RESEARCH IMPACT EVALUATION

Grapevine breeding Case Study

June 2016

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Executive Summary

The Challenge

Australia has no native grape varieties suitable for winemaking or table and dried grape production. As a result, grape varieties have historically been imported from overseas, but the imported varieties did not always suit Australian conditions such as heat waves and periods of limited water supply. New grape varieties were needed that would survive in these challenging conditions.

Another more contemporary challenge is for the Australian grape and wine industry to more profitably compete in a fiercely contested global marketplace. Australia must continue to improve the competitiveness of its wine, dried grape and table grape businesses through productivity gains, innovation, differentiation and meeting market demand.

The Response

CSIRO has a long history of involvement with the grape and wine industry, having commenced a wine grape research program in the early 1960s. Over the years, CSIRO has investigated 50,000 or more breeding lines to develop wine, table and dried grape varieties best suited to Australian conditions. Major grape varieties developed by CSIRO have been successfully released and adopted by grape growers and winemaking companies since 1975.

CSIRO also introduced several other innovations to the industry, including the first mechanical harvesters for wine grapes in Australia, low-input, highly productive mechanised systems for dried grape production, and rootstocks that are nematode-tolerant and, for the wine industry, with low to medium vigour.

The Impact

CSIRO's grapevine breeding program has led to novel grape varieties providing a range of delivered and potential impacts, including increased yield and grape quality, resilience in hot inland environments, and novel product options for growers. As a result, the wine and grape industry has improved capacity to reduce costs and to increase sales in a competitive global marketplace. Innovations introduced by CSIRO have enabled Australia's grape and wine industry to grow from modest beginnings to become a major export earner and international producer.

The net present value (NPV) of CSIRO's grapevine breeding work for wine grapes is approximately $334.2 million which includes $8.0 million yield benefits and $326.2 million product benefits in terms of blending benefits and new novel wine products.

This project provides an excellent example of how CSIRO has become an important and trusted adviser to the Australian grape and wine industry and enabled the industry to address a range of scientific and technical challenges and help it to grow its business over time.

This case study uses the evaluation framework outlined in the CSIRO Impact Evaluation Guide. The results of applying that framework to the Grapevine Breeding Program case study are summarised in Figure 1.

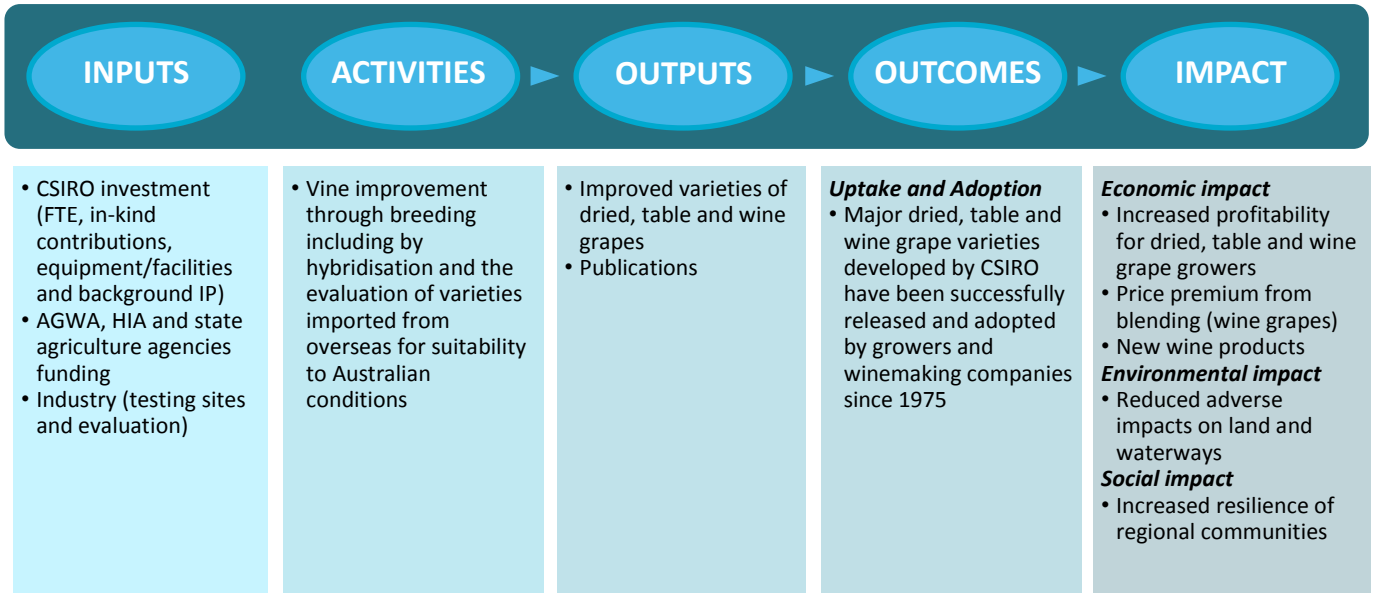

Figure 1: Impact Pathway for Grapevine Breeding Program

Purpose and Audience

This evaluation is being undertaken to assess (to a range of stakeholders) the positive impacts arising from CSIRO's Grapevine Breeding program. This case study can be read as a standalone report or aggregated with other case studies to substantiate the impact and value of CSIRO's activities relative to the funds invested in these activities.

This case study is proposed for accountability, reporting, communication and continual improvement purposes. Audiences for this report may include members of Parliament, Commonwealth Departments, CSIRO and the general public.

Background

The Grape and Wine Industry

The first Australian vineyards were established in the early 1800s, however, most Australian vineyards are new, with 71.8 per cent of businesses having been established between 1990 and 2014[1]. In 2012, there were 6,200 growers of grapes (for all uses) in Australia. Grapes contributed

[1] Professor Kym Anderson AC and Nanda R. Aryal, Growth and cycles in Australia's wine industry: A statistical compendium, 1843 to 2013, Wine Economics Research Centre, University of Adelaide, February 2015, p. 226.

to approximately $1.3 billion to the economy, with wine grapes, table grapes and dried grapes accounting for $880 million, $350 million and $35 million respectively[2].

In 2015, there were 1,852 individual businesses that listed wine manufacturing as their primary purpose[2]. Compared to grower businesses, winemaking businesses are generally larger and more diversified. They are more likely to undertake both growing and production, with the largest 18 winemaking businesses crushing in excess of 20,000 tonnes of grapes per year[3]. With the exception of the Northern Territory, wine production occurs in all Australian jurisdictions. South Australia, New South Wales and Victoria are the leading states for wine production. ABS data indicates that 46 per cent of grapes were produced in South Australia, followed by 31 per cent in New South Wales and 20 per cent in Victoria[4].

Table grapes are grown in all mainland states with a small industry also located in the Northern Territory. In total, there are about 900 table grape growers (600 businesses) with an estimated production value of approximately $350 million (Australian Table Grape Association). Approximately 80 per cent of the total production is located in the Murray Valley. Exports of table grapes account for 50-60 per cent of the production, depending on the season.

Dried grape production is a small but locally significant industry based in the Murray Valley, with approximately 600 growers and a value of $35 million.

Challenges

As Australia had no native grape varieties suitable for winemaking or table consumption, grapevine varieties were imported from Europe and other countries. The first known record of successful European grape production in Australia dates from 1791. Australia is such a large country that almost every climate and soil type can be found. This means that not all varieties imported from overseas will be suited to Australian conditions. The production of new grape characteristics is needed in Australia in order to meet challenges associated with Australian conditions such as tolerance of arid environments, including limited water supply and heat waves, drought events and tolerance of alkaline soils.

Another challenge for the Australian grape and wine industry is to be able to more profitably compete in a fiercely contested global marketplace. Australia must continue to improve the competitiveness of its wine, dried grape and table grape businesses through productivity gains, innovation, differentiation and meeting market demand. Breeding, as opposed to importing, allows the Australian industry to be strategic in many ways. For example, traits that will make a commercial difference to the Australian industry can be selected for as a high priority. Varieties with such traits will have the advantage of being uniquely Australian.

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[2] CSIRO and Senator Inquiry 2016.

[3] Department of Agriculture.

[4] Australian Bureau of Statistics, 1329.0.55.002: Vineyards Estimates 2014–15, 'Table 1: Vineyards production, area and number of businesses – Australia, States and Territories–2014-15'.

Moreover, it is not always possible to obtain new varieties from overseas due to utilisation of plant breeders' rights and other forms of protection for new cultivars, adoption of exclusive distribution and/or marketing arrangements or to simple restrictions on the export of new cultivars to establish marketing advantages. This is now the case with USDA varieties which are not patented but their export is prohibited until they are established commercially in the USA.

The capability of the Australian grape and wine industry to meet these challenges may be limited by the restricted number of grape varieties currently grown. There is great potential for Australian researchers to exploit scientific and technical solutions to meet these challenges.

CSIRO's involvement

CSIRO's involvement with the grape and wine industry commenced in a significant way in the early 1960s, when CSIRO began a grape research program at its laboratory and field station at Merbein, Victoria, on the Murray River. In those early years the focus was on wine grapes and dried grapes. Among other things, the CSIRO team at Merbein were responsible for the importation, evaluation and release of new nematode-tolerant rootstocks and the introduction of:

- A wide range of grapevine varieties and clones from Europe and other countries;
- new virus-tested vine varieties from the University of California;
- the first mechanical harvesters for wine grapes and their evaluation in Australia,
- light mechanical and minimal pruning techniques, both innovations from CSIRO research and;
- low-input, highly productive mechanised systems for dried grape production developed by CSIRO based on in-situ trellis drying techniques.

CSIRO's importation of key varieties from all around the world enabled it to begin breeding programs for wine grape production and for improved dried grapes and table grapes. Since that time CSIRO has investigated 50,000 or more breeding lines.

As a consequence of these innovations, by 1994 Australia had the world's highest percentage of vines mechanically harvested and Australian winemakers could economically harvest quality grapes from grapevines grafted to nematode-tolerant rootstocks. This in turn meant that winemakers could produce wine grape varieties with good yield and grape composition on the large areas of irrigable land along the Murray River, and this transformed the Australian wine industry into a significant employer with international recognition[5]. Similarly, Australia has led the world with both the development and adoption of mechanised dried grape production[6].

[5] CSIROpedia – Transforming the Australian Wine Industry

[6] CSIROpedia – Transforming the Australian Wine Industry

Impact Pathway

Inputs

The breeding program has been supported strongly by CSIRO and in the case of dried grapes and table grapes with financial support from Horticulture Australia Ltd (HAL), now Horticulture Innovation Australia (HIA) and Dried Fruits Research and Development Council (DFRDC). The table grape evaluation program has also involved inputs from the state / territory agriculture agencies in Western Australia, Queensland and Northern Territory. Estimates of the funding by institution for the development of varieties released from the program are shown in Tables 1 to 3.

Table 1: Total investment in dried grape breeding and evaluation including dried grape varieties Carina, Sunmuscat, Sunglo, Black Gem and Shirana (2015$)

Year	CSIRO	DFRDC	HAL
Pre-1989	1,006,731	-	
1988-89	63,768	63,768	-
1989-90	114,494	114,494	-
1990-91	112,429	116,148	
1991-92	112,546	121,006	
1992-93	159,671	159,671	
1993-94	154,569	154,569	
1994-95	152,400	152,400	
1995-96	124,580	86,585	
1996-97	144,631	102,215	
1997-98	150,864	106,146	
1998-99	204,009	133,737	
1999-00	202,281	145,830	
2000-01	201,913	148,572	
2001-02	210,618		160,597
2002-03	211,073		159,088
2003-04	211,891		144,638
2004-05	152,884		203,622
2005-06	154,246		190,445
2007-07	154,851		192,334
2007-08	156,158		195,096
2008-09	156,250		196,372

2009-10	145,333	193,360
2010-11	151,452	193,878

Note: a) All dollars are in 2015 $; b) Dried Fruits Research Development Council (DFRDC).

Source: CSIRO

Table 2: Total investment in table grape breeding and evaluation including table grape varieties M 51-18, M 13-01 and M 44-14 (2015$)

Year	CSIRO	[1]HAL
Pre-1998	97,218	
1997-98	139,898	14,516
1998-99	556,997	88,760
1999-00	612,876	168,293
2000-01	663,123	172,856
2001-02	684,918	177,926
2002-03	696,191	192,402
2003-04	492,381	227,703
2004-05	255,372	289,288
2005-06	272,940	320,802
2006-07	270,374	304,797
2007-08	291,987	302,936
2008-09	287,424	298,569
2009-10	174,022	267,987

Note: a) all dollars are in 2015 $; b) [1]HAL contributions include funds provided to state agencies, Department of Agriculture and Food (WA), Department of Agriculture and Fisheries (Qld) and Department of Primary Industry and Fisheries (NT) to enable evaluation of advanced selections in WA, Qld and NT.

Source: CSIRO.

Table 3: Total investment in wine grape breeding and evaluation including wine grape varieties Tarrango, Taminga, Tyrian, Cienna and Rubienne (2015 $)

Year	CSIRO
1965	49,936
1966	44,750
1967	44,750
1968	58,748
1969	61,996
1970	77,442
1971	70,152
1972	127,844
1973	118,192
1974	124,422
1975	140,800

1976	136,542
1977	140,342
1978	106,190
1979	106,828
1980	106,828
1981	91,024
1982	91,024
1983	86,600
1984	86,600
1985	105,264
1986	99,882
1987	104,770
1988	104,770
1989	104,770
1990	104,770
1991	106,954
1992	134,842
1993	121,426
1994	94,072
1995	94,072
1996	95,494
1997	95,494
1998	111,212
1999	129,074
2000	113,156
Total	3,591,032

Source: CSIRO

Activities

Grapevine breeding is the most prominent method used for the improvement of grape varieties and is distinct from clonal selection and virus elimination. Vine improvement through breeding in this analysis includes the evaluation of two table/dried grape selections introduced from USDA and evaluated for suitability to the Australian production system and environment and the production by hybridisation of new varieties better suited to Australian conditions. Grapevines are bred for specific purposes, including to produce wine grapes, dried grapes and table grapes. Key attributes sought in the breeding programs are explained below.

Wine grapes

CSIRO's wine grape breeding aims to develop varieties suited to the hot regions which produce a large percentage of Australia's wine grapes. Usually there is very little leeway in hot areas between the time at which the sugar in the grapes reaches the desired level and that at which the acid falls too low. Only cooler areas escape this problem of a very short period of optimum maturity. What is required is varieties with a distinctive flavour and aroma, excellent colour and

tolerance of heat, and if possible, suitability to modern production methods and for mechanical harvesting without damage.

The wine grape breeding is complemented by vine management research aimed at optimising canopy function with decreased inputs while maintaining wine aroma, flavour and colour. The intention is to better understand the vine's ability to respond to strategically applied water deficits to enhance berry composition and wine quality, but also to ensure carry-forward of sufficient carbohydrate reserves from one season to the next. Ideally, the new wine grape varieties are suited to these modern production methods.

Dried grapes

CSIRO's dried grape breeding has targeted seedless varieties that are ideally superior to the Sultana, Zante and Gordo varieties that were the mainstay of the dried grape industry in the 1970s and 1980s. This is in the context of all major dried grape traits, covering, for example, rain tolerance, consistent fruitfulness from season to season, graft compatibility with particular rootstocks, resistance to key diseases and other disorders, and all yield and quality traits. The highest priority has been development of high yielding sultana types with seedless, sweet fruit that do not split or excessively brown in wet harvests.

There is an expectation also that new varieties will have good processing and storage characteristics, including the ability to hold premium quality throughout the marketing chain, including on the supermarket shelf and on to the consumer.

Table grapes

CSIRO's table grape breeding targets seedless, large and sweet berries with good flavour and crisp texture. It has included inheritance studies of key characteristics. The best selections are extensively evaluated for production characteristics, including resistance/tolerance to pests and disease, yield and product quality, postharvest characteristics and consumer appeal. This involves evaluation of the best selections in the major production regions, specifically the Murray Valley (Sunraysia and Robinvale / Euston regions of south west New South Wales and north-west Victoria) and in Western Australia, Queensland and the Northern Territory.

Outputs

The key outputs for the grapevine breeding program have been grape varieties released for commercial production by grape growers and winemaking companies. Since 1975, major dried, table and wine grape varieties have been released by the grapevine breeding program (see Table 4). These varieties are suited to a range of environments and market types. They possess tolerance of hot conditions during the production season and produce good yields of grapes that meet desired quality specifications. The range of varieties permit development of a wide range of end products.

In addition, a range of other outputs including publications and field days have been produced as part of this program.

Table 4: Varieties Released from Grapevine Breeding Program since 1975.

Varieties	Year of release	Region
Wine grape varieties		
Cienna	2000	Warmer Australia
Rubienne	2000	Warmer Australia
Taminga	1982	Warmer Australia
Tarrango	1975	Warmer Australia
Tyrian	2000	Warmer Australia
Table grape varieties		
M 51-18 muscat flavoured grape	2004	Carnarvon (WA) region
M 13-01 a seedless black grape	2005	Southern and northern regions
M 44-14, a seedless white grape	2010	Southern and northern regions
Dried grape varieties		
Carina	1975	Sunraysia
Sunmuscat	1997	Sunraysia
Sunglo	2010	Sunraysia
Black Gem	2010	Sunraysia
Shirana	2002	Sunraysia

Note: Of the 13 varieties, 11 have been bred and released by CSIRO. Two are USDA-bred, CSIRO-evaluated, released jointly by CSIRO and USDA.

Publications

Antcliff, A.J. (1975) Four new varieties released for testing. Journal of the Australian Institute of Agricultural Science. 41, 262-264.

Antcliff, A.J. (1982) Taminga: a new white wine grape with varietal character. Journal of the Australian Institute of Agricultural Science. 48, 161-162.

Clingeleffer, P.R. (1985) Breeding of grapevines for hot climates. Australian Grapegrower and Winemaker (256), 99-104.

Kerridge, G.H., Clingeleffer, P.R. and Possingham, J.V**.** (1992) The performance of the CSIRO-bred varieties Tarrango and Taminga in several viticultural regions of Australia. Australian Grapegrower and Winemaker (345), 10-13.

Clingeleffer, P., McCarthy, B., Gordon, C., Cameron, I., Oag, D., McConchie, C. and Walker, R. (2014). Developments in the Australian table grape breeding program. Proceedings 7th International Table grape Symposium, Mildura, 12-14 November, 2014. 39-42.

Clingeleffer, P.R., Emanuelli, D.E., Tarr, C.R., Singh, D.P., Sykes, S.R. and Walker, R.R. (2011) M 48-42 (Syn. Black Gem), a new early ripening, disease tolerant currant variety. Vine 7 (3) 32-33.

Clingeleffer, P.R. (2006). Management practices for Sunmuscat (*Vitis vinifera L.*): a new drying variety. Australian Journal of Grape and Wine Research, 12(2); 128-34.

Clingeleffer, P.R. (2012) Enhanced dried grape types for the Australian industry. Final report to Horticulture Australia. 2012. DG09000.

Outcomes

Adoption

The program has a track record of integrating good science with successful delivery of new varieties of grapes for drying, table and wine to target industries with strong adoption outcomes. Examples of significant business adoption include:

- Innovative and major Australian wine companies, e.g. Brown Brothers (progressive new wine styles, trialing/adoption of CSIRO wine varieties and advanced selections), Australian Vintage Ltd (evaluation of red wine grape selections), Treasury Wine Estates and McWilliams Wines (innovative blended wine products), Trentham Estate Winery, Peter Drayton Wines and Ramco Wines (novel, niche bottled wine varietals).
- Table Grapes Western Australia Inc. and Special New Fruit Licensing Ltd (commercialisation of new table grape varieties).
- Dried Fruits Australia (commercialisation of new dried grape varieties).

Major dried, table and wine grape varieties developed by CSIRO have been successfully released and adopted by grape growers and winemaking companies since 1975. The varieties have provided the Australian wine, dried and table grape industries with ongoing capability to meet the challenges associated with climate change, limited water supply and drought and various soil conditions.

Strategic knowledge has been produced that can be used by CSIRO in other breeding programs for improving the long-term efficiency of horticulture. For example, the expertise that CSIRO has gained from the project is being used in future breeding involving marker assisted selection.

BOX 1 OUTCOMES OF SELECTED TABLE AND WINE GRAPE VARIETIES

Dried grapes

- Dried Fruits Australia appointed National Commercialiser.
- Carina provides all of Australia's dried currant production.
- Sunmuscat comprises 15% of the Australian dried grape industry.
- Over 40,000 vines of Sunglo planted between 2010 and 2015.

Table grapes

- Table Grapes Western Australia appointed National Commercialiser.
- Special New Fruit Licensing Ltd appointed International Commercialiser.
- Plant Breeders Rights granted in Australia (M 51-18, M 13-01 and M 44-14) and Trade Mark names granted (Magic Seedless and Mystic Seedless) or pending (Millennium Muscat).
- Around 30,000 vines of M 13-01 in production. Fruit is mostly exported to Asia.

Wine grapes

- Tyrian is a successful both as a bottled varietal and blending variety.
- Cienna is currently #2 in the Australian Fruity Red wine category.
- Cienna is a major domestic and export variety for Brown Brothers.

SOURCE: CSIRO

Impacts

CSIRO's grape breeding program has led to a range of delivered and potential impacts, including increased yield and grape quality, resilience in hot inland production environments, and novel product options for growers and processors. Using CSIRO's triple bottom line impact classification approach, Table 5 summaries the nature of the existing and potential impacts.

Table 5: Impact of Grapevine Breeding Program

TYPE	CATEGORY	INDICATOR	DESCRIPTION
Economic	Productivity and efficiency	Increased yield and grape quality	Increased grape quality translates to a price premium in the marketplace. Rain-tolerant varieties lead to increased yield and reduced losses and crop downgrades.
Economic	Productivity and efficiency	Reduced costs of production	Disease resistant varieties, e.g. Black Gem, lead to reduced costs to growers through minimized or avoided application of fungicides. Reduced input costs due to suitability to mechanical pruning and harvesting.
Economic	Trade and competitiveness	Price premium from blending	Wine products using CSIRO varieties for blending, e.g. Tyrian, attract a price premium as compared to other regular comparable products.
Economic	New services, products, experiences and market niches	Sales value of new wine product	Novel wine varietals including Cienna, Taminga and Tarrango leading to increased revenue for wine companies.
Environmental	Land quality	Soil moisture and erosion	Drought-resilient varieties offer potential for fewer on-farm interventions, reducing soil compaction and fuel consumption.
Social	Resilience	Income and employment	The use of new varieties potentially gives grape growers improved capacity to be competitive and profitable. The use of new varieties may contribute to greater consistency in production, employment and therefore stability in rural communities.

For the benefits identified, economic benefits are estimated in monetary terms, as discussed in the section below. Given the constraints on data availability for environmental and social costs and benefits, these benefits are noted, but not assessed.

Clarifying the Impacts

Counterfactual

Innovations introduced by CSIRO have enabled Australia's grape and wine industry to grow from modest beginnings to become a major export earner and international producer. Work to develop the new grape varieties evaluated within this case study itself extends back more than two decades.

There are a number of other research organisations that are important players in grape and wine related research, the larger ones including Australian Wine Research Institute (AWRI), National Wine and Grape Industry Centre (NWGIC), South Australian Research and Development Institute (SARDI) and Universities such as the University of Adelaide.

However, among these organisations, CSIRO has by far the strongest capability and longest track record in grape breeding, including:

- Australia's largest collection of grapevine germplasm.
- Staff working across a very broad range of disciplinary areas relevant to breeding work – including breeding, molecular breeding and genetics, plant physiology, biochemistry and crop based expertise - and this is thus an efficient partner for interaction.
- Access to a range of scientific equipment and facilities - some other potential partners would not have been able to provide access across this range.
- Researchers experienced in providing research services to industry and in designing solutions that are implementable by industry. Examples include new varieties of grapes for drying, table and wine, new varieties of citrus and new rootstocks for grape production.

It is therefore assumed that without CSIRO's involvement and investment in the grapevine breeding program, there would have been insignificant genetic improvement of grape varieties, less diversity and choice for consumers and reduced capacity to demonstrate point-of-difference for expanding export markets.

Attribution

The program has a track record of integrating good science with successful delivery of outputs to target industries with strong adoption outcomes. Examples include new varieties of grapes for drying, table and wine and new rootstocks for grape production.

CSIRO was the primary source of research, breeding expertise and resources that underpinned the development of new grape varieties. Other contributors to the successful implementation of CSIRO research include Australian Grape and Wine Authority (AGWA) and HIA and, in the case of table grapes, inputs from state agriculture agencies in WA, Qld and NT. The industry has also played an important role in CSIRO's development for new grape varieties by providing testing sites. However, the industry role in the research and development of these new grape varieties has been minor. In the wine industry, for example, this has mostly involved small lot processing and sensory evaluation of test products.

Since all of the CSIRO, AGWA and HIA, State agriculture agencies and the wine and grape industry were considered necessary to achieve the ultimate outcomes and impacts, it was appropriate to attribute benefits among the project on a cost-sharing basis. Based on the above, this case study will attribute total impacts as follows:

- Dried grape: CSIRO - 60%
- Table grape: CSIRO - 70%

- Wine grape: CSIRO - 85%[7]

Evaluating the Impacts

Given the data availability, the cost benefit analysis will only focus on wine grapes. In this report, two conceptually different approaches were adopted: a standard CSIRO impact evaluation and an ex-post cost benefit analysis, as follows.

Definition of cost benefit analysis

Input costs are the costs incurred by CSIRO and its research partners to produce the research outputs and include costs associated with such things as staff, in-kind contributions, equipment/facilities and background IP. Where data are available, input costs should also include usage and adoption costs borne by the end users including any trials, further development and market tests.[8]

In this analysis, only the primary benefit (yield benefit) is included. This benefit represents the quality improvements, and to some extent yield gains, from new varieties, which is calculated by relating the per-hectare gains to the number of hectares of the crop grown. In this analysis, we use industry value added measurement (also called 'industry gross product') to monetise the benefits, which is derived by subtracting production value with costs of goods and services in the grape growing industry.

Therefore, the formula for calculating a benefit cost ratio (BCR) is defined as value added benefits (Present Value) divided by all the research, adaptive development and extension costs (Present Value).

Definition of Impact Evaluation

Benefit cost ratios are typically calculated as the present value of revenues divided by the present value of all costs. CSIRO economic impact factors are similar, but the numerator is expressed as profit (revenue minus operating costs), and the denominator is limited to capital outlays. The objective in this case study was to assess the economic impact attributable to CSIRO research. In this analysis, we include both primary and secondary benefits for the economic impact evaluation. These secondary benefits represent the price premium from blending and sales value from new wine products, which is calculated by relating the per bottle premium/wholesale price to the number of bottles sold. This CSIRO economic impact factor was calculated as the ratio of profits made by wine producers (numerator) and the cost of CSIRO investment in grapevine research (denominator).

[7] Attribution for wine grapes is based on input and consultation from researchers and winemaking companies. For this analysis, we were unable to collect other costs beyond CSIRO due to resource constraints and commercial confidentiality issues.

[8] For this analysis, we were unable to collect usage and adoption costs beyond CSIRO due to resource constraints and commercial confidentiality issues.

Time period of analysis

Where CSIRO research such as the grape breeding program is an on-going activity, it is necessary to define a particular period for the economic analysis. Given the available data, the analysis is based on research activity since 1965.

In grape breeding research, there are lags between the initial hybridisation being conducted and the realisation of benefits through adoption and uptake by growers and winemaking companies. In recent years, these lags have averaged approximately 15 years, so that benefits by growers and winemaking companies generally do not take place until around the sixteenth year after the initial cross. However, the existing available data only support measurements of benefits from 1985 onwards. For benefits between 1980 and 1985, we estimated a 5-year average 1985-1990 and applied it to each year in 1980-1985. On that basis, the benefits are only measured from 1980 onwards, however, the costs from 1965 to 2015 are included.

Given the costs are measured until 2015, the benefit must be estimated for the future, since the varieties developed and released before 2015 will have a productive impact for many years. Based on a conservative approach principle, we decided that the period of analysis should only run to about 2025. This should provide greater confidence in the net benefits determined by the analysis.

Thus the analysis involves a large component of ex-post analysis (relating to the period 1965 - 2015), but also involves some ex-ante analysis for the benefits flowing from those activities over the period from 2015 to 2025. It should be noted that much of the benefit from the breeding projects is yet to be realised, as a significant number of breeding lines are still being evaluated in collaboration with commercial wine companies, and dried and table grape industries.

Defining the “with” and “without” scenarios

Not all the productivity gains in the grape and wine industry can be attributed to CSIRO’s grapevine breeding program. Some of the benefits would have occurred if there had been no research by CSIRO. However, it is likely that the rate of improvement would have been lower without the program. Thus the value of the program is the difference between the “with program” and the “without program” (counterfactual) benefits. Assumptions for the applicability of these benefits and their magnitude for each new variety are provided in Table 6.

The primary impact from the new varieties is quality improvements (to some extent yield gains), blending benefits and new product benefits. As estimating the yield of the variety replaced would have required further significant data, in this analysis it is assumed that CSIRO varieties would contribute to a 10 per cent yield gain and a 10 per cent price gain.

Wine companies using CSIRO wine varieties for blending have been able to develop quality wine products which are attractive to consumers, providing excellent value for money as compared to other regular comparable products. This additional value placed by consumers reflects the perceived benefits of blending, for example, using the CSIRO Tyrian variety. These include later ripening, medium to full bodied, excellent depth of colour, lifted aromatic fruit characters, ferments well and blends well with major red varieties Shiraz and Cabernet Sauvignon and adds a point of difference and another layer of complexity to the finished wine product. This assumes a current price premium for the final wine product of approximately $3 per bottle (compared to other similar wine on the market). In this analysis, we take a relatively conservative approach and assume an approximately 10 per cent price premium for final product.

Through research and innovation CSIRO also led the development of new wine using CSIRO varieties such as Taminga, Tarrango and Cienna. For example, Cienna (released 2000) is currently #2 in the Fruity Red category of Brown Brothers and is highly popular in Asian markets where sweeter wines are preferred. There is a sale price for the wine product in Australia of approximately $15 per bottle.

Table 6: Improvement with and without the grapevine breeding Program (% per year)

		On farm benefit-yield gain (%)	On farm benefit-price gain (%)	Product benefit from blending - Tyrian (%)	New product benefit – Cienna, Taminga and Tarrango (%)
-	**With CSIRO (A)**	10%	10%	10%	100%
-	**Without CSIRO (B)**	0%	0%	0%	25%
-	**Difference (C=A-B)**	10%	10%	10%	75%

Source: CSIRO

Cost benefit analysis

Costs

Establishing the costs involved throughout the entire inputs to impact pathway is an important aspect of a cost-benefit analysis. This includes both the input costs incurred by CSIRO and its researcher partners, as well as any usage and adoption costs borne by clients, external stakeholders, intermediaries and end users. Given the length of the project and commercial confidentiality issues, we are unable to identify usage and adoption costs borne by intermediaries and end users of CSIRO varieties. For the purpose of this evaluation, we only included inputs costs incurred by CSIRO.

As noted in previous sections, CSIRO contributed $3.6 million to the project between 1965 and 2000 in real terms. These contributions were compounded forward using a real discount rate of 7% per annum. As a result, CSIRO's contribution totals $37 million in 2015 dollars (that is, inflation-adjusted and in present value terms).

Benefits to 2025

The benefits calculated in the analysis are the net benefits from the wine grape breeding program, that is, the difference between the "with" and "without program" scenarios (as shown in Table 6). The analysis is equivalent to carrying out separate analyses for the "with program" and "without program" scenarios and calculating the difference between them.

The steps in quantifying the gains from the grapevine breeding program are as follows:

1. Combine grape yield in each year with the area planted due to the program, to get an estimate of the production that year and all subsequent years.
2. All past benefit flows from 1965 to 2015 were adjusted to real dollars using the CPI published by Australian Bureau of Statistics with base =100 at 2015. All benefits after 2015

were expressed in 2015 dollar terms. All costs and benefits were expressed in present value terms using a real discount rate of 7% per annum.

Table 7: On-farm Benefits from the Grapevine Breeding Program

Measure		Value	Source
With CSIRO research			
A_R	Yield per hectare for target adoption (tonnes per hectare)	Various	CSIRO
B_R	Crop area to produce target production (hectares)	Various	CSIRO
C_R	Average price to growers ($ per tonne)	500	CSIRO
D_R	Indicative growers' gross earnings for target adoption	$= A_R * B_R * C_R$	
E_R	Industry 10- year average value added ratio (%)	42	IBIS World
Counterfactual			
A_c	Yield per hectare (tonnes per hectare)	$=A_R *(1-10\%)$	CSIRO
B_c	Crop area to produce target production (hectares)		
C_c	Average price to growers ($ per tonne)	$= C_R *(1-10\%)$	
D_c	Indicative growers' earnings	$= A_c * B_c * C_c$	
Impact :	World with CSIRO - Counterfactual		
	Value of growers' additional gross earnings ($ per annum)	$=(D_R - D_c)* E_R$	

Benefit-cost results to 2025

Table 8 details the benefits of the CSIRO wine grape breeding program between 1965-2025.

Table 8: Analysis of Benefits of CSIRO Wine Grape Breeding Program 1965-2025

Year	Benefits from the program					Discounted benefits		
	Benefits ($') A	Attribution rate B	CSIRO benefits ($') C=A*B	Costs ($') D	Net benefits E=C-D	Benefits ($')	Costs ($')	Net benefits
1965				49,936	- 49,936		1,470,966	- 1,470,966
1966				44,750	- 44,750		1,231,964	- 1,231,964
1967				44,750	- 44,750		1,151,369	- 1,151,369
1968				58,748	- 58,748		1,412,637	- 1,412,637
1969				61,996	- 61,996		1,393,213	- 1,393,213
1970				77,442	- 77,442		1,626,472	- 1,626,472
1971				70,152	- 70,152		1,376,976	- 1,376,976
1972				127,844	- 127,844		2,345,216	- 2,345,216
1973				118,192	- 118,192		2,026,314	- 2,026,314
1974				124,422	- 124,422		1,993,573	- 1,993,573
1975				140,800	- 140,800		2,108,404	- 2,108,404
1976				136,542	- 136,542		1,910,881	- 1,910,881
1977				140,342	- 140,342		1,835,571	- 1,835,571
1978				106,190	- 106,190		1,298,026	- 1,298,026
1979				106,828	- 106,828		1,220,397	- 1,220,397
1980	14,897	85%	12,663	106,828	- 94,165	135,193	1,140,558	- 1,005,365
1981	14,897	85%	12,663	91,024	- 78,361	126,349	908,248	- 781,899
1982	14,897	85%	12,663	91,024	- 78,361	118,083	848,830	- 730,747
1983	14,897	85%	12,663	86,600	- 73,937	110,358	754,742	- 644,385
1984	14,897	85%	12,663	86,600	- 73,937	103,138	705,367	- 602,229
1985	6,445	85%	5,478	105,264	- 99,786	41,701	801,296	- 759,596
1986	6,646	85%	5,649	99,882	- 94,233	40,190	710,586	- 670,396
1987	6,848	85%	5,820	104,770	- 98,950	38,699	696,599	- 657,899
1988	7,049	85%	5,992	104,770	- 98,778	37,231	651,027	- 613,796
1989	47,498	85%	40,373	104,770	- 64,397	234,463	608,436	- 373,973
1990	76,258	85%	64,819	104,770	- 39,951	351,803	568,632	- 216,829
1991	98,392	85%	83,633	106,954	- 23,321	424,218	542,510	- 118,292
1992	67,066	85%	57,006	134,842	- 77,836	270,240	639,223	- 368,983
1993	79,432	85%	67,517	121,426	- 53,909	299,129	537,966	- 238,837
1994	107,910	85%	91,724	94,072	- 2,348	379,787	389,511	- 9,724
1995	71,223	85%	60,540	94,072	- 33,532	234,269	364,029	- 129,760
1996	74,623	85%	63,429	95,494	- 32,065	229,394	345,357	- 115,963
1997	92,966	85%	79,021	95,494	- 16,473	267,087	322,763	- 55,677
1998	99,480	85%	84,558	111,212	- 26,654	267,102	351,298	- 84,196
1999	144,747	85%	123,035	129,074	- 6,039	363,218	381,048	- 17,829
2000	93,849	85%	79,771	113,156	- 33,385	220,092	312,201	- 92,109
2001	126,733	85%	107,723		107,723	277,768	-	277,768
2002	171,158	85%	145,484		145,484	350,595	-	350,595
2003	187,520	85%	159,392		159,392	358,981	-	358,981
2004	183,556	85%	156,023		156,023	328,405	-	328,405
2005	192,047	85%	163,240		163,240	321,118	-	321,118
2006	189,989	85%	161,491		161,491	296,894	-	296,894
2007	200,320	85%	170,272		170,272	292,559	-	292,559
2008	117,635	85%	99,989		99,989	160,561	-	160,561
2009	130,067	85%	110,557		110,557	165,916	-	165,916
2010	119,401	85%	101,491		101,491	142,346	-	142,346
2011	103,722	85%	88,164		88,164	115,564	-	115,564
2012	148,710	85%	126,404		126,404	154,850	-	154,850
2013	44,668	85%	37,968		37,968	43,469	-	43,469
2014	48,811	85%	41,489		41,489	44,394	-	44,394
2015	67,588	85%	57,450		57,450	57,450	-	57,450
2016	79,472	85%	67,552		67,552	62,823	-	62,823
2017	80,077	85%	68,065		68,065	59,451	-	59,451
2018	80,681	85%	68,579		68,579	55,981	-	55,981
2019	86,723	85%	73,714		73,714	56,236	-	56,236
2020	93,369	85%	79,364		79,364	56,585	-	56,585
2021	100,015	85%	85,013		85,013	56,648	-	56,648
2022	106,661	85%	90,662		90,662	56,460	-	56,460
2023	119,350	85%	101,447		101,447	59,043	-	59,043
2024	132,038	85%	112,232		112,232	61,047	-	61,047
2025	144,726	85%	123,017		123,017	62,536	-	62,536

The flows of costs and benefits from 1965 to 2025 are used to calculate investment criteria. Investment criteria were estimated for the CSIRO investment as reported in Table 9. The low BCR is a result of low economic benefits flowing from yield improvement and high present value of research costs.

Table 9: Results of CSIRO Investment and Benefits to CSIRO

Criteria	
Present value of costs ($m)	37.0
Present value of benefits ($m)	8.0
Net Present Value (NPV) ($m)	-29.0
Benefit-cost Ratio (BCR)	0.2

In fact, high yield is not the primary objective of this breeding program. It is the secondary benefits such as blending benefits and novel wine offering which the program was targeting. Given the uncertainties around the evidence base, these secondary benefits were not included in this cost benefit analysis. Instead, we added a separate economic impact section below to discuss the blending benefits and new product benefits.

Sensitivity analysis

While the prospects look promising, the adoption of CSIRO's wine grapes in the wine industry is by no means certain. The take-up of new improved varieties on a large scale relies on an efficient production and marketing system that is capable of providing good quality product and competing in a fiercely contested global marketplace. It is also not clear whether new varieties would be able to continue delivering the price premium and new product benefits in the next 10 years.

Given these multifaceted uncertainties, it would be useful to look at results under different discount and adoption rates. NPV and benefit cost ratio calculations are particularly sensitive to changes in underlying parameters, so it is important to understand the results in perspective. In this section, we analyse the impact of variations in the discount and attribution rates as well as the wholesale price of wine on benefit and cost streams coming out of our central case. The results of that analysis are shown in Table 10.

Table 10: Results of sensitivity analysis (CSIRO investment)

Assumption	Central assumption	Low assumption	High assumption	BCR (Central)	BCR (low)	BCR (high)
Discount rate (%)	7	5	9	0.2	0.3	0.1
Benefits attributable to CSIRO (%)	85	70	100	0.2	0.2	0.3
Yield improvement (%)	10	5	15	0.2	0.1	0.3

Table 10 highlights the influence on our analysis of changes in key assumptions. The most important assumptions are about the discount and attribution rates. A higher discount rate of 9% reflects greater opportunity cost of capital and inevitably yielded a lower benefit cost ratio. Similarly, an attribution rate of 65% to CSIRO indicated that the benefits were likely to be lower than in the base case (85%). It also returned a lower NPV and benefit cost ratio.

While the parameters used in the base-case scenario seemed reasonable in the light of current realities on the ground, it was nevertheless important to test the robustness of our conclusions to variations in these assumptions. The low and high alternative assumptions used in the above sensitivity analysis were brought together to estimate benefit and cost streams under pessimistic (high discount rate and low attribution rate) and optimistic (low discount rate and high attribution rate) scenarios. The results under these different assumptions are summarised in Table 11.

Table 11: Alternative assumptions for sensitivity analysis (CSIRO investment)

	Pessimistic	Central (baseline)	Optimistic
Discount rate (%)	9	7	5
Benefits attributable to CSIRO (%)	65	85	100
Yield improvement (%)	5	10	15
Benefit Cost Ratio (%)	0.1	0.2	0.6

Economic Impact Evaluation

In addition to the primary yield benefits, there are also secondary product benefits on the wine production industry arising from the new varieties developed by CSIRO. For example, wine companies using CSIRO wine varieties for blending have been able to develop quality wine products which are attractive to consumers providing excellent value for money as compared to other regular comparable products. Through research and innovation CSIRO also contributed to the development of new wine using CSIRO varieties such as Taminga, Tarrango and Cienna.

The steps in quantifying the secondary product benefits from the grapevine breeding program are as follows:

1. Combine grape yield in each year with the area planted due to the program, to get an estimate of the production that year and all subsequent years.
2. Combine the price premium of 10% with the number of bottles produced using conversion ratio (bottles/tonnes of grapes) to get an estimate of the price premium benefit of blending using CSIRO Tyrian variety in that year and all subsequent years .
3. Combine the wholesale price of the bottle wine (Cienna, Taminga and Tarrango) with the number of bottles produced using conversion ratio (bottles/tonnes of grapes) to get an estimate of the new product benefit in that year and all subsequent years in value added terms.
4. All past benefit flows from 1965 to 2015 were adjusted to real dollars using the CPI published by Australian Bureau of Statistics with base =100 at 2015. All benefits after 2015 were expressed in 2015 dollar terms. All costs and benefits were expressed in present value terms using a real discount rate of 7% per annum.

Table 12: Price Premium for Blending – Tyrian only

Measure		Value	Source
With CSIRO research			
A_R	Total yield (tonne)	Various	CSIRO
B_R	Conversion (bottles/ tonne)	9000	CSIRO
C_R	Number of bottles equivalent to be sold upon maturity	= A_R * B_R	
D_R	Whole sale price ($ per bottle)	12	CSIRO
E_R	Industry 10- year average value added ratio (%)	28	IBIS World
F_R	Gross revenue from blending with CSIRO varieties ($)	= C_R* D_R * E_R	
Counterfactual			
A_c	Premium price per bottle (%)	10%	CSIRO
B_c	Wholesale price of other similar product ($ per bottle)	= D_R *(1- A_c)	
C_c	Gross revenue from manufacturing other similar product ($)	= B_c* C_R	
Impact :	World with CSIRO - Counterfactual		
	Value of additional earnings to wine companies due to blending ($ per annum)	=F_R- C_c	

Note: whole sale price= retail price*(1- trade/transport margin %). Trade/transport margin in the wine industry is assumed to be 20% based on ABS Input-Output Tables.

Table 13: New Product Benefit – Tarrango, Taminga and Cienna

Measure		Value	Source
With CSIRO research			
A_R	Total yield (tonne)	Various	CSIRO
B_R	Conversion (bottles/ tonne)	900	CSIRO
C_R	Number of bottles equivalent to be sold upon maturity	= A_R * B_R	
D_R	Whole sale price ($ per bottle)	12	CSIRO
E_R	Industry 10- year average value added ratio (%)	28	IBIS World
F_R	Adjusting factor for unsold product (%)	75	CSIRO
G_R	Gross revenue from manufacturing CSIRO varieties ($)	= C_R* D_R * E_R* F_R	
Without CSIRO research			
A_c	Adjusting factor for benefits incur anyway in the absence of CSIRO (%)	25%	CSIRO
B_c	Gross revenue from manufacturing other varieties ($)	= G_R* A_c	
Impact :	World with CSIRO – Counterfactual		
	Indicative earnings from manufacturing to wine companies ($ per annum)	=G_R- B_c	

Table 14: Benefits of CSIRO Wine Grape Breeding Program 1965-2025

Year	Benefits from the program					Discounted benefits		
	Benefits ($') A	Attribution rate B	CSIRO benefits ($') C=A*B	Costs ($') D	Net benefits E=C-D	Benefits ($')	Costs ($')	Net benefits
1965				49,936	- 49,936		1,470,966	- 1,470,966
1966				44,750	- 44,750		1,231,964	- 1,231,964
1967				44,750	- 44,750		1,151,369	- 1,151,369
1968				58,748	- 58,748		1,412,637	- 1,412,637
1969				61,996	- 61,996		1,393,213	- 1,393,213
1970				77,442	- 77,442		1,626,472	- 1,626,472
1971				70,152	- 70,152		1,376,976	- 1,376,976
1972				127,844	- 127,844		2,345,216	- 2,345,216
1973				118,192	- 118,192		2,026,314	- 2,026,314
1974				124,422	- 124,422		1,993,573	- 1,993,573
1975				140,800	- 140,800		2,108,404	- 2,108,404
1976				136,542	- 136,542		1,910,881	- 1,910,881
1977				140,342	- 140,342		1,835,571	- 1,835,571
1978				106,190	- 106,190		1,298,026	- 1,298,026
1979				106,828	- 106,828		1,220,397	- 1,220,397
1980				106,828	- 106,828		1,140,558	- 1,140,558
1981				91,024	- 91,024		908,248	- 908,248
1982				91,024	- 91,024		848,830	- 848,830
1983				86,600	- 86,600		754,742	- 754,742
1984				86,600	- 86,600		705,367	- 705,367
1985	278,605	85%	236,814	105,264	131,550	1,802,689.17	801,296	1,001,393
1986	287,311	85%	244,215	99,882	144,333	1,737,404.87	710,586	1,026,819
1987	296,018	85%	251,615	104,770	146,845	1,672,947.20	696,599	976,348
1988	304,724	85%	259,015	104,770	154,245	1,609,487.41	651,027	958,460
1989	2,053,317	85%	1,745,320	104,770	1,640,550	10,135,687.87	608,436	9,527,252
1990	3,296,591	85%	2,802,103	104,770	2,697,333	15,208,223.12	568,632	14,639,591
1991	4,253,425	85%	3,615,411	106,954	3,508,457	18,338,691.06	542,510	17,796,181
1992	2,899,231	85%	2,464,347	134,842	2,329,505	11,682,308.27	639,223	11,043,086
1993	3,433,804	85%	2,918,734	121,426	2,797,308	12,931,162.14	537,966	12,393,196
1994	4,664,889	85%	3,965,156	94,072	3,871,084	16,417,974.72	389,511	16,028,464
1995	3,078,931	85%	2,617,092	94,072	2,523,020	10,127,318.71	364,029	9,763,290
1996	3,225,895	85%	2,742,011	95,494	2,646,517	9,916,558.39	345,357	9,571,202
1997	4,018,874	85%	3,416,043	95,494	3,320,549	11,545,994.34	322,763	11,223,231
1998	4,300,439	85%	3,655,373	111,212	3,544,161	11,546,648.89	351,298	11,195,351
1999	6,257,307	85%	5,318,711	129,074	5,189,637	15,701,705.89	381,048	15,320,658
2000	4,057,026	85%	3,448,472	113,156	3,335,316	9,514,442.55	312,201	9,202,242
2001	6,012,834	85%	5,110,909		5,110,909	13,178,653.31		13,178,653
2002	7,933,292	85%	6,743,298		6,743,298	16,250,303.02		16,250,303
2003	8,667,192	85%	7,367,113		7,367,113	16,592,150.43		16,592,150
2004	8,941,569	85%	7,600,333		7,600,333	15,997,576.71		15,997,577
2005	9,351,496	85%	7,948,771		7,948,771	15,636,436.50		15,636,437
2006	9,163,575	85%	7,789,039		7,789,039	14,319,829.87		14,319,830
2007	9,513,403	85%	8,086,392		8,086,392	13,893,927.67		13,893,928
2008	5,951,979	85%	5,059,183		5,059,183	8,123,941.62		8,123,942
2009	6,227,273	85%	5,293,182		5,293,182	7,943,639.07		7,943,639
2010	5,855,069	85%	4,976,809		4,976,809	6,980,231.40		6,980,231
2011	4,649,994	85%	3,952,495		3,952,495	5,180,914.49		5,180,914
2012	7,776,767	85%	6,610,252		6,610,252	8,097,843.03		8,097,843
2013	2,547,748	85%	2,165,586		2,165,586	2,479,378.98		2,479,379
2014	2,487,208	85%	2,114,126		2,114,126	2,262,115.34		2,262,115
2015	3,757,849	85%	3,194,172		3,194,172	3,194,171.77		3,194,172
2016	3,859,378	85%	3,280,471		3,280,471	3,050,838		3,050,838
2017	3,905,342	85%	3,319,541		3,319,541	2,899,416		2,899,416
2018	3,951,306	85%	3,358,610		3,358,610	2,741,627		2,741,627
2019	4,002,708	85%	3,402,302		3,402,302	2,595,600		2,595,600
2020	4,054,715	85%	3,446,507		3,446,507	2,457,312		2,457,312
2021	4,106,721	85%	3,490,713		3,490,713	2,326,009		2,326,009
2022	4,158,727	85%	3,534,918		3,534,918	2,201,369		2,201,369
2023	4,216,775	85%	3,584,259		3,584,259	2,086,071		2,086,071
2024	4,274,823	85%	3,633,600		3,633,600	1,976,438		1,976,438
2025	4,332,872	85%	3,682,941		3,682,941	1,872,220		1,872,220

The flows of costs and benefits from 1965 to 2025 are used to calculate investment criteria. Investment criteria was estimated for the CSIRO investment as reported in Table 15.

Table 15: Results of CSIRO Investment and Benefits to CSIRO

Criteria	
Present value of costs ($m)	37.0
Present value of benefits ($m)	334.2
Net Present Value (NPV) ($m)	297.2
Economic Impact Factor (EIF)	9.0

Sensitivity analysis

Table 16 highlights the influence on our analysis of changes in key assumptions. The most important assumptions are about attribution and counterfactual rates, and wholesale price of wine.

Table 16: Results of sensitivity analysis (CSIRO investment)

Assumption	Central assumption	Low assumption	High assumption	EIF (Central)	EIF (low)	EIF (high)
Discount rate (%)	7	5	9	9.0	14.0	5.9
Benefits attributable to CSIRO (%)	85	70	100	9.0	7.4	10.6
Wholesale price of wine ($ per bottle)	12	8	16	9.0	6.1	12.0
Counterfactual for new product benefit (%)	25	15	35	9.0	7.5	10.6

The low and high alternative assumptions used in the above sensitivity analysis were brought together to estimate benefit and cost streams under pessimistic (high discount rate, low wholesale price and low attribution and counterfactual rates) and optimistic (low discount rate, high wholesale price, and high attribution and counterfactual rates) scenarios. The results under these different assumptions are summarised in Table 17.

Table 17: Alternative assumptions for sensitivity analysis (CSIRO investment)

	Pessimistic	Central (baseline)	Optimistic
Discount rate (%)	9	7	5
Attribution rate (%)	70	85	100
Wholesale price of wine ($ per bottle)	12	8	16
Counterfactual for new product benefit (%)	35	25	15
Economic Impact Factor	2.7	9.0	25.4

The pessimistic and central (baseline) perhaps offered conservative yet realistic forecasts of future benefits. In this we estimated that the economic impact factor is between 2.7 and 9.0.

Distribution effects on users

Although distributional effects were not considered to be a significant issue, it is noted that the majority of the benefits identified accrue to grape growers, winemaking companies, dried grape marketers and processors, table grape marketers and exporters. These benefits allow them to either increase production level, or reduce costs for the same level of production. There are potentially significant differences in the impacts on grape growers and winemaking companies.

Externalities or other flow-on effects on non-users

In terms of flow-on effects, some of the benefits assigned to grape growers and winemaking companies will be shared along the input supply and market supply chains, including both domestic and foreign consumers. There may be some small potential benefits to foreign consumers of Australian grapes and wine.

Limitations and Future Directions

This Case Study has employed a mixed method to assess the research impacts arising from CSIRO's Grapevine Breeding Program. It combines quantitative and qualitative methods to illustrate the nature of economic, environmental and social impacts. In cases where the impacts can be assessed in monetary terms, a cost-benefit analysis (CBA) has been used as a primary tool for evaluation. As a methodology for impact assessment, CBA relies on the use of assumptions and judgments made by the authors. This relates to economic indicators for impact contribution, attribution and counterfactual. These limitations should be considered when interpreting the above analytical results.

Given the scope and budget for the analysis, we acknowledge that there are some limitations with regard to the evidence base of impacts. For example, we had limited knowledge about the pattern of wine grape prices across Australia over time and whether variety is an important factor accounting for variations in wine grape prices. In addition, the likely environmental and social impacts were not quantified but treated as potential benefits due to the lack of reliable data.

We understand that research impact evaluation is an evolving practice and suggest that as part of its evolution, it needs to address some key data constraints by planning for impact and monitoring progress towards it. It is also important to engage with customers and other stakeholders to collect data/information and ensure a robust and thorough investigation of all the triple-bottom-line outcomes and impacts.

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WE ASK, WE SEEK AND WE SOLVE

FOR FURTHER INFORMATION

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