxera identification and management.
- Considerable scientific knowledge on genetic variation in phylloxera, significance of different biotypes and general interaction between phylloxera and grapevines.

Industry Outcome:

- Phylloxera currently infests around 1.5% of grapevines in Australia – or around 1,500 ha. R&D in this area is aimed at limiting its further spread. (However, there are likely to be infested areas where phylloxera is present but has not yet been detected – usually takes 2 to 3 years to notice.)
- Understanding of what rootstocks to use in different areas.
- Scientific knowledge and trained researchers (PhD).

Benefit in Use:

- While grape growers with phylloxera may be able to more cost effectively manage their infestations, the main benefit will be realised from limiting further spread.
- Without the proposed projects it is assumed that phylloxera would spread at a moderate rate – across 80,000 ha of susceptible rootstock over the next 100 years. Only a moderate rate of spread is expected given the control and quarantine culture that exists.
- The vineyard impact of phylloxera typically requires a one-off re-planting with resistant rootstock as well as a yield loss during vine reestablishment – estimated at $50,000 ha.



Adoption:

- Adoption of outcomes will be high given the current awareness and quarantine controls.
- Over the next 20 years phylloxera infested areas could reach 2,500 ha without GWRDC investment (new infestations not those that exist now but have yet to be detected).
- It is anticipated that the spread of phylloxera can be limited to current areas.

Risk: Moderate risk because (50% chance of success):

- Rate of spread could be substantially higher and infestations more widespread hence limiting impact of R&D outputs.
- Current dissemination pathways are well established and utilised by grape growers.

Conclusion:

- The NPV is estimated at $10.4m with a BCR of 12.4
- Driver of pay off is extent that the spread of phylloxera can be reduced. Breakeven point is 260 ha protected from phylloxera over 20 years.
- Break-even vineyard cost is a one-off control of $4,000 per ha.

R&D Output:

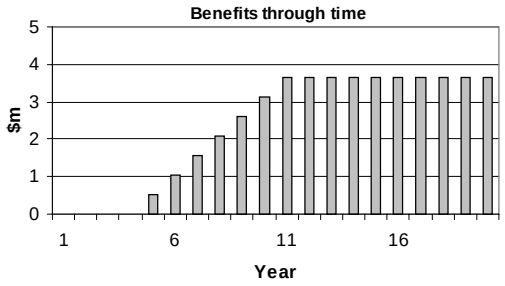
- Package of weed control strategies, developed through a number of on-farm trials, that are cost effective against existing practices.
- Effective bacteria based biological weed control agent and application methods.
- Evaluation of Swiss style ground cover methods for weed control.
- Scientific knowledge that will contribute to on-going work on improving grape yield and quality.

Industry Outcome:

- Projects within this group are aimed at providing cost effective alternatives to traditional weed control practices based on reduced herbicide requirements.
- More effective use of existing practices – for example selection of ground cover species.
- Environmental benefits are also targeted through increased biodiversity and reduced herbicide drift.

Benefit in Use:

- It is anticipated that herbicide use could be reduced by up to 50% without any loss in yield or grape quality (new spray applicators in US achieving 50% to 80% reduction p221 10th AWI Technical conference).
- Herbicide application cost around $225 ha – 55% chemical, 37% labour & 8% machinery or $34m a year across the industry (Agriculture Departments gross margins & ABARE benchmarks). 50% reduction equates to $112 per ha. No additional implementation costs are assumed.
- Environmental saving have not been estimated at this stage, but are likely to be of less value than economic gains (less than $5 ha).



Adoption:

- General application across industry with impact of three year funding across 20%
- Adoption starts in 5 years with moderate take up over 7 years.
- No additional commercialisation costs

Risk: high risk because (20% chance of success):

- Chemical control very cost effective and will be difficult to get reduced chemical use without any loss in yield or quality.
- R&D is largely fundamental in nature.

Conclusion:

- The NPV is estimated at $3.3m with a BCR of 4.5.
- Breakeven for the investment was calculated at a minimum profit gain of $100 ha with at least 7,500 ha adoption as a result of the projects.
- Real value of investment is in understanding the floor ecosystem and helping position industry to respond to more stringent regulations and OH&S requirements and development of niche organic markets.

R&D Output:

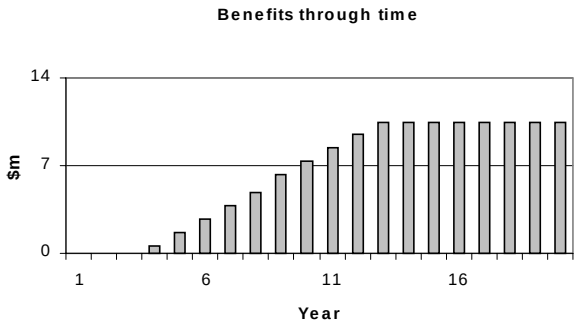
- Collated information about scion-understock combinations – create database about certified combinations. Establish small-scale grafting tests
- Development and validation of novel, highly specific and sensitive PCR assays for four most important grapevine viruses.
- Characterise grapevine virus populations, study the spread of GLRaV-3 and etiology of Restricted Growth Syndrome.
- Increase stock of knowledge about Leafroll (GLRaV-1) in the field, assess current detection protocols and produce appropriate certification protocol

Industry Outcome:

- Decrease the possibility of virus spread in key propagation materials using diagnostic tests and reduce spread potential by detection of insect vector
- Reduced incidence of under-performing scion-understock combinations – particularly Spring Growth Syndrome in Merlot D3 V14.

Benefit in Use:

- Reduced incidence of viral diseases and increase yields of vineyards.
  - Assume average yield increase of 1t/ha for adopting vineyards (yield increase highly variable – 15% yield loss common)
  - Average price of fruit (@$700/t)
- Annual total benefit at maximum adoption = $10.5 million
- Additional on-going research costs would be required to support supply of disease-free planting material (@$0.4 million per annum for 5 years)



Adoption:

- Maximum adoption - 10% of industry. Key targets include Merlot production areas, southern WA. Most analysis to date focusing on Sultana varieties and within warm irrigated areas.
- Rate of adoption – 1% per annum. Adoption driven by industry expansion and replanting, along with demand for rootstock verse own-root planting.

Risk: Medium-high risk because (25% chance of success):

- A significant component of the research involves development of diagnostic tests which employ currently know techniques and approaches
- Rootstocks to be used for experimentation are already fully established mature vines
- Difficult to correlate between the disease symptoms in the field and the diagnosis of particular viruses as seen in the laboratory

Conclusion:

- Investment attractive with NPV = $14.1 million and BCR = 8.9
- Reduced potential for Phylloxera outbreak also generates substantial economic benefits for industry.

R&D Output:

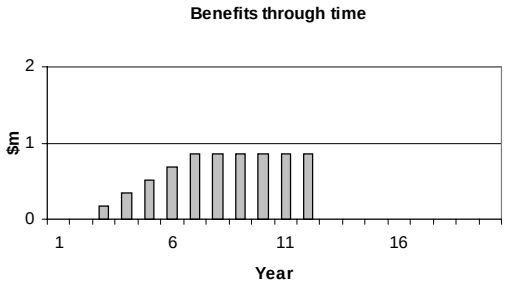
- Develop and evaluate strategies, notably application rate and volume, for the use of new fungicides (strobilurins) for control of powdery and downy mildew – including potential for resistance
- Establish baseline sensitivities for new fungicides and to develop early warnings of resistance
- Determine protective and curative limitations of new fungicides for the control of grape diseases.

Industry Outcome*:*

- Reduce fungicide use on grape vines through strategic use of strobilurin fungicides
- Decrease potential for residues to impact upon export demand for Australia grape and wine products
- Decrease the potential for off-site impacts of sulfur and DMI pesticide products.
- Reduce the estimated $17.2 million production loss cost impact of powdery mildew on the Australia grape industry.

Benefit in Use*:*

- Decreased the impact of powdery mildew
  - Assume decrease in farm-level powdery mildew cost by 5% at maximum adoption
  - Assume adoption of improved product has no additional labour, capital or consumable costs. (lower number of more expensive sprays)
- Annual total benefit across target segment of industry = $0.9m
- Additional on-going research and development costs would be required to extension of project recommendations (@$0.05m per annum, for 3 years)



Adoption:

- Max adoption – assume that adoption results in a 5% reduction in cost of powdery mildew.
- Assumed that new strategies are launched by 2004
- Rate of adoption - 5 yrs to maximum adoption
- Competitive lead of 10 years included, as private industry could commercialize strobilurin products in Australia

Risk: Medium risk because (50% chance of success):

- Demonstrated success of *Research to Practice* programs within viticulture industry
- Industry need to be convinced of increased efficacy or other benefits of alternate fungicide products

Conclusion:

- Investment attractive with NPV = $2.1 million and BCR = 11.4.
- Likely to be extension and development follow-on funding requirements (even if leverage off current extension).

R&D Output:

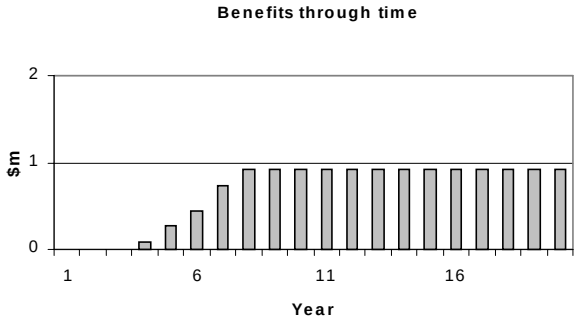
- Information on potassium metabisulphite (PMS) and calcium activity for Botrytis control
- Establish baseline sensitivities of Botrytis to new and existing fungicides
- A better understanding of Botrytis infection pathways, distribution of mating strains and mechanism of resistance development
- Optimal disease management strategies to optimise wine quality

Industry Outcome*:*

- Improved fungicide resistance management strategies and reduced potential for increase in impact of Botrytis
- Decrease potential for residue impacts of export demand for Australia grape and wine products
- Reduce the estimated $18.3 million (production loss and quality) farm-gate impact of Botrytis on the Australia grape industry – largely through accurate prediction of spray timing to prevent late disease expression and resistance management.

Benefit in Use*:*

- Decrease the cost impact of Botrytis
  - Assume decrease in farm-level Botrytis production loss cost by 5% at maximum adoption
  - Assume adoption of improved product has no additional labour, capital or consumable costs (lower number of more expensive sprays)
- Annual total benefit across target segment of industry = $0.9m
- Additional on-going research and development costs would be required to extension of project recommendations (@$0.1m per annum, for 3 years)



Adoption:

- Maximum adoption – assume that adoption results in a 5% reduction in cost of Botrytis. Key areas targeted for adoption include cooler climates where current use of fungicides and disease outbreaks are most substantial.
- Rate of adoption - 5 yrs to maximum adoption with new management launch in 2005

Risk: Medium risk because (50% chance of success):

- Demonstration success of *Research to Practice* programs within viticulture industry.
- Variable nature of Botrytis may confound simple and readily adopted recommendations
- Artificial inoculation technique and overhead misters will ensure results not dependent on weather
- Substantial demand by industry for improved fungus management programs

Conclusion:

- Investment attractive with NPV =$2.9m and BCR = 5.2
- Likely to be extension and development follow-on funding requirements

R&D Output:

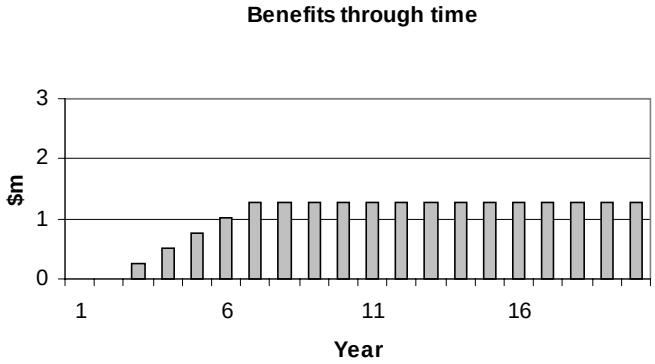
- Manual, available for commercial distribution, on subsoil amelioration practices. Viability of practices tested - performance trials in 2 vineyards.
- Novel machinery developed to prototype stage with documentation of appropriate practices for subsoil amelioration.
- Scientific knowledge on role of arbuscular mycorrhizal fungi, developed for inoculation of rootlings, for better nutrient recycling.

Industry Outcome*:*

- Water savings are expected to be realised as vine roots access additional subsoil moisture. This will reduce the need for river extractions and increase water availability in dry seasons from on-farm storage facilities.
- On vineyards with irrigation only from on-farm storage, yields are expected to increase as a result of greater water availability in drier seasons.
- Reduced salt build up in soil may lower wine sodium content in some areas
- Trained researchers in the field of soil health and nutrient recycling.

Benefit in Use*:*

- On irrigated vineyards with water allocations the saving of 1 ML (12% of water used per ha) would reduce irrigation and drainage costs by $31 and generate $14.50 from sale of the allocation (ABARE).
- On vineyards utilising only their on-farm water storage a yield increase of 2% a year is assumed. Downside yield risks from adverse climatic conditions (including for example late frosts, dry spring, wet weather, hail and sunburn) were estimated at 14% on average yields across Australian production. At an average yield of 12t per ha and $700t, the yield increase is valued at $168 ha. Allowing for harvesting costs of $50 t, the net benefit is estimated at $156 ha. (Same argument could be couched in terms of quality gains rather than yield.)
- Implementation costs estimated at $30 ha – based on labour and capital costs associated with 2 hours of machine time per ha each year (Gross margin estimates).



Adoption:

- Target market based on 60% of vineyards with known soil compaction problems
- 50% of vineyards use river extractions.
- Moderate adoption - 25% of target market over 5 years from 2004. Can be trialed on small part of vineyard to assess benefits

Risk: medium risk because (50% chance of success):

- Commercialisation path straight forward as potential technologies will only require slight modification to existing equipment.
- Understanding of soil health impacts on yield / quality to be researched.

Conclusion:

- The NPV is estimated at $5.8m with a BCR of 6.6.
- Breakeven assumptions are $80 profit increase per ha (yield or quality) and 8% adoption.
- Significant upside potential – water prices likely to increase in future.

R&D Output:

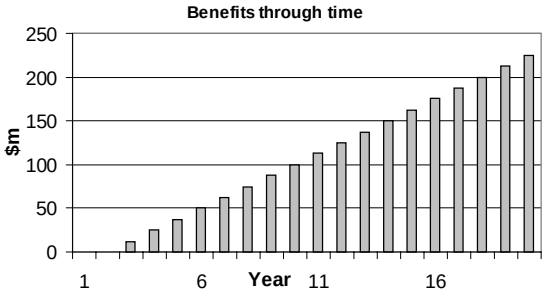
- R&D in this area is mainly of a strategic nature with an industry reference group used to ensure commercial relevance is maintained and promote adoption across the industry.
- Technical papers in a range of Australian and international journals.
- Master and PhD dissertations.
- Recommendations on viticultural and oenological techniques to improve red wine colour and mouth feel.

Industry Outcome*:*

- R&D in this area will continue over 10 years ($0.55m annual investment) and will enable wine makers to use the generated information and technologies to better plan their operations and achieve desired wine quality.
- To foster adoption and strengthen links between R&D and commercial production additional funding will be required – estimated at $200,000 a year.
- Trained researchers at the Masters and PhD level. Viticulturists, winemakers, and oenologists who are experienced in experimental winemaking and continue to strengthen a culture of innovation.

Benefit in Use*:*

- The impact of work in this area will be the continued increase in quality of Australian red wines. No additional winery costs assumed.
- It is unknown how much work in this area has contributed to quality gains to date – but it is assumed that 250ML can continue to be improved as a result of investment in this area over the next 20 years. The assumed margin increase per litre is $1 over the next 20 years.



Adoption:

- Adoption assumptions are implicit in the assumed rate of product up-grade over the next 20 years.
- Continued investment will be required with industry impacts lagged 2 years to enable commercialisation of ideas.

Risk: High risk because (10% chance of success):

- R&D is very strategic and involves the development of innovative scientific methods.
- Outcomes rely on identification of suitable quality parameters and the endorsement of processes to improve the control on colour and mouthfeel properties.
- Will involve optimisation of R&D outputs and adoption to commercial production.

Conclusion:

- The NPV is estimated at $94m with a BCR of 13.1.
- Breakeven adoption is 19 ML and breakeven premium is 8c a litre.
- Main driver of pay off is risk and lag for commercial impact of R&D.
- High cost investment.

Grape Composition and Flavours (CRV 6AWR, AWR6)

R&D Output:

- Develop precise analytical methods for quantification of key volatiles
- Develop specifications for flavor constituents of wine grapes. For example, chemical nature of compounds related to black pepper flavour in Shiraz wines
- Availability of stable Isotope Dilution Analysis and Chemical Ionisation methods to determine abundance of grape components
- Determine the influence of viticultural practices on the levels of grape flavour
- Protocols to manage the production of 4-ethylphenol in red wines

Industry Outcome:

- Enhancement of grape and wine quality through development of tools (key volatiles) and viticultural practices recommendations to optimise grape flavour.
- Specifically, strategic information on the identity and chemical nature of compounds, for example, those responsible for black pepper aroma in Shiraz wines extended, and viticultural and oenological practices synthesised to control the aroma.

Benefit in Use:

- Enhancement of wine quality (primary focus)
  - Eventual wine price increase
- Benefits not quantified as the research is largely strategic in nature
- Additional on-going research and development costs would be required to extension of project recommendations (@$0.3m per annum, for 5 years)

Not relevant

Adoption:

- Max adoption – Possibly black pepper aroma research relevant to Shiraz style wines.
- Adoption of industry outcome not likely before 2010, as research largely generating information.

Risk: Medium risk because:

- Substantial demand by industry for improved production and objective measurement techniques
- Objective tests require further calibration.
- Considerable research effort required, largely strategic in nature

Conclusion:

- Investment returns not calculated as project generating strategic information for future product enhancement.
- Nature of premium difficult to predict as impact of analytical tools and improved viticulture practices on wine quality not readily apparent.

R&D Output:

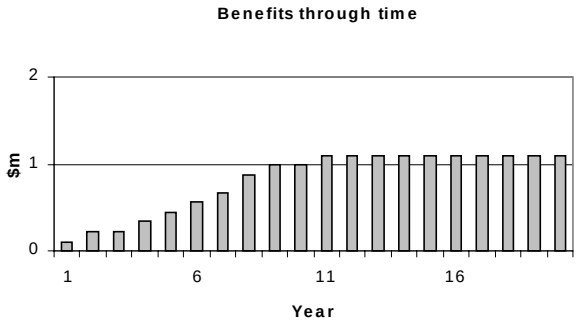
- Development of a NIRS method for analysing grape samples for colour, pH and total soluble solids that entails minimal sample preparation and employs cost-effective fibre optic probe instrumentation.
- Evaluation of feasibility of NIRS determination of grape seed and wine phenolic composition.
- Increase in stock of knowledge about use of NIRS to assess degree of Botrytis infection in grapes

Industry Outcome*:*

- Enhancement of grape quality through development of simple, rapid and cost-effective tool to objectively evaluate fruit characteristics (colour, pH and total soluble solids).
- Enhanced dispute resolution between growers and wine makers due to objective measurement
- Reduce the cost of objective measurement. Current techniques, including grape colour assessment, terpene analysis, nitrogen concentration, phenolics analysis and GG-analysis are costly and have slow turn-around. NIRS is also likely to have an impact on methanol content measurement in the medium term.

Benefit in Use*:*

- Reduced cost of red and white grape sampling.
  - Assume average cost of red/white grape sampling reduced from 0.5 hours per sample to 0.1 hours per sample, a saving of $8 per sample (Labour = @$20/hour. Consumable and capital costs not estimated)
  - Assume 100,000 grape sample tests (including colour, GG) undertaken per year. Annual total benefit = $0.8m per annum, reduced cost of methanol content analysis. (@$0.3 million per annum)
- Additional development costs would be required to extend NIR (@$0.1m per annum, for 5 years)



Adoption:

- Rate of adoption - 10 yrs to maximum adoption
- Benefits projected from 2002 onwards (currently only limited use of NIR_
- No dis-adoption assumed to occur

Risk: Low risk because (50% chance of success):

- Substantial demand by industry for improved objective measurement techniques, although some resistance to adoption of objective techniques for fruit payment, due to subjective elements of grape quality.
- Calibration of flavour objective measurements needs to be refined, along with components of flavour further investigated.

Conclusion:

- Investment attractive NPV = $3.7 million and BCR = 5.9
- Would break-even on methanol testing benefits alone

R&D Output:

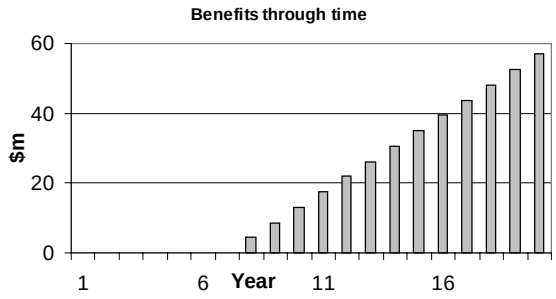
- Understanding of malolactic fermentation and wine flavour.
- Understanding of how yeast contributes to wine flavour and fermentation activity and development of novel yeast to give wine makers more control.
- Investment to run over 5 years.

Industry Outcome*:*

- Information to assist wine makers select better performing yeasts and malolactic bacteria.
- Novel yeast products including genetically modified strains.
- Better control of fermentation process will reduce problems such as need for additives or re-inoculation, dilution or blending extended fermentation times and poor flavour profiles. No additional development costs.
- Better control of wine microbiology will also build a platform for winemakers to exploit opportunities to improve wine flavour. This will enable winemakers to further differentiate their wines through style.
- Trained researchers to PhD level.

Benefit in Use*:*

- Longer term gains in wine flavour are likely, and this will translate to increased demand for wine as consumer needs are better targeted. The increase in price as a result of greater consumer demand is assumed to be an extra 25c litre. The main market will initially be wine in the premium segment - accounts for around 50% of production or some 500ML.



Adoption:

- Maximum adoption is high – estimated at 70% as winemakers continually implementing strategies to differentiate their wines.
- Rate of take-up expected to be slow as there will need to be considerable commercial validation of information or products – assume over 20 years starting from 2008.

Risk: high risk because (10% chance of success):

- Fundamental and strategic work
- commercialisation risk moderate as infrastructure for product manufacture and delivery well established – costs may actually increase.
- Outcomes might only be applicable to niche opportunities rather than across the industry.

Conclusion:

- NPV estimated at $11.1m and BCR at 2.9.
- Breakeven adoption is 24% and breakeven premium is 9c litre. However, pay off not overly sensitive to these variables. .
- High cost project for level of potential benefits – risk is the main issue for management of the proposed investment.

R&D Output:

- Determination of the impact of water stress on relative flow of photosynthates to sugar accumulation and secondary metabolism (colour and flavour)
- Increase understanding of physiological and anatomical aspects of berry shrivel
- Examination of environmental triggers for the onset of ripening delay in major cultivars (experiments & analysis of historical data)
- Quantification of the influence of stress signals – eg. from partial root drying (PRD) on flows of carbon into primary and secondary metabolism
- Development of model to incorporate impacts of stress and management variables on accumulation of sugar, colour, shrivel and flavour in red grape berry
- Characterising the genes for key enzymes in the ABA biosynthetic pathway and how pathway affected by water deficit

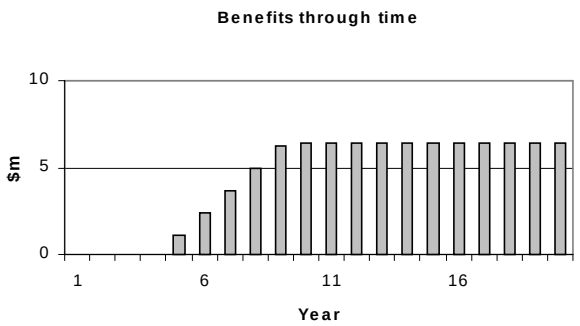
Industry Outcome*:*

- Enhancement of grape quality and production through development of decision support systems and viticultural systems
- Reduced incidence of sub-optimal maturation profiles for key Australia grape varieties – resulting in low sugar accumulation and disruption in winery intake schedules.
- Decreased incidence of berry weight loss, through extension of best pre-harvest management

Benefit in Use*:* Enhancement of red grape quality and production through improved management

- Assume red grape price increase by 5% (@$35/t)
- Assume red grape production increase by 3% (@$700/t) – less shrinkage

- Additional on-going research and development costs would be required to extension of project recommendations (@$0.2m per annum, for 5 years)



Adoption:

- Max adoption – assume that 15% of red wine production for quality and reduced shrinkage practices
- Rate of adoption - 5 yrs to maximum adoption.
- Initial adoption = 2006 (extension of best practices and systems begins)

Risk: Medium risk because (25% chance of success):

- Incorporation of decision support system into Viticare 3 (participatory farm trials), along with industry requests for vineyard management systems

Conclusion:

- Investment attractive with NPV = $9.2 million and BCR = 5.4
- Strategic plant breeding benefits not incorporated in analysis, the inclusion of which, would increase estimated industry returns.

R&D Output:

- Information on regional winegrape crush and prices received for different varieties.
- Estimated future winegrape production and winery intake – 2004/05.
- Viticulture and wine production data across Australia – including bearing and non-bearing areas.
- Extension forum through National Winegrape Outlook Conference.

Industry Outcome*:*

- Information and forecasts on viticulture and winemaking is used across the industry to plan future production (by variety) and to assist in price negotiations.
- Imbalances in future demand (preferred intake) and supply (bearing areas) assessed by industry to plan regional plantings.
- Coordinating information collection and analysis through a central body, enables cost efficiencies to be gained – from avoiding duplication and achieving more robust estimates at regional and national level.

Benefit in Use*:*

- Benefit to industry will be determined by the cost efficiencies achieved.
- Industry is able to pay for the information as benefits likely to exceed costs.
- No quantification made as issue for GWRDC is whether or not current investment represents the most equitable means of payment across industry members.

Benefits not quantified

Adoption:

- Information disseminated at a regional level and also at National level through existing networks.

Risk: No risk because (100% chance of success):

- Survey design and implementation straight forward
- Information is disseminated through established industry networks.
- Information delivered is central to investment planning decisions made across the industry

Conclusion:

- Expectation is that benefits exceed costs from National coordination rather than individual collection and analysis at either regional or business level.
- Public good nature of information suggests that adoption of user pays unlikely to be successful.

R&D Output:

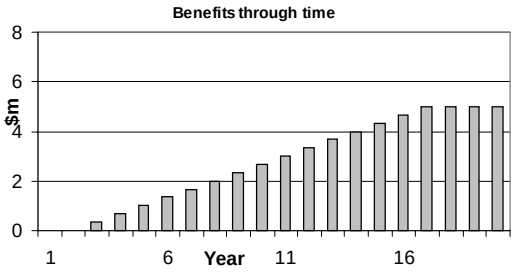
- Number of publications produced on the impact of management techniques on beneficial arthropods and the economics of these management systems compared to alternatives.
- Information on environmental impacts of pesticide use and development of simple farm level tools to monitor movement and impacts of pesticides on farms.
- Development and validation of suitable biological indicators for use on Australian winegrape growing properties.

Industry Outcome*:*

- Identification of indicators of management practices which lead to increased levels of benefits without compromising yield or quality may lead to decreased reliance on pesticides.
- Tools and information on environmental impacts of winegrape production that will support investment work in on-going integrated pest management systems. Ultimate benefits will require further investment. Benefits will be realised through other R&D investment areas. Such benefits will include reduced production costs, increased yields, and more important, reduced environmental impacts associated with winegrape production in conventional production systems.
- R&D will enhance the image of Australian wines as a leading industry in addressing long term environmental concerns.

Benefit in Use*:*

- Main impact will be to tap into growing consumer concerns over environmental management and influence demand for Australian wines relative to wines from other origins. Impact could be the reverse where demand erosion is avoided.
- No premiums exist now, but increase in demand should see some price impact – estimated at 10c litre over 50 ML over the next 15 years.



Adoption:

- Target market is 50ML of increased consumer demand over 15 years – slow consumer response.
- Adoption starts 2004.

Risk: Medium to high risk because (35% chance of success):

- Regional variations in production may require more specific strategies.
- Demand for Australian wine is quite price elastic and achieving price impacts will require considerable discrimination by consumers.
- Costs of producing more "eco-friendly" may be significant and offset any price effects.

Conclusion:

- NPV estimate at $8m and BCR at 6.6
- Breakeven at 2c per litre premium or 8 ML of production that attracts the 10c litre premium.
- Economic benefits likely to be substantial with environmental benefits able to "free ride"- strategic importance for industry.

R&D Output:

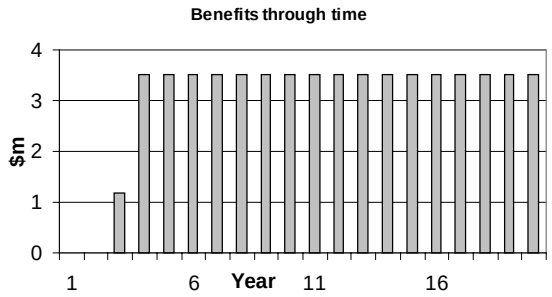
- Understanding of losses associated with hot water treatments including identification of pathogens involved.
- Protocols for hot water treatments to minimise losses of planted vines – cause of losses largely a result of before and after hot water treatment practices.
- Extension seminars and QA systems and manual for hot water treatment with Australian Vine Improvement Association accreditation.

Industry Outcome*:*

- Introduction of a bar-coded identity preservation and data processing system for cuttings.
- Reduced costs associated with failure of planted vines – cost of replanting and delayed earning of profit.

Benefit in Use*:*

- Vines are typically replanted every 15- 20 years – some 7,500 ha a year.
- Planting costs are $3.5 per vine with 1,800 vines per ha - $6,300 per ha.
- Vine failures are 12.5% of plantings.
- Lost profits over 20 years is $1,563 based on delayed production by one year and farm cash income of $2,000 per ha.
- Maximum annual cost of vine failure is $7m – proposed R&D investment should reduce this cost by 50%.



Adoption:

- Benefits first realised in 2004.
- Take-up over 3 years across nursery industry – very quick given AVIA accreditation.
- No additional cost of implementing protocols.

Risk: Medium to low risk because (60% chance of success):

- Based on application of established principles and scientific methods.
- Relationship between known pathogens and vine failure needs to be established.
- Developed protocols will need to be cost effective – no additional cost on nursery sector.

Conclusion:

- NPV estimated at $19.4m with BCR at 21.5.
- Breakeven risk is 3% or 2% reduction in vine failure.
- Greatest sensitivity is the extent to which vine failure can be reduced – at given 60% chance of success only need a reduction in vine failure from 12.5% to 12%.

R&D Output:

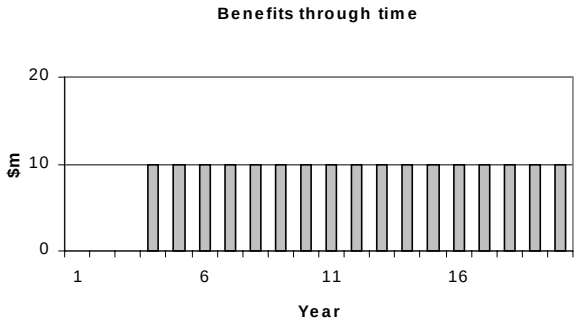
- Provision of packaged technical information (compendium) on topic-specific issues for all wine industry practitioners
- Production of complementary training material (targeting recurring wine making problems) for structured workshops, publish manual on the internet
- Provision of Technical Review
- Update of Minimum Residue Limits (MRL) for export countries
- Provision of largest collection of wine technical information in Australia
- Specialized technical consulting and technical problem solving.
- Publish the outcomes of wine sample analysis to further the technical ability of the Australian wine industry.
- Conduct advanced wine assessment courses (AWAC)

Industry Outcome:

- The projects have the major impact of enhancing the skills capacity of Australian wine makers and grape growers
- As a result of education, the occurrence of commonly observed wine making problems has been reduced (Spoilage and other costs decreased).
- Additional on-going extension costs would be required to extension of project recommendations (@$0.8m per annum)
- Improved knowledge of alternative and developing technologies (also residue limits to meet international market expectations)

Benefit in Use:

- Decrease in the cost of wine making problems, largely associated with microbial and physical instabilities
  - Increase the price of wine by @$0.5/L for 3% of wine production
  - Assume 454 problems solved by AWRI per annum, and each recommendation applied to 40,000 L of production
- Annual total benefit across wine production industry = $9.8m



Adoption:

- Wine production (657ML)
- Max adoption - 80% of wine production use information and assume 3% of wine production captures price increase
- Extension on-going, beginning in 2004
- Rate of adoption – current level of 80% adoption maintained.

Risk: Low risk project because (80% chance of success):

- Extension of known technical information and 'best' practices
- Threat of litigation growing
- Risks of trade barriers reduced with MRL quantification

Conclusion:

- Investment attractive with NPV = $64.4 million and BCR = 8.1
- Difficult to quantify economic benefits associated with capacity development and value of problem prevention

R&D Output:

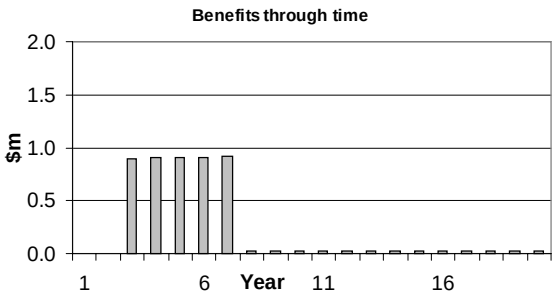
- Training program and manual for winegrape growers on new technologies and practices that will help them improve ultimate wine quality.
- 20 people trained as presenters through Research to Practice™ workshops.
- Four pilot workshops held before July 2001 (100 winegrape growers) will be used to refine content and delivery of workshop material. 10 workshops will be held in 2001/02 involving some 250 winegrape growers.

Industry Outcome*:*

- Faster uptake of technologies (products, processes or information) that will enable winegrape growers to increase their profitability from production of higher quality grapes – and ultimately better quality wine.
- Feedback on technology application and adoption drivers will assist development of technologies in other areas of R&D endeavour.

Benefit in Use*:*

- The focus of investment in this area is the promotion of commercially available technologies. It is assumed that technology take-up – or lead time - would occur five years earlier than it otherwise would.
- Profit gains across the industry will be driven by increase in total factor productivity – TFP -(efficiency of outputs produced for inputs used) and the relative change in prices received to prices paid. CIES (Discussion Paper 0102) estimated that TFP will increase by almost 3% a year in the future for wine. Given that yields are often traded-off with quality increases and using increases in wine production as a benchmark, a 3% annual increase in profitability across the industry was assumed.
- R&D is assumed to contribute 2 percentage points of the increased profit with this investment area contributing 0.5 percentage points. Farm cash income is taken as $2,000 per ha.



Adoption:

- Continual profit gains expected to be captured by 60% of industry – reach of workshops.
- Lag of 2 years from grower involvement in workshops to realisation of benefits on-farm.
- Investment costs assumed to continue over 3 years to ensure adoption reached.

Risk: Low risk because (95% chance of success):

- approach built on successful formula developed through Research To Practice™ system.
- Technologies are commercially available.

Conclusion:

- NPV estimated at $3.1m with BCR of 8.5
- Breakeven lead time only 2 years and breakeven on contribution to profit gain estimated at 0.2 percentage points. Impact at individual vineyard level will vary – with some operators recording significant gains.
- Caution needed in evaluating benefits to individual technologies so that benefits not double counted across GWRDC portfolio.
- Consideration could be given to achieving self funding as direct and quantifiable benefit to growers from technologies

R&D Output:

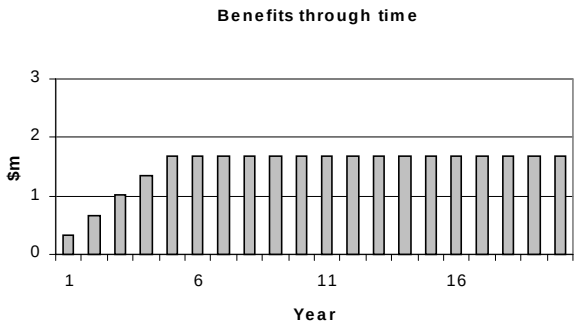
- Certificate level training program developed based on *Research to Practice* Model.
- Contents of *Advanced Spray Application in Vineyards* course standardised, training materials developed (manual & presentations) and workshop series commercialised.
- Researchers coordinated for development of workshop information
- Regional delivery of spray application workshops

Industry Outcome:

- Improved understanding of label rates and knowledge of efficacy of low volume application products
- Increased knowledge about vine-row-volume concept and optimal use of existing equipment.
- Optimal timing of applications – lower input production systems

Benefit in Use:

- Reduced incidence of downy mildew, powdery mildew and light brown apple moth pesticide applications
- Fruit quality improvement as a result of more effective spraying programs
  - Assume fruit premium of $20 per tonne of grapes
  - No yield implication from reduced spraying
- No additional monitoring costs, or information search costs, included for growers.



Adoption:

- Maximum adoption - 10%, with 5% of industry reaping fruit quality premium
- Adoption limited to some extent by additional risks, requires knowledge about pests and diseases and possibly capital expenditure if additional equipment needs to be acquired
- Rate of adoption - uptake should be moderate - 5 yrs to maximum adoption

Risk: Medium risk because (40% chance of success):

- Spray programs may not be widely adopted due to increased production risks and costs associated with knowledge acquisition associated with pests and diseases.
- Chances of success would be increased with heightened community pressure about pesticide applications and residue concerns in export products.

Conclusion:

- Investment attractive with NPV = $6.7 million and BCR = 63.5
- Only 1% of industry would have to adopt improved practice for the project to break-even

R&D Output:

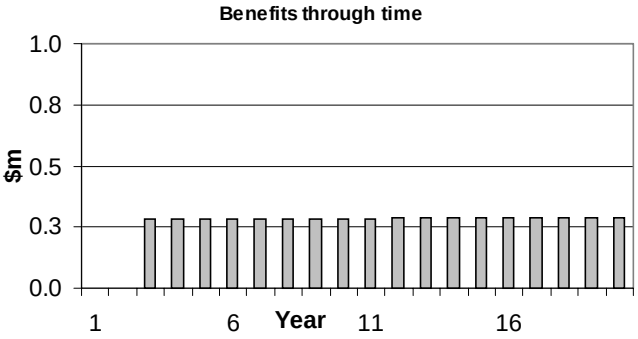
- Information on how growers can implement farm trials of technologies (products, processes or information) to measure the impact on farm profitability. This project commenced in 1999 and has 2 more years to run.
- Series of workshops to develop and demonstrate how farm trials are set up and results analysed.
- Demonstration trials will target technologies in areas of cover crops, mulches and weed management, effective irrigation strategies, pest management and canopy management. Eight regions covered.

Industry Outcome*:*

- Increased use of farm trials of available technologies.
- Faster uptake of technologies through time.
- Rate of productivity gain across the industry will increase.

Benefit in Use*:*

- The focus of investment in this area is the promotion of available technologies where private incentives to speed up adoption are limited – typically involving changed farm practices rather than specific products. It is assumed that technology take-up – or lead time - would occur two years earlier than typical rates of adoption in the industry (assumed to be around 7 years).
- Profit gains across the industry will be driven by increase in total factor productivity – TFP -(efficiency of outputs produced for inputs used) and the relative change in prices received to prices paid. Given that yield increases often involve a trade-off with quality, a 3% annual increase in profitability across the industry is assumed (see Quality Management evaluation on page 29).
- R&D is assumed to contribute 2 percentage points of the increased profit across the industry each year. Farm cash income is taken as $2,000 per ha.



Adoption:

- Will have broad application across technology up-take across the industry.
- Lag of 2 years from grower involvement in workshops to realisation of benefits on-farm.

Risk: Medium risk because (50% chance of success):

- Farm trial will involve some complexity that may limit use.
- Methods for farm trials not readily available and will need to be developed specifically for winegrape industry.

Conclusion:

- NPV estimated at $0.4m with BCR of 1.4.
- Significant investment with more longer term gains.
- Breakeven lead time only 1 year.
- This area of investment form part of the overall extension work supported by GWRDC. Adoption of available technologies will be the key and pay off should be assessed as part of overall extension investment.

R&D Output:

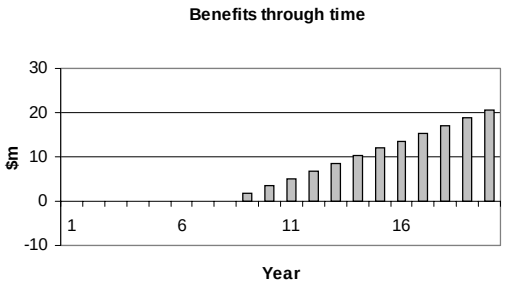
- Isolation of major resistance gene to powdery mildew (including marker development, genetic linkage map, BAC library construction) and incorporate in grapevine (20 individual Chardonnay lines for each gene)
- Increase understanding of factors influencing Botrytis susceptibility and infection pathways – including the nature of inheritance of berry cluster architecture influencing susceptibility
- Increased knowledge of biological processes involved in the infestation of grapevine roots by pests, identification of grape vine genes capable of disruption of infestation and incorporation of genes into transgenic vines
- Production and evaluation of transgenic grapevines with improved berry quality (decreased browning, improved anthocyanin, optimal sugar accumulation, altered flavour)

Industry Outcome*:*

- Reduce the estimated costs of powdery mildew ($31 million pa. impact), Botrytis ($27 million) and root pests on the Australian grape industry.
- Increased berry quality and higher price of fruit
- Additional on-going research and development costs would be required (@$0.75 m for the evaluation period)

Benefit in Use*:*

- Key disease outcome likely to be the decreased the impact of powdery mildew (Decrease in powdery mildew and botrytis costs by 30%). Annual total benefit across target segment of industry = $17.4 million
- Improved berry quality and higher price. (Assume a colour premium is received by farmers - with no yield decrease. Price premium of @$60/t).
- Assume average yield increase of 0.5t/ha for adopting vineyards as a result of reduced root pest problems (@$700t)



Adoption:

- Maximum adoption – assume that adoption of transgenic varieties results in reduction in cost of major pests & diseases and $60/t increase in fruit price.
- Transgenic product launch = 2010.
- Rate of adoption @1% per year. Adoption driven by industry expansion and replanting .

Risk: High project risk (20% chance of success):

- Development of GMOs and related consumer resistance
- Using molecular techniques - the results of which - have not been extensively tested in the field

Conclusion:

- Investment attractive with NPV = $7.7 million and BCR = 3.3
- A probability of success of at least 4% is required for the transgenic varieties project to break-even.

R&D Output:

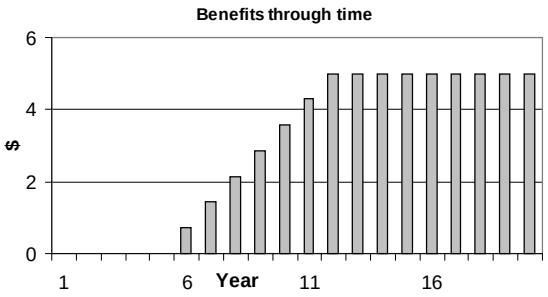
- Project started in 99/00 and will be completed in 01 / 02.
- Information on the nature and extent of within vineyard variation in grape yield and quality – two sites selected.
- Understanding of the cause of variation.
- Assessment of suitability of high resolution remote sensing to identify variations in soil properties and vine vigour.
- Methods to measure yield / quality responses under different practices.

Industry Outcome*:*

- Robust methods to monitor and measure within vineyard variability, including sampling and analysis strategy for quantifying soil variation.
- Information for growers on how they can measure within vineyard variations in yield and quality.
- Longer term outcome, if successful, will be changes in farm practices that will enable inputs to be better targeted at lower and higher performing areas within the vineyard. The direct benefit to farmers will be an increase in the consistency of quality at maturity and fruit style. Further R&D will be required to determine appropriate changes in level of input use. This could be realised with a further 3 years investment at $200,000 a year.

Benefit in Use*:*

- While this area of investment is concerned with the economic feasibility of using robust measurement of variations within a vineyard, the longer term impact will be that growers will be able to reduce the variation in grape quality across their vineyard. Mean yields are expected to remain the same.
- A price premium of $35 / tonne is anticipated. Offsetting this is the expected increase in costs of $10 tonne. Across a typical ha yielding 10 t of premium grape, the gain would be $250 per ha.



Adoption:

- While application in other industries is growing, adoption likely to be slow given the complexity in use (takes longer to learn how to use technology than to develop it).
- Take up assumed across 20,000 ha over 7 years starting from 2005/06.

Risk: Medium to high risk because (35% chance of success):

- Concepts well demonstrated in other primary industries
- Measurement methods commercially available and only application in viticulture being assessed. Some adoption already by Southcorp and Simeon wines.
- Extent to which different cost effective practices can be developed is uncertain at this stage. Improved understanding of input-output relationship in grape production needed before yield / quality impacts can be achieved.

Conclusion:

- NPV estimated at $9.1m with BCR at 12.4.
- Breakeven adoption is 2,000 ha and breakeven on quality gain is $12/tonne.
- Higher implementation costs will significantly limit adoption.

R&D Output:

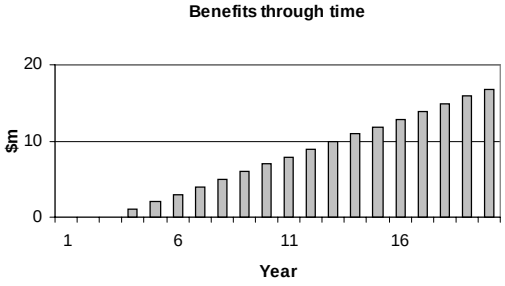
- Evaluation of crop control techniques to stabilise yields and quality
- Extension of a reliable, robust and objective crop forecasting system
- Enhanced understanding of physiological, environmental and cultural determinants of crop yield

Industry Outcome:

- Availability of a reliable crop forecasting technique and crop variability may decrease the costs associated with overproduction, waiting, transporting, inappropriate processing and unnecessary inventory
- Increase in grape quality – principally through the adoption of thinning practices to decrease yields and increase sugar content during the forecast upcoming period of oversupply. Leads to enhanced quality of wine.

Benefit in Use:

- Reduced costs of production instability
  - Assume annual cost of grape production instability $160 million (transporting, inappropriate processing and unnecessary inventory) and improved forecasting and adoption of crop yield stability practices reduces cost by 25%
- Enhanced of grape quality
  - Assume manipulation for quality results in net benefit equivalent of 5% grape price increase (@$35/t)
- Additional on-going research and development costs would be required to extension of project recommendations (@$0.1m per annum, for 5 years)



Adoption:

- Enhanced crop control recommendations launched in 2005
- Rate of adoption @1% per year of all industry per annum across forecast evaluation period.

Risk: Medium risk because (40% chance of success):

- Applied research and development involving incorporation of decision support system into Viticare 3 (participatory farm trials) and *Research to Practice* extension programs.
- Vineyard demand (Riverlink, VWIA-DNRE, Project Industry Reference Group) for crop control management systems
- Extent of adoption difficult to predict, will be largely driven by wineries demanding increased precision in farmer consignment estimates.

Conclusion:

- Investment attractive with NPV = $26.8 and BCR = 21.5
- A break-even maximum rate of adoption of 0.1% per year of industry would be required to justify project expenditures.

R&D Output:

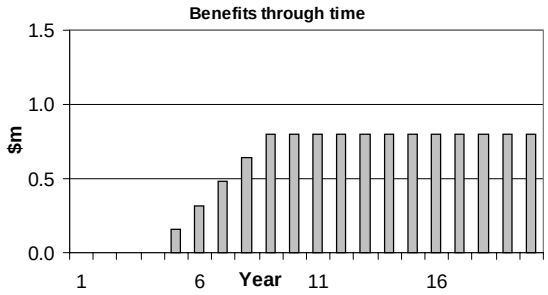
- Identify seasonal period of phytoplasma inoculation by insect vector of various host plant species.
- Determine vector status of common leafhopper species.
- Identify AGY host status of common vineyard weeds.
- Quantify risk of spread to establishing vineyards when AGY infected grapevine material is used.

Industry Outcome:

- Work in this area is very strategic in nature with no direct industry outcome at the completion of the research.
- Understanding of how the disease organism is transmitted will be gained, and this can subsequently be used to develop more appropriate control strategies. If successful, further research over 3 years at $100,000 a year would be required.
- Longer-term outcomes will be reduced spread of the disease, although it is anticipated that current incidence is widespread.

Benefit in Use:

- The main benefit will be reduced yield losses associated with the disease. Losses tend to be variable across seasons and regions. Yield losses of up to 13% have been reported in a season with recovery in following years. Reduced spread will deliver longer-term benefits, which will be more marginal to the current investment decision.
- It is assumed that AGY losses in any year across Chardonnay and Riesling varieties occur in 10% of production (25kt). At a loss of 13% in yield the cost of the disease is $2.3m.
- Costs of control are unknown but estimated at $10 ha on a routine basis. Net gain therefore estimated at $0.8m a year.



Adoption:

- If part of routine control would expect full adoption over medium timeframe - 5 years.

Risk: Moderate to high risk because (10% chance of success):

- Impact of AGY may be more marginal than expected.
- Variability in incidence and impact of the disease may make it difficult to determine how the disease is transmitted.
- Considerable technical difficulties faced including isolation of yellows from other diseases and how to control.

Conclusion:

- NPV estimated at $0.2m with BCR at 1.4
- Breakeven annual cost of AGY is $2m.
- Control strategies will be critical to ultimate pay-off. If control costs are significant – such as having to be carried out on a routine basis because incidence is variable through time, then the annual cost of AGY will need to be considerably higher to ensure adoption.

R&D Output:

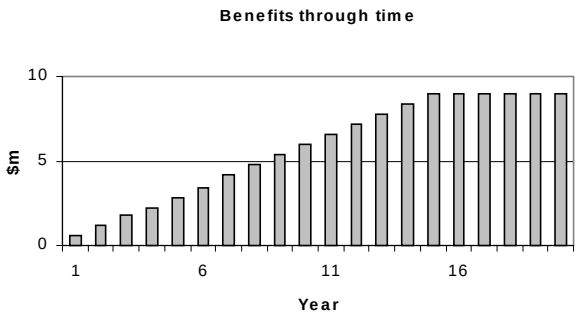
- Improved understanding of the effect of different viticultural and wine making practices on the composition of unstable proteins in grapes
- Increased stock of knowledge about the biochemical properties of PR proteins
- Develop a method for the varietal discrimination of wines based on their protein composition
- Evaluation and development of alternate methods (heat and enzyme treatments and haze protective mannoproteins – HPF) for protein removal from juices and wines

Industry Outcome:

- Demonstrate that unstable wine proteins are not 'turned' on by water stress, hence more efficient and lower cost irrigation systems are not constrained by haze consideration
- Alternate protein removal methods to bentonite – used to prevent haze formation – will be investigated and include proteolytic enzymes and heat treatment.
- HPF – a yeast cell wall mannoprotein is another alternate to bentonite being tested and offers a less costly haze prevention strategy.
- Additional on-going research and development costs would be required to extension of project recommendations (@$0.2 m per annum, for 5 years)

Benefit in Use:

- Decrease in the cost of wine losses as a result of haze prevention.
  - Currently, the cost of haze prevention is estimated to be $45m per annum (primarily wine loss associated with bentonite fining)
  - Assume cost of haze prevention could be decreased by 25%
- Annual total benefit across wine production industry = $11.3 m



Adoption:

- Max adoption – assume 80% of wine makers adopt reduced cost haze prevention products
- Reduced cost practices launched in 2002
- Rate of adoption - 15 yrs to maximum adoption.

Risk: Medium risk because (30% chance of success):

- A commercial HPF product would not involve GMO technology and consequently, would not face consumer resistance issues.
- Market resistance to heating wine and possible loss of quality.

Conclusion:

- Investment attractive with NPV = $17.0 million and BCR = 20.1
- A cost reduction of 1.2% required haze prevention research to break-even.

Random Oxidation (AWR 9)

R&D Output:

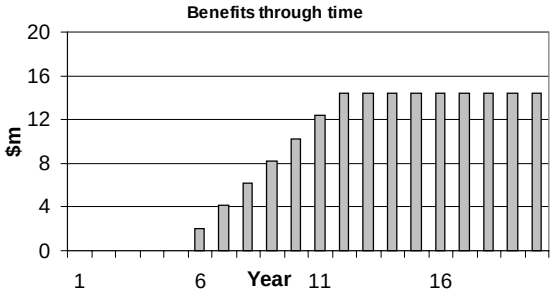
- Work in this area started in 1995.
- Knowledge of factors causing different browning rates in wine.
- QA processes that can be installed in labeling lines to screen aged bottles.
- QA process to screen closures before bottling.
- Information on performance of closures to limit random oxidation.

Industry Outcome:

- Random oxidation effects all wine makers. While there may be significant market share impacts for individual winemakers, there would be no net impact across the industry as consumer impact is on label choice.
- Main outcome will be the development of technologies to reduce the incidence of random oxidation in aged bottles. Aged bottle sales account for 10% of all wine sold – or some 100ML by volume. At present wines are subjectively screened – with limited success – prior to labeling. Product returns are common. Technology available in 2007 following 3 additional years for technology commercialisation. Take-up of synthetic closures could make technologies obsolete – however application to aged bottles likely to occur much later than for younger wines.

Benefit in Use:

- Incidence of oxidation is 4% each year. Value of aged bottles ex-winery estimated at $8 per bottle (average value all wine is $4 per bottle). Total industry cost is $32m.
- R&D expected to lead to reduction in incidence from 4% to 1%.
- Minimal technology cost assumed. If cost was greater than 32c per bottle then would not be viable.



Adoption:

- Adoption across larger wineries likely (60% of production) as over a moderate time period of 7 years. Considerable incentive for individual wineries to adopt to protect market share.
- Smaller wineries may ultimately benefit if closure industry can improve their product in the future – these gains not considered.

Risk: High risk because (25% chance of success):

- Development of low cost technologies will be critical.
- R&D largely strategic in nature with downstream technical and commercial risks to be assessed once causes better understood.

Conclusion:

- NPV estimated at $19.4m with BCR at 22.3.
- Attractive investment given modest costs and level of risk faced. Benefits diminished if use of synthetic closures becomes widespread.
- Break-even net gain to industry would only need to be 36c per oxidised bottle.
- Development of low cost technology to prevent random oxidation will be critical for success.

R&D Output:

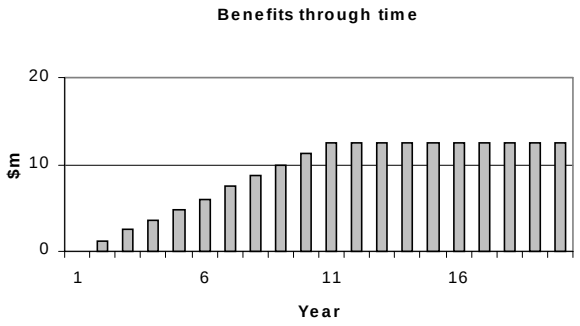
- Development of a rapid and accurate assay for oak components in wines (& oak components)
- Development of an assay for 4-ethylphenol and 4-ethylguaiacol in red wines.
- Investigation of the effect of wood heating on the generation and extractability of volatile oak components
- Ability to influence oak-related wine making practices – in precise chemical terms

Industry Outcome*:*

- An assay has been made available to industry and an increase in the stock of knowledge about oak components in wines, specifically - 4-ethylphenol and 4-ethylguaiacol in red wines has been achieved.
- Increase in red wine price – principally through enhanced oak flavoring of wine – resulting from sensory and component studies
- Additional on-going research and development costs would be required to extension of project recommendations (@$0.2m per annum, for 3 years)

Benefit in Use*:*

- Enhanced wine quality
  - Assume wine price increase by $0.5/L
  - Assume quality premium captured by 25 ML of wine production
  - Assume no change in production costs
- Annual total benefit across all wine grape production industry = $12.5m



Adoption:

- Max adoption – assume that 25 ML of wine production would attract a premium as a result of improved oak cooperage practices
- Enhanced oak cooperage practices launched in 2003 (analytical test already available to industry)
- Rate of adoption - 10 years to maximum adoption.

Risk: Medium risk because (30% chance of success):

- Strong interest among wine makers in determining 4-ethylphenol in red wines
- Test already developed, research into precursors in oak and factors that determine formation of volatile components currently underway.

Conclusion:

- Investment attractive with NPV = $27.5 million and BCR = 43
- Only 0.6 ML of wine production would need to capture a premium for oak cooperage research to break-even

R&D Output:

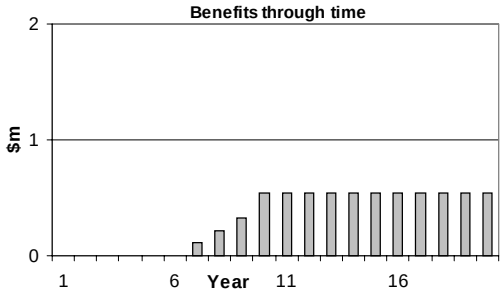
- Understanding of microorganisms in winery waste (Lees and waste water) that may be of value as treatment agents.
- Identification and scale-up of selected bacteria that can be used as a substitute or compeiment to existing cleaning agents.
- Industrial testing of the efficacy of bacterial treatments for winery waste.

Industry Outcome:

- This investment is strategic in nature, and if successful there will be a period required for registration, scale-up and delivery as a commercial agent. Aim is to use bacteria extracts to minimise registration and product development requirements. An additional 3 years is assumed at an annual cost of $100,000.
- Facilitating winery wastewater BOD reduction by encouraging the growth of a suitable population of microorganisms.
- Developing alternative methods for removing "brown skin" films in fermenters through the extraction and application of microbial enzymes.

Benefit in Use:

- Wineries have aggressively addressed water use in their operations and typically waste water creation is now around 1 KL per tonne of grapes crushed. Treatment costs of waste water – as a result of removing "brown skin" cleaning agents and residues is around $4KL and allowing for some additional capital cost in storage facilities, it is envisaged that a cost saving of $0.5 KL may be realised. Winegrape crush a year is some 1.4mt – implying a water use of 1,400 ML a year and a cost saving of $0.7m.
- No account of reduced waste water volume or change in basic nature of waste has been made. Benefits will be driven by reduction in costs associated with "brown skin" removal.



Adoption:

- Greatest adoption will be in larger wineries where waste treatment can be a significant cost and could be more cost effectively managed – largest 9 wineries account for 77% of industry crush.
- Rate of adoption would be moderate – 5 years – given that savings in this are marginal.

Risk: High risk because (15% chance of success):

- Novel application – work of a very strategic nature and achieving changes in the basic nature of waste will be difficult.
- Chesser Chemicals have now developed an enzyme preparation and preparations developed under this project will need to yield significantly better results for commercial success.

Conclusion:

- NPV estimated at negative $0.4m with BCR at 0.6
- Breakeven cost saving of around $1 KL.
- High risk project with limited scope for generating significant benefits.

DETAILS OF EVALUATION METHOD - BENEFIT COSTS ANALYSIS

In this section the fundamentals of BCA are discussed to a level of detail that will enable readers to work through the individual evaluations of projects submitted to the GWRDC for funding consideration.

There are two critical aspects in the benefit-cost assessment of a proposed research and development project. The first involves an assessment of what technology (be it a product, process or information) will ultimately be made available for commercial use in the industry. The second involves an assessment of how the technology will increase industry profits. The first part requires consideration of the technical aspects of a proposed project while the latter involves a costing of industry benefits once the likely industry outcome has been identified.

For any valid comparisons to be made between projects in which GWRDC could invest, it is essential that there be consistency in the data used, assumptions made, approach taken to cost industry benefits and how the likely pay offs are evaluated. Without this consistency evaluations provide little value to decision makers.

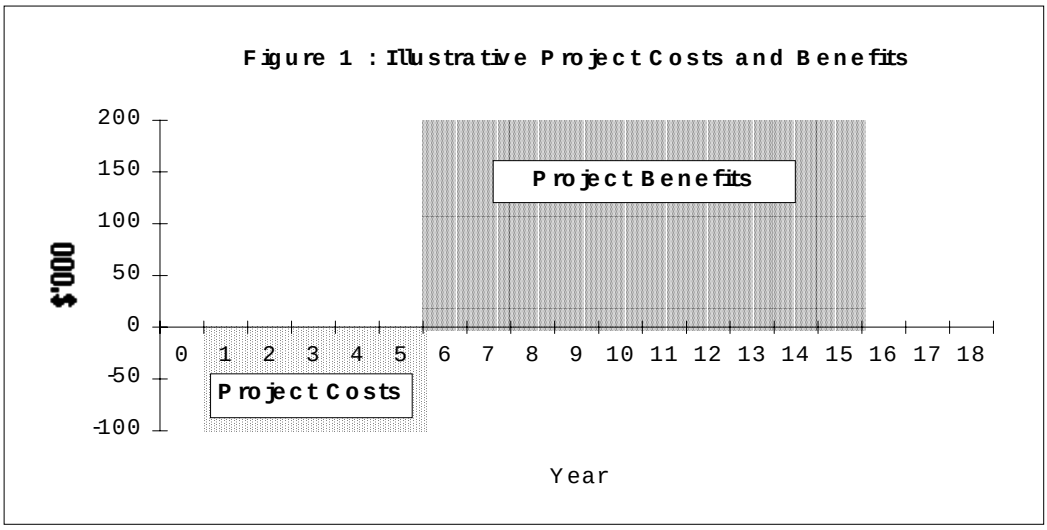
Two of the main strengths of using benefit cost analysis are that assumptions can be made explicit and evaluation results can be readily reproduced. Benefit cost analysis is a "tool" for research decision makers and the extent to which it is used and the detail given should be matched closely to the needs of individual decision makers. Although the degree of detail required may vary from project to project there will always remain a number of key factors that should be considered. These include: the likely specifics of the technology that would be produced through R&D and the associated cost; the strategy which would be followed to ensure that the technology is used commercially; how industry participants would use the technology; and what impact the technology will have on their profitability.

What is BCA?

Benefit-cost analysis is simply a comparison of project benefits against project costs that are realised or incurred through time. Project costs are the costs incurred in carrying out a given research project plus the costs involved in developing research outcomes for direct commercial application in the wine and wine grape industry. Project benefits are the gains realised by these industries and the Australian community at large from the commercial application of research and development outcomes.

In Figure 1 a representative stream of project costs and benefits through time is illustrated. In this example, annual project costs of $100,000 are planned for 5 years after which annual benefits of $200,000 are generated for a period of 10 years. In total, $500,000 is invested in the project for a return of $2 million. But, is the investment worthwhile?

Two measures of project pay off are used to answer this question. The first is the net value of the project, measured by the total value of benefits minus the total value of costs. In our example, the net value of the project is $1.5m, and as this sum is greater than zero the project would represent a profitable investment. However, because we are concerned with the relative attractiveness of projects, projects should be ranked on the basis of the benefit realised for every dollar invested.



The second measure reflects this and is called the benefit/cost ratio. It is calculated by dividing total project costs into total project benefits. In our example the benefit cost ratio is equal to 4. Hence, for every dollar invested in the project a return of $4 is realised.

An important consideration in BCA is the treatment of project costs and benefits that are incurred or generated at different points in time. Generally speaking, in a decision to have a dollar today or at some later date, individuals would show a preference for having the dollar today. In a commercial environment, the extent to which an individual would be prepared to postpone having the dollar is at least equal to the rate of interest that could possibly be earned from having the dollar today and investing it. In other words, if you could get an interest rate of 6% over a year so that after one year your dollar was worth $1.06, then, to compensate you for waiting one year to have your dollar, it would be necessary to offer you $1.06 after the year.

In BCA the extent to which individuals prefer a dollar today as opposed to a dollar in a later period is called the discount rate. The discount rate utilised for these benefit cost analyses is 6% each year, and reflects market interest rates (net of inflation) on borrowed capital.

Handling project benefits

The estimation of project benefits is usually the most difficult part of any BCA. Project benefits are the total net gains realised directly by users of R&D outcomes and indirectly by other participants in the industry or the community at large. To determine project benefits, a clear understanding of the anticipated direct industry impact is essential. In BCA there are three aspects which need to be considered when estimating project benefits. These are the size of the gain to individual users, the number of users realising the gain (target market and adoption), and the likelihood that R&D will be successful in delivering the anticipated commercial outcomes.

Estimating individual gains

The net gain to an individual user can be measured by the difference in profits that could be earned with and without the use of the developed technology (commercial R&D outcomes in the form of a product, process or information).

Technological improvement can increase profitability of a given business in several ways. It can:

(i) increase yields or the volume of output given existing resources.

(ii) enable higher prices to be realised on output sold.

(iii) decrease the unit cost of inputs used.

(iv) decrease the volume of inputs used.

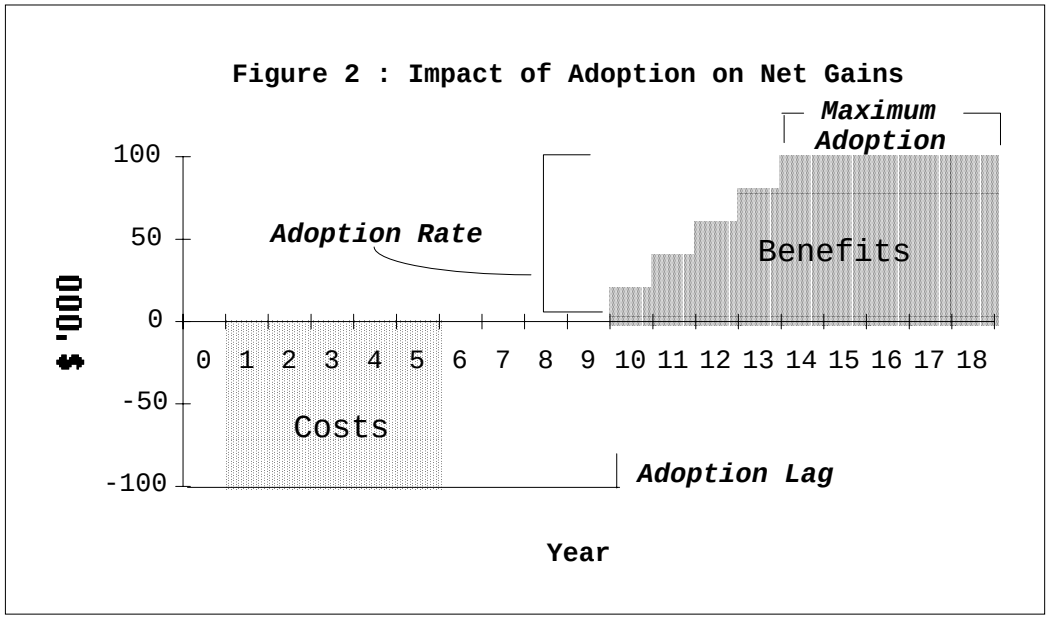
In most cases, these impacts can be adequately expressed in terms of a given unit of production, for example, per tonne of grapes sold. Offsetting these impacts are the costs to the individual of purchasing and using the technology.

Adoption

To derive total net gains from the use of a developed technology it is necessary to estimate the net gain to all individuals that could potentially benefit from adoption and use of the technology, and then sum these gains. Obviously, this would not be practical, and instead, a representative business for the target group of potential beneficiaries should be selected and net gains estimated for this business alone. This group would therefore represent the potential users of the technology, and adoption would reflect the extent to which the technology would be taken up within this group.

The rate and level of adoption of a new technology in the derivation of total net gains is usually very understated in benefit cost analysis. The total net gain in any given year is simply the sum of individual net gains that are generated in that year. The effect of halving net individual gains or total net gains is the same as halving the anticipated rate of adoption of the new technology.

Technology adoption has three components critical to benefit cost evaluation. These components are illustrated in Figure 2.



1. Adoption Lag - the time lag between successful R&D and the first commercial use of a technology (adoption lag).

   Once the R&D project has been brought to a successful close the technology would then be ready for commercialisation and release into the market. During this phase the technology would be produced in commercial quantities, marketed and distributed. While the costs incurred during this phase are reflected in the price at which the technology is sold, the time taken from project commencement to the first commercial use of the technology is important because, as the realisation of benefits is delayed in time the attractiveness of the project declines.

2. Adoption Rate – the rate at which a technology is taken up within the target market.

   The rate of technology adoption is important because, like adoption lag, it influences the extent to which gains are realised in any one year. In practise, technology adoption tends to occur gradually at first, then quite rapid for a while before tapering off. In prospective evaluations a constant rate of adoption through time (linear) is a reasonable assumption to make in the absence of detailed market survey information. The main factors that will influence the rate of adoption through time are the size of the benefit realised by the user, the complexity of use of the technology, the ease with which the technology can be integrated into existing business practices, the degree of financial risk and the communicability of benefits between users.

3. Maximum Adoption – the ultimate level of technology take up within the total market.

   The final component is the maximum level of adoption within the target group. The factors described above that influence the rate of adoption also affect the adoption ceiling.

Probability of Project success

The final aspect in the estimation of total net gains is the likelihood that a R&D project will be successful in ultimately delivering the anticipated benefits to the fishing industry. For project success, the research, development and commercialisation phases must meet all their desired objectives. The probability of project success is therefore conditional on the success of each phase. As an example, if the probability of success for each phase was 50%, then the probability of project success would be 12.5%. Because of project risks, project benefits need to be weighted accordingly and expressed in terms of an expected benefit to the funds invested. This is done simply by multiplying annual project benefits by the probability of project success.

Dealing with project costs

Project costs are the planned expenditures in the research and development phase of a project – by all parties involved. In order to carry out a BCA, project costs need to be estimated on an annual basis over the anticipated life of the project. The end of the project will be when the research output has been fully developed and is ready for commercialisation.

Price Effects

Simplifying assumptions have been made on price effects as a result of increased industry profitability. Price impacts are important and should be considered. Such impacts determine the distribution of R&D benefits between different industry participants - including grape growers, wine makers and consumers. Price effects also indicate the extent to which production increases following technology adoption that results in higher industry profitability or stimulates consumer demand. For the purpose of the evaluations carried out for GWRDC it has been assumed that Australia is largely a price taker on world markets and that export parity drives domestic prices. Therefore, no leakage of R&D benefits to overseas consumers is assumed.

Research Lead Time

Research lead time (RLT)is a measure of the competitive advantage of GWRDC's R&D investment. RLT has been incorporated into individual evaluations in one of two ways.

First, because GWRDC is only one of many players in the R&D market it is most likely that benefits would be realised without GWRDC's financial involvement. The involvement of GWRDC in given areas of R&D will enable industry benefits to be realised sooner than would otherwise be the case or to a greater extent through time. In some cases GWRDC's and partner's investment will accelerated the rate of take up of a technology compared to what would otherwise occur. Underlying this is an assumption that economic units or businesses – will ultimately take up a technology if its is profitable. GWRDC and their partners are not the sole source of technology improvements captured by the industry. Many of the extension investments are of this nature.

Second, in some cases GWRDC investment delivers incremental benefits to users that would not be realised without GWRDC involvement. This is typically the case when private incentives are minimal and the majority of investment in R&D is supported by the GWRDC.