Grape and Wine Research and Development Corporation



Evaluation of Selected GWRDC Projects

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Evaluation Summary

Evaluation Background

eSYS Development and BDA Group were contracted by the GWRDC to undertake economic evaluation of six completed areas of research. The projects purposely selected and were believed to have generated substantial benefit. Areas of research and selected projects include:

- **IPM (1)**
  - CRV 96/4 – Control of pests and diseases in grapevines: From research to Practice ™ IPM Viticulture: Research to Practice ™(including Training Workshop Manual).
  - DAV 95/1 - Strategic Management of Botrytis Bunch Rot and Light brown apple moth on grapevines.
  - DAN 92/1 – Practical Management strategy for bunch rot of grapes.
  - DAN 92/4 – Adoption of strategies to reduce the use of pesticides in wine grape production.

- **DNA finger printing (2)**
  - CSH 5GW (CSH 93/1) – DNA fingerprinting of grapevine cultivars.

- **Rootstocks (3)**
  - DAS 12GW - Assessment of French and American hybrid varieties as suitable rootstocks for vineyard establishment in acid soils.
  - CSH 94/3 – Field assessment of selected rootstock hybrids for quality wine production.

- **Irrigation technology (4)**
  - CSH 92/2 – Heterogeneous rootzone hydration – implications for vine vigour.
  - DAS 11 – Improving wine quality by regulated deficit irrigation.

- **Using saline water (5)**
  - DAS 15GW – Maximising vineyard returns with low quality saline irrigation water.
  - DAS 16GW – Overhead irrigation management for improved grapevine yield and quality under saline conditions.
  - CSH 8GW - Use of Rootstocks to reduce chloride and sodium levels in export wines.

- **Bottle closures (6)**
  - AWR 11V – Evaluation of new techniques and of processing aids for wine-making.

Approach

- Each project area was assessed using benefit cost analysis and expected economic pay off was calculated. Pay off was 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).

- Industry benefits considered included lower production costs, higher quality production and enhanced yields. Environmental benefits associated with habitat preservation, ecosystem enhancement or other off site impacts have not been incorporated in the cost-benefit framework.

Estimated Pay-Off

- Industry benefits were estimated for each project area. A summary of economic attractiveness, as dictated by benefit-cost ratio estimates, and comments about industry value and pay-of is provided in the following table.

PROJECT	APPROACH	COMMENT	PAY-OFF
1. IPM	Investment attractive with NPV = $16.9 m and BCR = 7.0.	Moderate commercial pay-offs. IPM principles already adopted by farmers. Difficult to forecast IPM adoption and impact, as differing practices used by farmers in various situations and regions.	***Moderate***
2. DNA finger printing	Not quantified. Research considered to be of strategic value to industry	Investment has product integrity and brand protection value, along with quality assurance benefits.	***NA***
3. Rootstocks	Investment attractive with NPV = $5.0 million and BCR = 10.5	Demonstration that different scion-rootstock combinations perform on differing soils and result in desired berry quality. Relatively small project cost.	***Moderate***
4. Irrigation technology	Considerable pay off with NPV at $16.1m and BCR at 14.3	By 1998 5% of growers had adopted deficit irrigation and 10% drip irrigation – latter expected to continue to increase. Benefits likely to increase with time as water scarcity leads to higher water prices	***Moderate***
5. Using saline water	Substantial pay off with NPV at $15.1 and BCR at 15.4	Break-even adoption estimated at only 216 ha over the next 20 years – this target probably met already (around 400,000 vines replanted). Adoption may occur across larger area in future if salinity in other areas increases.	***Moderate***
6. Bottle closures	Substantial pay off with NPV at $143m and BCR at 76	Break-even adoption only 1.5m bottles over 20 years. To date there has been increase in use of screw closures. AWRI work has had global impact.	***High***

- Investment in bottle closure research is forecast to generate the most substantial economic benefits. A benefit-cost ratio of 76 was estimated, which suggests that for each dollar invested in research, $76 dollars in industry benefits will be realised.

- The commercial benefits for DNA fingerprinting are likely to be marginal, although, only small increments in crop productivity and product quality would justify the financing of this project.

- The average benefit-cost ratio for a range of rural development corporation was estimated to be 7.2:1 (see AFFA, 2001 – Innovating Rural Australia, RDC Outcomes, AFFA, Canberra). Projects evaluated in this report indicate that selected GWRDC research is delivering economic benefits above average returns experienced by other funding bodies. However, it is inappropriate to draw conclusions about portfolio performance from a number of selected projects. Typically, a small number of projects will deliver considerable returns while most will either be marginal or contribute more widely to knowledge rather than the development of specific technological outcomes.

- Given the risky nature of research, a number of high impact projects are required to lift the performance of the overall portfolio. While evaluation results presented in this report indicate that these types of outcomes have been successfully targeted by the GWRDC, it is difficult to ascertain whether or not GWRDC's R&D investment in the past has generated an acceptable return to its stakeholders. A comprehensive evaluation of GWRDC's past portfolio investments would be required for this purpose.

Evaluation Approach

It has not been the role of this study to assess the technical outcomes from research projects, or the performance of researchers in conducting their research. The contribution of research outcomes to the realisation of economic benefits has drawn significantly on the opinion of researchers and consultation with wine-makers and viticulturists . The evaluation approach adopted here is benefit cost analysis, and is detailed in attachment 1. Each project evaluation has been reported in a consistent manner with key assumptions made explicit. The format used is described in the box below.

BOX 1: REPORTING FORMAT FOR INDIVIDUAL EVALUATIONS

RESEARCH OUTPUTS

- What were the key deliverables from the project?
- How have the outputs been used to generate economic and environmental impacts?

INDUSTRY OUTCOME

- How are research outputs used by industry participants?
- What has been the economic impact of project outputs on the commercial operations of wine grape growers and wineries across Australia?

BENEFITS IN USE

- What is the value of industry outcomes in monetary terms for a typical technology user?
- What is the total value of benefits that can be attributed to the project?

ADOPTION

- To what extent have project outputs been adopted to date?
- What is the expected rate and level of adoption in the future?

RISK

- For three of the projects assessed it was determined that there was still some risk that expected project benefits or adoption may not be achieved.
- Where there remains some risk, what are the main factors that will influence achievement of project benefits across the industry?

CONCLUSION

- Has the project yielded significant environmental or economic benefits?
- What has been the main driver of the pay off on the project investment?
- Has the investment delivered significant net benefits, where project benefits are likely to exceed project costs?

1. Integrated Pest Management (CRCV 96/4, DAV 95/1, DAN 92/1 & DAN 92/1)

R&D Output:

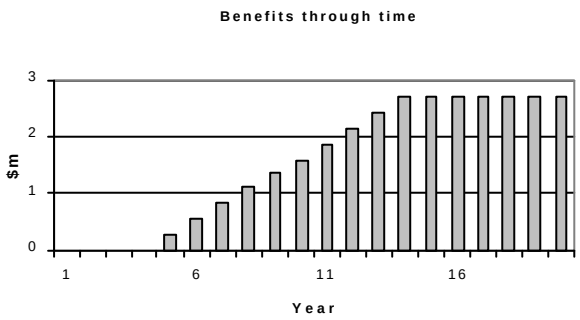
- Disease and pest management training program developed - *Research to Practice*.
- Resistance management strategies developed for key pests and diseases
- Best practices extended to growers via training materials (manual & presentations) and workshop series.
- Regional delivery of IPM workshops (more than 70 workshops)

Industry Outcome*:*

- Improved understanding about optimal management of disease and insect pests of vineyards.
- Appropriate timing of applications – lower input production systems
- Increased vineyard productivity and increased fruit quality as a result of reduced pest and disease pressure.

Benefit in Use*:*

- Reduced incidence of downy mildew, powdery mildew and light brown apple moth pesticide applications as a result of improved spray timing and effectiveness of control
- Price premium for fruit as a result of improved quality
  - Assume premium of $20 per tonne of grapes
- Annual total benefit across 10% of industry (1.395 million tonnes) = $2.8m
- No additional monitoring costs, or information search costs, included for growers.
- On-going cost of GWRDC supported industry development leader for pest management extension (@$0.1 million per annum)



Adoption:

- Maximum adoption - 40% of industry, with 10% of vineyard production gaining price premium for fruit as a result of enhanced quality.
- Rate of adoption - 10 yrs to maximum adoption
- Extension started in 1997.

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

- IPM principles already adopted by farmers.
- Large number of farmers have attended workshops, including many corporate vineyard managers
- Difficult to forecast IPM adoption and impact, as differing practices used by farmers in various situations and regions.

Conclusion:

- Investment attractive with NPV = $16.9 m and BCR = 7.0.
- Only a price premium of $3 per tonne is required for the project to break-even.

2. DNA Fingerprinting of Grapevine Cultivars. (CSH 93/1)

R&D Output:

- Major wine producers and other relevant authorities consulted to obtain list for varieties to be included on an Australian DNA profiles database
- DNA prepared from most cultivars and profiles obtained
- DNA isolation methods simplified to allow DNA extraction from leaves, berries and wood
- DNA has been isolated from run-off of a first crush and DNA profiles obtained
- International DNA database established that contains Australia data
- A DNA profile service has been established through collaboration of CSIRO, AWRI and the CRC for Viticulture

Industry Outcome*:*

- Reduced complexity and cost of DNA fingerprinting procedure to make it suitable for application through a standard laboratory testing procedure.
- Fingerprinting provides quality assurance for variety and germplasm identification, along with improving label integrity.
- The profile service allows objective determination of grape varieties, and possibly, more objective payment for fruit at wineries.
- The service may facilitate improved grower farming practices, encourage variety diversification, protect integrity of Australian brands, and in the longer term, increase the average price paid to viticulturists.
- The chances of vines having to be removed, as a result of being incorrectly determined varieties reduced. Replanting entails considerable cost.

Benefit in Use*:*

- Total industry cost of fingerprinting service relatively small

Adoption:

- Output of project primarily of strategic use to industry and researchers

Risk: Medium risk because (80% chance of success):

- Fingerprinting research has been undertaken and the service established.
- Difficult to determine the nature of economic benefits from improved quality assurance.

Conclusion:

- Investment likely to be moderately attractive due to low cost of project
- Investment has product integrity and brand protection value, along with quality assurance benefits.

3. Rootstock Development (DAS 12GW, CSH 94/3)

R&D Output:

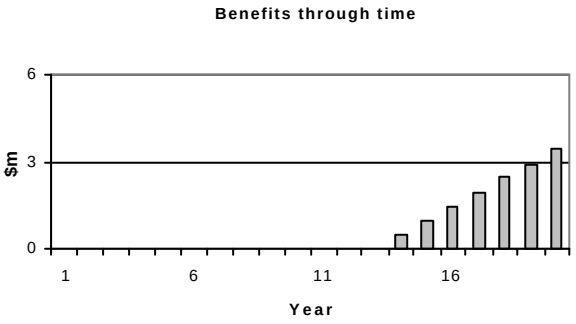
- Effectiveness of 42 French and American hybrids used as rootstocks (Pinor Noir scion) in acid soils analysed and shown to be of limited value
- Alternate rootstock to Ramsey, which has lower postassium uptake and improved berry pH, organic acid composition and spectral parameters (red wine) was identified

Industry Outcome:

- Improvement in rootstock, notably Ramsey (*V.champini*), for warmer irrigated areas (65% of Australian wine-grape production). In particular, the development of 'improved pH' rootstocks has resulted in enhanced berry quality (acid balance) and reduced the need for wine makers to make grape juice pH adjustments, such as the inclusion of tartaric acid.
- Rootstocks have also been screened for resistance to root pests. An increased diversity in the genetic background of rootstocks decreases the probability of widespread losses due to root pests and diseases.

Benefit in Use:

- Increased in fruit quality, particularly in replant areas
  - Assume price premium of 5% ($35/t)
  - Average base farm-gate grape price @$700/t
  - Alternative rootstocks could be adopted by 10% of bearing area
  - Grape production = 1.395 million tonnes in 2002
- On-going research required for next two years (@$0.2 million per year)



Adoption:

- Annual total benefit across target segments of industry = $4.9 million
- Max adoption – specified above
- Improved rootstocks from these projects forecast to be launched in 2005
- Rate of adoption – 1% per annum

Risk: Low risk because (60% chance of success):

- Demonstration that different scion-rootstock combinations and varieties perform on differing soils and result in desired berry quality
- Adoption of rootstocks developed during projects maybe superseded by novel varieties, - resulting in less adoption in the longer term

Conclusion:

- Investment attractive with NPV = $5.0 million and BCR = 10.5
- Only a small premium for fruit derived from improved rootstock required for the projects to break-even due to the relatively small project size
- Reduced risk of major disease & pest outbreak benefits have not been quantified.

4. Irrigation Technology (DAS11, CSH92/2 & CSH95/3)

R&D Output:

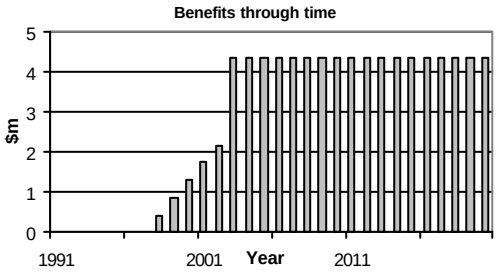
- Work in this area started in 1990/91 with an examination of regulated deficit irrigation (RDI) and withholding irrigation. In 1992 work on partial rootzone drying (PRD) commenced.
- The main R&D output from PRD was information on the success of more strategic application of water in vineyards that demonstrated how water application could be reduced without any offsetting loss in grape yield or quality. Previous work had shown that reducing water applications by 50% could lead to yield losses of between 15% and 50%.
- Output from the RDI work demonstrated how red wine grape quality could be improved through higher maturity levels.
- Information was transferred to industry through workshops, seminars, public lectures, and more recently as a component of the Research to practice™ series.
- A total of $1.6m was invested in this area between 1990 and 2000.

Industry Outcome*:*

- Over the 1990's there had been growing concern over water availability and discharges. Environmental concerns and the rising cost of water has promoted uptake of new farm designs, recycling systems, use of micro-irrigation systems, siphons and farm laser leveling.
- Outcomes from this project have enabled growers to reduce the volume of water applied to vines. Savings of between 44% and 68% have been achieved without any loss in grape yield or quality. Also, better control of vegetative growth has improved grape quality through more consistent berry size and flavour at maturity.

Benefit in Use*:*

- On irrigated vineyards water savings have been estimated at 50% for PRD. At an average application of around 7ML per ha and at an annual value of $14.50, the benefit is calculated at $51 per ha.
- For RDI assumptions taken from previous economic evaluation for CRCV work in this area. Increase in baume by 2 units gives extra $2005 per ha, offsetting yield loss of 1.9 t per ha reduced benefits by $1,425, Net gain is $580 per ha.
- No additional costs are assumed as most changes would involve minor changes to existing infrastructure.



Adoption:

- By 1998 5% of growers had adopted RDI and 10% drip irrigation – latter expected to continue to increase.
- RDI applicable to around 10,000 ha and would have occurred but over 20 year period.
- Adoption is assumed to reach 50% of growers over a 10 year period from 1998.

Conclusion:

- Considerable pay off with NPV at $16.1m and BCR at 14.3
- Breakeven adoption estimated at only 3,680 ha (PDI 3,450 ha and RDI 230 ha) – this target probably met already.
- Benefits likely to be higher through time as water scarcity leads to higher water prices.

5. Using Saline Water (DAS 15GW, DAS 16GW & CSH 8GW)

R&D Output:

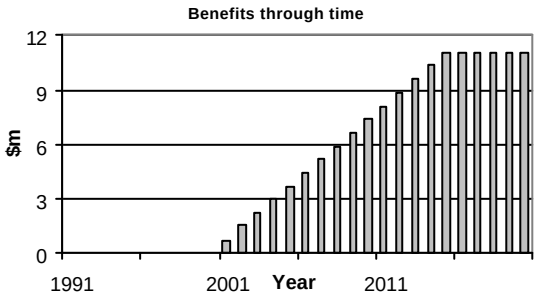
- Work in this area started in the 80's with growing concerns over elevated salt levels in export wine as a result on increasing salinity of irrigated water. Main problem was with red wines where salt stored in grape skins is mobilised during wine making.
- Two streams of R&D were supported over the 1990's. The first involved identifying more appropriate application systems and timing of water applications to limit salt uptake by vines. The second involved an evaluation of different rootstocks for their capacity to limit salt uptake.
- Information was extended to industry through workshops and seminars as well as through publications in industry journals.
- A total of $1.3m was invested in this area between 1990 and 1998.

Industry Outcome*:*

- Work in application timing supported the general thrust towards use of drip systems instead of overhead systems. These systems also adopted because they give growers more control, result in less fungus problems, use less water and give better yields. (Frost protection that is lost is a downside.)
- While salt content in wine was the motivator for this R&D it was found that considerable yield gains could be made. In areas where salinity levels exceeded 2.5 dS / m it was found that yields could be improved by at least 10% to 15% by converting from vines on own roots to vines on salt tolerant rootstocks without any observable loss in grape quality. Salt content in wine was also reduced.

Benefit in Use*:*

- The main production areas where elevated water salinity is a problem is in South Australia. It is estimated that production across some 10,000 is constrained by elevated water salinity.
- Vines are typically replaced every 15 years, and in those areas where salt is a problem use has been made of rootstocks such as 1103 Paulsen and 140 Ruggeri. After allowing for 3 years for vine maturity, yield gains of, on average, 1.8 tonnes per ha have been achieved. At a price of $700 / tonne an extra $1,260 has been earned per ha. Offsetting this gain are costs associated with grape harvest – estimated at $85 per tonne. The net gain is estimated at $1,107 per ha.



Adoption:

- Adoption commenced in 1998, with annual take up of 650 ha a year.
- A major driver of adoption has been grower's positioning themselves for possible increases in water salinity in the future.

Conclusion:

- Substantial pay off with NPV at $15.1m and BCR at 15.4
- Breakeven adoption estimated at only 216 ha over the next 20 years – this target probably met already (around 0.4m vines replanted). Breakeven net benefit per ha estimated at $72 per ha.
- Application of R&D outputs may occur across larger area in future if water salinity in other areas increase.

6. Bottle Closures (AWR11)

R&D Output:

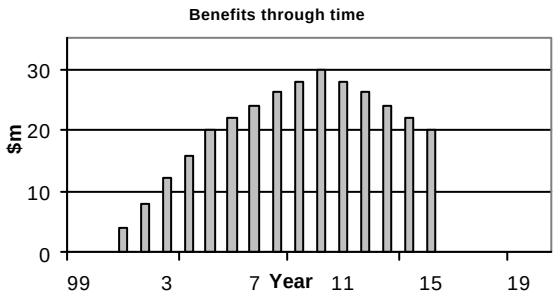
- During the 1990's considerable research had been undertaken into the problem of "cork taint' and other problems associated with closures including breakage or cracking of corks during insertion, excessive dust and inconsistent application of surface coatings. Although commercial production of synthetic closures was progressing uptake across the industry was limited because of inadequate protocols for assessing the performance of different closures.
- This project commenced in 1999 with the specific objective of assessing performance of different closures and developing protocols for the rapid and reliable testing of new or existing closures. In 1999 14 different closures were tested using Semillon wine from the Clare Valley region. Performance to date has been assessed and testing of bottles is on going, up to 10 years of age.
- A total of $2.5 will be invested in this area between 1999 and 2008.

Industry Outcome*:*

- Results from the trials so far have demonstrated that synthetic closures can be successfully used to avoid 'cork taint', and preserve the positive sensorial properties of wine, for up to 2 years of age.
- There have also been cost savings in wine production. Synthetic closures cost only a few cents while corks range from around 20c to 35c each.
- Adoption of synthetic closures has been limited to date. R&D outputs have been readily transferred to industry and there has been an observable increase in use of synthetic closures, particularly screw cap closures.

Benefit in Use*:*

- The incidence of 'cork taint has been estimated at around 4% to 8% across bottled wine, or a cost of $160m annually world-wide. Australia accounts for around 3% to 4% or some $5m annually – equivalent to 500,000 bottles. This would provide an upper estimate as many bottles would be consumed rather than returned, although the proportion of returns is increasing with greater consumer awareness. However, there would be a price effect from reduced demand with a net effect of less than $5m annually. These benefits have not been included as they are marginal to cost savings.
- Saving from lower closure costs is estimated at 20c per bottle, and is applicable across all bottled wine. Some 400m bottles of wine are produced each year – with a potential saving of $80m annually.



Adoption:

- Adoption impacts started in 2001.
- Adoption is expected to be substantial – 50% of bottle closures, but moderately slow – over 10 years.
- Without the AWRI work adoption would be lagged by 5 years with take-up over 20 years.

Conclusion:

- Substantial pay off with NPV estimated at $143m and BCR at 76
- Breakeven adoption estimated at an additional 1.5m bottles in 20 years.

Appendix 1 - Details of Evaluation Method

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 selected completed GWRDC projects.

There are two critical aspects in the benefit cost assessment of a research and development project. The first involves an assessment of what technology (be it a product, process or information) has been made available for use in the industry. The second involves an assessment of how the technology will increase industry profits, recreational benefits or deliver environmental improvements. The first part requires consideration of the technical outcomes from a project while the latter involves a valuation of economic and environmental impacts.

Two of the main strengths of using benefit cost analysis are that assumptions can be made explicit and evaluation results can be readily reproduced.

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 grape & wine industries.

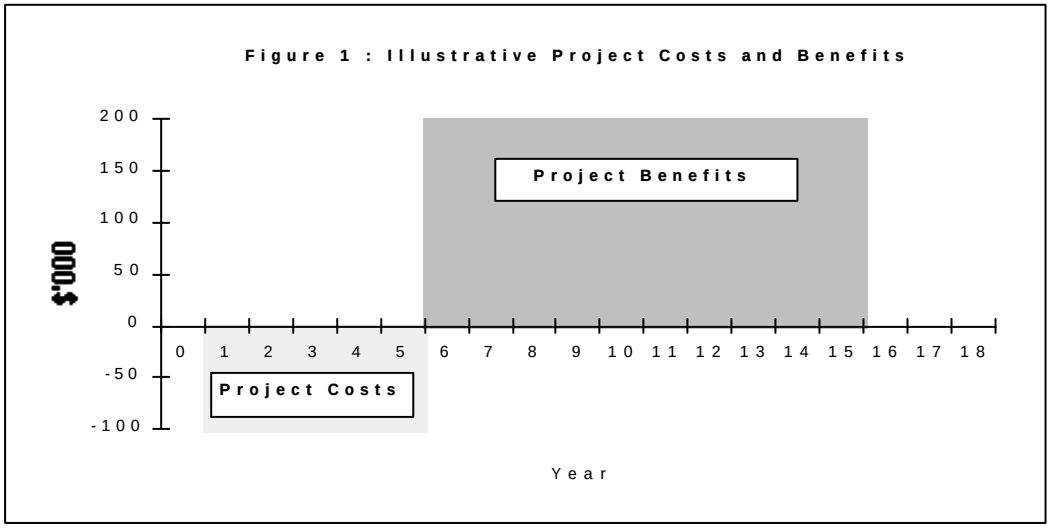
Project benefits are the gains realised by grape & wine industries and the Australian community at large from the application of research and development outcomes.

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.

The second measure reflects the relative attractiveness of a project 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 that 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 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 kg of grape or wine sold. Offsetting these impacts are the costs to the individual of purchasing and using the technology.

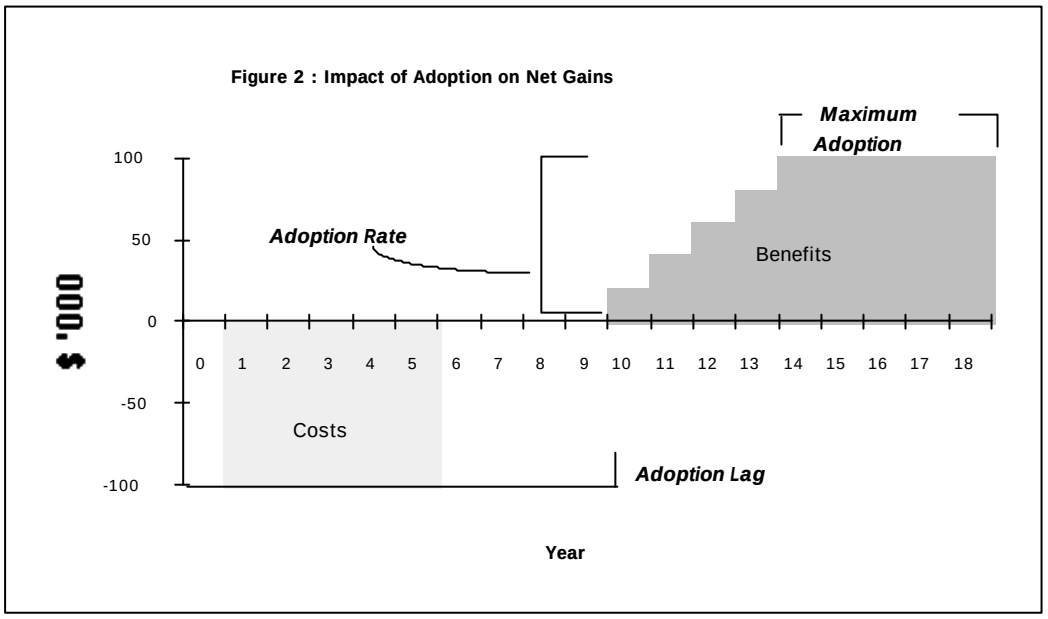
Adoption

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 on 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.

Dealing with project costs

Project cost is the total expenditure incurred by all parties involved to reach a commercial outcome. In some cases it will be necessary to estimate additional costs from project completion to account for the cost of "brining a technology to market".