Hort Innovation

Final Report

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Horticulture Impact Assessment Program:

Appendix 10: Improved Soilborne Disease Diagnostic Capacity for the Australian Vegetable Industry (VG15009 Impact Assessment)

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MT18011

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What the report is about

This report presents the results of an impact assessment of a Horticulture Innovation Australia Limited (Hort Innovation) investment in *VG15009: Improved Soilborne Disease Diagnostic Capacity for the Australian Vegetable Industry.* The project was funded by Hort Innovation over the period December 2015 and August 2019.

Methodology

The investment was analysed qualitatively within a logical framework that included activities and outputs, outcomes, and impacts. Impacts were categorised into a triple bottom line framework. Principal impacts identified were then considered for valuation. Past and future cash flows were expressed in 2019/20 dollar terms and were discounted to the year 2019/20 using a discount rate of 5% to estimate the investment criteria.

Results/key findings

The investment has contributed to a reduction in production losses resulting from certain soilborne diseases, especially diseases of carrots and brassicas. Positive environmental and social impacts are also anticipated. Environmental impacts may include the potential for less chemical in the farm environment with fewer pre-plant soil treatments. Social impacts may include increased researcher, grower, and advisor capacity in the testing and interpretation of DNA-based soil tests and future contributions to regional community wellbeing with a more profitable and sustainable vegetable industry.

Investment Criteria

Total funding from all sources for the project was $1.69 million (present value terms). The investment produced estimated total expected benefits of $8.55 million (present value terms). This gave a net present value of $6.86 million, an estimated benefit-cost ratio of 5.1 to 1, an internal rate of return of 23.7% and a modified internal rate of return of 10.7%.

Conclusions

Three environmental and social impacts were not valued. When inability to value all impacts is combined with conservative assumptions for the principal economic impacts valued, it is reasonable to conclude that the valuation may be an underestimate of the actual performance of the investment.

Keywords

Impact assessment; cost-benefit analysis; VG15009; vegetable industry, soilborne disease, diagnostics, DNA, PREDICTA

Introduction

Horticulture Innovation Australia Limited (Hort Innovation) required a series of impact assessments to be carried out annually on a number of investments in the Hort Innovation research, development, and extension (RD&E) portfolio. The assessments were required to meet the following Hort Innovation evaluation reporting requirements:

- Reporting against the Hort Innovation's current Strategic Plan and the Evaluation Framework associated with Hort Innovation's Statutory Funding Agreement with the Commonwealth Government.
- Annual Reporting to Hort Innovation stakeholders.
- Reporting to the Council of Rural Research and Development Corporations (CRRDC).

Under the impact assessment program (Project MT18011), three series of impact assessments were conducted in calendar 2019, 2020 and 2021. Each included 15 randomly selected Hort Innovation RD&E investments (projects). The third series of impact assessments (current series) was randomly selected from an overall population of 56 Hort Innovation investments worth an estimated $38.9 million (nominal Hort Innovation investment) where a final deliverable had been submitted in the 2019/20 financial year.

The 15 investments were selected through a stratified, random sampling process such that investments chosen represented at least 10% of the total Hort Innovation RD&E investment in the overall population (in nominal terms) and was representative of the Hort Innovation investment across six, pre-defined project size classes.

Project *VG15009: Improved Soilborne Disease Diagnostic Capacity for the Australian Vegetable Industry* was randomly selected as one of the 15 investments under MT18011 and was analysed in this report.

General Method

The impact assessment follows general evaluation guidelines that are now well entrenched within the Australian primary industry research sector including Research and Development Corporations, Cooperative Research Centres, State Departments of Agriculture, and some universities. The approach includes both qualitative and quantitative descriptions that are in accord with the impact assessment guidelines of the CRRDC (CRRDC, 2018).

The evaluation process involved identifying and briefly describing project objectives, activities and outputs, outcomes, and impacts. The principal economic, environmental, and social impacts were then summarised in a triple bottom line framework.

Some, but not all, of the impacts identified were then valued in monetary terms. Where impact valuation was exercised, the impact assessment uses cost-benefit analysis as its principal tool. The decision not to value certain impacts was due either to a shortage of necessary evidence/data, a high degree of uncertainty surrounding the potential impact, or the likely low relative significance of the impact compared to those that were valued. The impacts valued are therefore deemed to represent the principal benefits delivered by the project. However, as not all impacts were valued, the investment criteria reported for individual investments potentially represent an underestimate of the performance of that investment.

Background & Rationale

Background

The Australian vegetable industry is one of Australia's largest horticultural industries with a five year estimated annual production value for levied vegetables of $2.9 billion and a production volume of 1.7 million tonnes – Table 1.

Table 1: Levied Australian Vegetable Production and Value 2015/16 to 2019/20

Year Ended 30 June	Production (tonnes)	Gross Value of Production ($m)	Farmgate Value of Production ($m)
2016	1,627,149	2,462.1	2,339.0
2017	1,638,539	2,762.5	2,624.4
2018	1,709,198	2,792.2	2,652.6
2019	1,752,690	3,092.5	2,937.9
2020	1,749,935	3,330.9	3,164.4
Average	1,695,502	2,888.0	2,743.6

Source: Horticulture Statistics Handbook 2018/19 and 2019/20 total vegetable production less estimates for potato, tomato, onion, mushroom, asparagus, sweetpotato, garlic, and ginger. Farmgate value estimated by AgEconPlus.

Australian vegetable growers grow more than 130 different vegetable crops. The majority of growers are located in New South Wales, followed by Queensland and Victoria. The top three states by value of production are Queensland, Victoria, and South Australia.

The vegetable industry has a research and development (R&D) levy that is used for vegetable RD&E activities across a range of disciplines targeting both on-farm and supply chain sectors in accordance with industry priorities. The levy is collected on the majority of vegetable commodities, with exceptions of particular note being potato, onion, and tomato, and is matched by Hort Innovation with funding from the Australian Government. Some 1,676 growers pay the vegetable levy each year (Hort Innovation, 2017).

Vegetable R&D levy investment is guided by the Vegetable industry's Strategic Investment Plan (SIP). The current SIP has been driven by levy payers and addresses the Australian vegetable industry's needs from 2017 to 2021. Strategies and priorities in the Plan have been driven by a set of five desired outcomes (Hort Innovation, 2017):

1. Growth in the domestic market
2. Growth in export markets
3. Improved farm productivity
4. Increased levels of post-farmgate integration
5. Improved industry capabilities for adoption and innovation.

Rationale

Soilborne disease is a major limiting factor for the Australian vegetable industry and is both costly and difficult to manage. Previous research has highlighted that practical and economic methods of disease control are limited once the crop has been established. Knowing the disease risk prior to planting provides the grower with the knowledge to make informed decisions while the full range of available options can be implemented including the option of not planting, if risk cannot be managed.

With the advent of soil DNA testing, fast, robust, multi-target quantification of soil pathogen levels is possible, and this service can be provided on a commercial basis. The South Australia Research and Development Institute (SARDI) is an established provider of pre-plant soilborne pathogen testing to both the cereal (PREDICTA B) and potato (PREDICTA Pt) industries. By linking SARDI's experience in the development and provision of risk management tools for soilborne pathogens with expertise and project initiatives on disease control (e.g., VG15010) and improvement of soil health (e.g., VG13076), this project will contribute to a reduction in the losses resulting from soilborne diseases.

Project Details

Summary

Project Code: VG15009
Title: *Improved Soilborne Disease Diagnostic Capacity for the Australian Vegetable Industry*
Research Organisation: SARDI
Principal Investigator: Michael Rettke
Period of Funding: December 2018 to October 2019

Objectives

The objective of this project was to use cutting edge DNA testing technology to provide vegetable growers with a way of assessing the risk of soilborne diseases caused by specific pathogens prior to planting. This knowledge when applied in conjunction with sound disease and soil health management strategies would contribute to a reduction in the losses resulting from soilborne diseases.

Logical Framework

Table 2 provides a description of VG15009 in a logical framework.

Table 2: Logical Framework for Project VG15009

Activities	• Work with 47 vegetable growers (VIC, SA, TAS, QLD, WA) assessing over 250 vegetable plantings to determine the usefulness of 17 existing and 3 new DNA tests designed to provide information about soil pathogen load and aid pre-plant decision making. • Key disease targets for delivering pre-plant risk assessments were cavity spot of carrots and clubroot of brassicas. • Also investigated were root knot nematodes (RKN), root lesion nematodes (RLN) and Rhizoctonia which impact a wide variety of vegetables. • The value of soil health indicators such as labile carbon, total carbon, soil respiration and the free-living nematode community were assessed to better understand disease risk in partnership with specific DNA-based tests. • information generated from field assessment was used to scope the viability of a commercial soilborne disease testing service. • Scoping included preparation of a guide for growers and their advisors on the use of DNA-based soil tests to manage the risk of soilborne diseases of brassica and carrot crops, and the interpretation of test results. • Project progress was communicated through one-on-one meetings with growers and advisors and through participation in field days associated with VG15010 and VG13076.
Outputs	• Access to pre-plant, DNA-based soil tests for vegetable growers. Prior to project completion DNA-based tests were made available to growers through SARDI's PREDICTA research service. • Two new DNA-based pre-plant soil tests were developed and evaluated for assessing the risk of cavity spot in carrot crops.

	• A new DNA-based pre-plant soil test was developed and validated to assess the risk of clubroot in brassica crops. • DNA tests were also assessed for the detection of nematodes in carrot, soil grown greenhouse crops, field grown capsicums, sweet potatoes. and brassicas. Tests were found to be comparable to traditional nematode counts. • A booklet to provide guidance to growers and their advisors on the use of DNA-based soil tests to manage the risk of soilborne diseases. • Access to soil test results for research purposes (e.g., project research established that Pythium violae which causes carrot cavity spot overseas was more common in Australia than previously thought). • Project presentations to growers and advisors, magazine, and journal articles. • Hort Innovation reporting including milestone reports and a final project report.
Outcomes	• A contribution to a reduction in production losses resulting from certain soilborne diseases, especially diseases of brassicas and carrots, the primary focus of the project. • A contribution to optimisation of disease management practices e.g., moderation in the use of pre-plant soil management chemicals. • A contribution to accelerated research outcomes from the analysis of DNA-based test data collected from vegetable growers across five states.
Impacts	• [Economic] Avoidance or mitigation of soilborne disease costs for brassica and carrot growers adopting DNA-based pre-plant soil tests. • [Environmental] The potential for less chemical in the farm environment with fewer pre-plant soil treatments. • [Social] Increased researcher, grower, and advisor capacity in the testing and interpretation of DNA-based soil tests. • [Social] Future contribution to regional community wellbeing with more profitable and sustainable vegetable growers.

Project Investment

Nominal Investment

Table 3 shows the annual investment (cash and in-kind) in project VG15009 by Hort Innovation and other investors. Funds were also contributed to the project by SARDI.

Table 3: Annual Investment in the Project VG15009 (nominal $)

Year ended 30 June	Hort Innovation ($)	Other ($)	Total ($)
2016	230,200	26,416	256,616
2017	345,300	26,416	371,716
2018	172,650	26,416	199,066
2019	172,650	26,416	199,066
2020	230,200	26,416	256,616
Totals	**1,151,000**	**132,080**	**1,283,080**

Program Management Costs

For the Hort Innovation investment the cost of managing the Hort Innovation funding was added to the Hort Innovation contribution for the project via a management cost multiplier (1.162). This multiplier was estimated based on the share of ‘payments to suppliers and employees’ in total Hort Innovation expenditure (3-year average) reported in the Hort Innovation’s Statement of Cash Flows (Hort Innovation Annual Report, various years). This multiplier was then applied to the nominal investment by Hort Innovation shown in Table 3.

Real Investment and Extension Costs

For the purposes of the investment analysis, investment costs of all parties were expressed in 2019/20 dollar terms using the GDP deflator index. Project extension included awareness raising through articles in industry publications, liaison with agribusiness networks, industry associations and peak bodies. One-on-one engagement with growers and their advisors occurred as part of project field work at demonstration sites established for VG13076 and VG15010. Post project completion SARDI continues to promote pre-plant DNA soil tests through its PREDICTA research service.

Impacts

Table 4 provides a summary of the principal types of impacts delivered by the project. Impacts have been categorised into economic, environmental, and social impacts.

Table 4: Triple Bottom Line Categories of Principal Impacts from Project VG15009

Economic	• Avoidance or mitigation of soilborne disease costs for brassica and carrot growers adopting DNA-based pre-plant soil tests.
Environmental	• The potential for less chemical in the farm environment with fewer pre-plant soil treatments.
Social	• Increased researcher, grower, and advisor capacity in the testing and interpretation of DNA-based soil tests. • Future contribution to regional community wellbeing with more profitable and sustainable vegetable growers.

Public versus Private Impacts

Impacts identified in this evaluation are principally private in nature. The principal private impact is avoidance or mitigation of soilborne disease costs for brassica and carrot growers adopting DNA-based pre-plant soil tests. Public impacts include increased researcher, grower, and advisor capacity in testing and interpreting DNA-based soil tests as well as a future contribution to regional community wellbeing with more profitable and sustainable vegetable growers.

Distribution of Private Impacts

The impacts on the vegetable industry from investment in this project will be shared along the vegetable supply chain with service providers, growers, transporters, wholesalers, retailers, and exporters all capturing a share of the impact. The share of total impact retained by each link in the supply chain will be dependent on a combination of both short- and long-term supply and demand elasticities.

Impacts on Other Australian Industries

DNA-based soil testing technology has now been proven commercially in the cereals, potato, carrot, and brassica industries. Its application to other soil-based cropping sectors would also appear to hold potential e.g., canola production, wine grape growing.

Impacts Overseas

The technology is directly applicable to overseas soil-based vegetable growers. Overseas industries also experience production losses associated with clubroot in brassica crops and cavity spot in carrot crops.

Match with National Priorities

The Australian Government's Science and Research Priorities and Rural RD&E priorities are reproduced in Table 5. The project findings and related impacts will contribute to Rural RD&E priority 1 and 2 and to Science and Research Priority 1.

Table 5: Australian Government Research Priorities

Australian Government	
Rural RD&E Priorities (est. 2015)	**Science and Research Priorities (est. 2015)**
1. Advanced technology 2. Biosecurity 3. Soil, water and managing natural resources 4. Adoption of R&D	1. Food 2. Soil and Water 3. Transport 4. Cybersecurity 5. Energy and Resources 6. Manufacturing 7. Environmental Change 8. Health

Sources: (DAWR, 2015) and (OCS, 2015)

Alignment with the Vegetable Strategic Investment Plan 2017-2021

The strategic outcomes and strategies of the Vegetable industry are outlined in the Vegetable Industry's SIP 2017-2021[1] (Hort Innovation 2017). Project VG15009 addressed Outcome 3 ('Increased farm productivity and decreased production costs through better utilisation of resources, adaptation to climate, reduced impact of pests and diseases and better utilisation of advanced technologies on the farm').

[1] For further information, see: https://www.horticulture.com.au/hort-innovation/funding-consultation-and-investing/investment-documents/strategic-investment-plans/

Valuation of Impacts

Impacts Valued

Analyses were undertaken for total benefits that included future expected benefits. A degree of conservatism was used when finalising assumptions, particularly when some uncertainty was involved. Sensitivity analyses were undertaken for those variables where there was greatest uncertainty or for those that were identified as key drivers of the investment criteria.

Two impacts from the project were valued – avoided costs associated with soilborne disease in carrots and avoided costs associated with soilborne disease in brassicas.

Impacts Not Valued

Not all of the impacts identified in Table 4 could be valued in the assessment. Environmental and social impacts were hard to value due to lack of evidence/data, difficulty in quantifying the causal relationship and pathway between VG15009 and the impact and the complexity of assigning monetary values to the impact.

The environmental and social impacts identified but not valued were:

- The potential for less chemical in the farm environment with fewer pre-plant soil treatments.
- Increased researcher, grower and advisor capacity in the testing and interpretation of DNA-based soil tests.
- Future contribution to regional community wellbeing with more profitable and sustainable vegetable growers.

Valuation of Impact 1: Increased yield with less soilborne disease in carrots

VG15009 has established the usefulness of two new DNA-based tests for assessing the risk of soilborne carrot disease prior to planting. These tests are available to growers through SARDI's PREDICTA research service. Use of DNA-based soil tests to detect soilborne diseases will contribute to a reduction in production losses and project documentation forecasts a 6% increase in marketable carrot yield. Growers will incur testing costs (SARDI charges plus sampling labour), but these costs are assumed to be offset by grower production cost savings (e.g., disease mitigation expenses) (Hort Innovation 2015).

Valuation of Impact 2: Increased yield with less soilborne disease in brassicas

Similarly, VG15009 has established the usefulness of a new DNA-based pre-plant test for assessing the risk of the soilborne disease clubroot in brassicas. The test is available to growers through SARDI's PREDICTA research service. Use of a DNA-based soil test to detect clubroot in brassicas (broccoli and cauliflower) will contribute to a reduction in production losses and project documentation forecasts a 3% increase in marketable brassica yield. Growers will incur testing costs (SARDI charges plus sampling labour), but once again these costs are assumed to be offset by grower production cost savings (e.g., disease mitigation costs) (Hort Innovation 2015).

Attribution

A 50% attribution factor has been assumed for VG15009's contribution to a reduction in production losses resulting from soilborne diseases – VG15010 (disease control) and VG13076 (soil health) will also contribute to this impact.

Counterfactual

It is assumed that in the absence of Hort Innovation investment in VG15009, it is only 20% likely that DNA-based soil tests for carrots and brassicas would have been investigated.

Summary of Assumptions

A summary of the key assumptions made for valuation of the impacts is shown in Table 6.

Table 6: Summary of Assumptions

Variable	Assumption	Source/Comment
Impact 1: Increased yield with less soilborne disease in carrots		
Average annual carrot production.	331,132 tonnes.	Three year average to 2020 sourced from Hort Innovation 2020.
Farmgate profit on recovered carrot production.	$140/tonne.	Australian Vegetable Production Statistics published by AUSVEG using ABARES data https://ausveg.com.au/resources/economics-statistics/australian-vegetable-production-statistics/#pricecost
Impact 2: Increased yield with less soilborne disease in brassicas		
Average annual broccoli and cauliflower production.	149,822 tonnes.	Three year average to 2020 for broccoli (76,231 tonne) and cauliflower (74,591 tonne) sourced from Hort Innovation 2020.
Farmgate profit on recovered broccoli and cauliflower production.	$155/tonne.	Australian Vegetable Production Statistics published by AUSVEG using ABARES data https://ausveg.com.au/resources/economics-statistics/australian-vegetable-production-statistics/#pricecost
Assumptions common to valuation of both impacts		
Share of production impacted by soilborne diseases.	80%	Analyst assumption.
Share of impacted production adopting DNA-based testing.	60%	Analyst assumption informed by project previous analysis (Hort Innovation 2015).
Year of first impact.	2018/19	Testing available to vegetable growers prior to project completion in 2019/20.
Attribution of impacts to VG15009.	50%	See above text.
Counterfactual.	20%	See above text.
Probability of valuable outputs.	100%	Valuable outputs have been delivered to industry.
Probability of valuable outcome.	90%	Analyst assumption.
Probability of valuable impact.	90%	Analyst assumption.

Results

All costs and benefits were discounted to 2019/20 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the Modified Internal Rate of Return (MIRR). The base analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the project investment period plus 30 years from the last year of investment (2019/20) as per the CRRDC Impact Assessment Guidelines (CRRDC, 2018).

Investment Criteria

Tables 7 and 8 show the investment criteria estimated for different periods of benefit for the total investment and Hort Innovation investment, respectively. The present value of benefits (PVB) attributable to Hort Innovation investment only, shown in Table 8, has been estimated by multiplying the total PVB by the Hort Innovation proportion of real investment (91%).

Table 7: Investment Criteria for Total Investment in Project VG15009

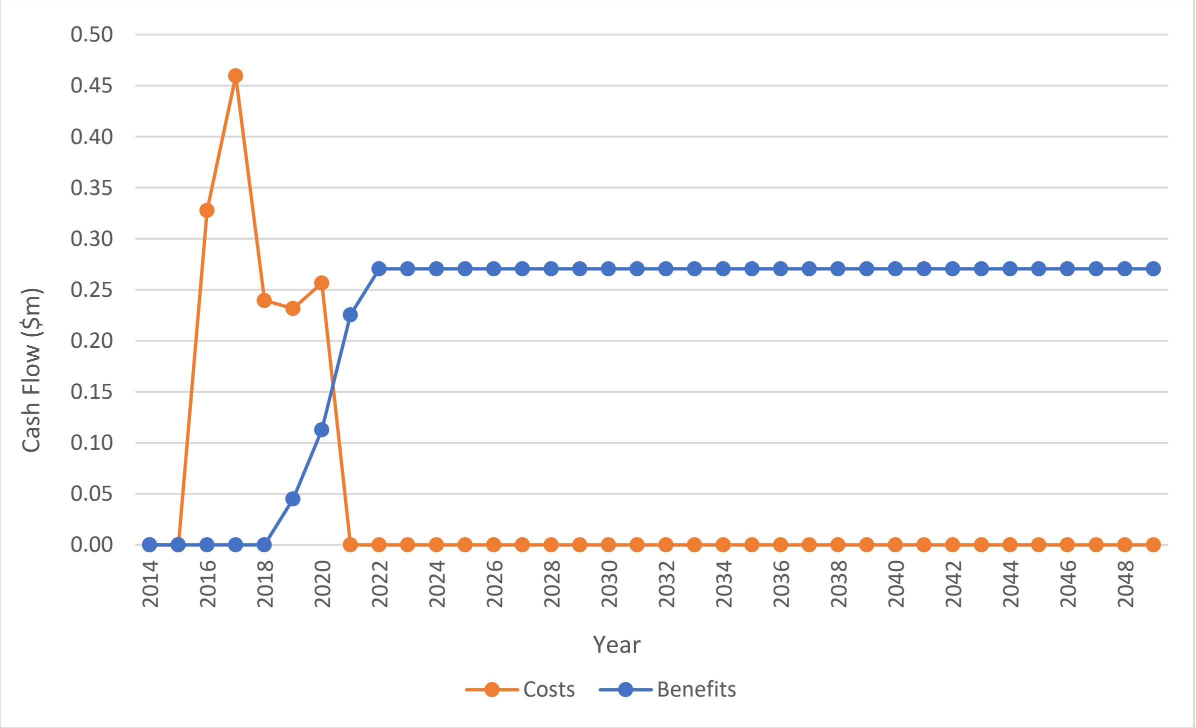
Investment Criteria	**Years after Last Year of Investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present Value of Benefits ($m)	0.32	2.58	4.41	5.85	6.98	7.86	8.55
Present Value of Costs ($m)	1.69	1.69	1.69	1.69	1.69	1.69	1.69
Net Present Value ($m)	-1.37	0.88	2.72	4.15	5.28	6.16	6.86
Benefit-Cost Ratio	0.19	1.52	2.60	3.45	4.12	4.64	5.05
Internal Rate of Return (%)	negative	14.5	21.4	23.0	23.5	23.6	23.7
MIRR (%)	negative	10.9	13.5	13.0	12.1	11.3	10.7

Table 8: Investment Criteria for Hort Innovation Investment in Project VG15009

Investment Criteria	**Years after Last Year of Investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present Value of Benefits ($m)	0.29	2.34	4.01	5.31	6.34	7.14	7.76
Present Value of Costs ($m)	1.54	1.54	1.54	1.54	1.54	1.54	1.54
Net Present Value ($m)	-1.25	0.80	2.47	3.77	4.79	5.60	6.22
Benefit-Cost Ratio	0.19	1.52	2.60	3.45	4.11	4.63	5.04
Internal Rate of Return (%)	negative	14.4	21.3	22.9	23.4	23.6	23.6
MIRR (%)	negative	10.9	13.5	13.0	12.1	11.3	10.7

The annual undiscounted benefit and cost cash flows for the total investment for the duration of VG15009 investment plus 30 years from the last year of investment are shown in Figure 1.

Figure 1: Annual Cash Flow of Undiscounted Total Benefits and Total Investment Costs



Source of Benefits

Estimates of the relative contribution of each benefit valued, given the assumptions made, are shown in Table 9.

Table 9: Contribution to Total Benefits from Each Source

Impact Valued	Contribution to PBV ($m)	Share of benefits (%)
Avoided costs associated with soilborne disease in carrots	6.84	80.0
Avoided costs associated with soilborne disease in brassicas	1.71	20.0
Total	8.55	100.0

Sensitivity Analyses

A sensitivity analysis was carried out on the discount rate. The analysis was performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values. Table 10 present the results. The results are moderately sensitive to the discount rate.

Table 10: Sensitivity to Discount Rate
(Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5%	10%
Present Value of Benefits ($m)	16.45	8.55	5.34
Present Value of Costs ($m)	1.51	1.69	1.89
Net Present Value ($m)	14.94	6.86	3.45
Benefit-cost ratio	10.86	5.05	2.82

A sensitivity analysis was then undertaken for the assumed share of impacted production adopting DNA-based testing. Even with a halving of the assumed proportion of impacted production adopting project findings, the project produces a positive return on investment – Table 11.

Table 11: Sensitivity to Share of Impacted Production Adopting DNA-based Testing (Total investment, 30 years)

Investment Criteria	Proportion of Impacted Production Adopting Project Findings		
	30%	**60% (base)**	**90%**
Present Value of Benefits ($m)	4.27	8.55	12.94
Present Value of Costs ($m)	1.69	1.69	1.69
Net Present Value ($m)	2.58	6.86	11.25
Benefit-cost ratio	2.52	5.05	7.64

A final sensitivity test examined the assumed carrot yield recovered following adoption of DNA-based testing – avoided carrot production loss was the largest contributor to total project impacts. If yield recovery is as little as 1%, and all other assumptions are held constant, investment in VG15009 will continue to deliver a favourable return on investment – Table 12.

Table 12: Sensitivity to Recovered Profit (Total investment, 30 years)

Investment Criteria	Recovery in Carrot Yield Attributable to VG15009		
	1%	**3%**	**6% (base)**
Present Value of Benefits ($m)	2.85	5.13	8.55
Present Value of Costs ($m)	1.69	1.69	1.69
Net Present Value ($m)	1.16	3.44	6.86
Benefit-cost ratio	1.68	3.03	5.05

Confidence Rating

The results produced are highly dependent on the assumptions made, some of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made, including the linkage between the research and the assumed outcomes.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 13). The rating categories used are High, Medium, and Low, where:

High: denotes a good coverage of benefits or reasonable confidence in the assumptions made

Medium: denotes only a reasonable coverage of benefits or some uncertainties in assumptions made

Low: denotes a poor coverage of benefits or many uncertainties in assumptions made

Table 13: Confidence in Analysis of Project

Coverage of Benefits	Confidence in Assumptions
Medium-high	Low-Medium

Coverage of benefits was assessed as medium-high. The main benefits of the research project were avoided costs associated with soilborne disease and this was quantified.

Confidence in assumptions was rated as low-medium. Data were mostly drawn from Hort Innovation and AUSVEG/ABARES sources, as well as estimates prepared by the researcher.

Conclusion

The investment has contributed to a reduction in production losses resulting from certain soilborne diseases, especially diseases of carrots and brassicas. Positive environmental and social impacts are also anticipated. Environmental impacts may include the potential for less chemical in the farm environment with fewer pre-plant soil treatments. Social impacts may include increased researcher, grower, and advisor capacity in the testing and interpretation of DNA-based soil tests and future contributions to regional community wellbeing with a more profitable and sustainable vegetable industry.

Three environmental and social impacts were not valued. When inability to value all impacts is combined with conservative assumptions for the principal economic impacts valued, it is reasonable to conclude that the valuation may be an underestimate of the actual performance of the investment.

Glossary of Economic Terms

Cost-benefit analysis:	A conceptual framework for the economic evaluation of projects and programs in the public sector. It differs from a financial appraisal or evaluation in that it considers all gains (benefits) and losses (costs), regardless of to whom they accrue.
Benefit-cost ratio:	The ratio of the present value of investment benefits to the present value of investment costs.
Discounting:	The process of relating the costs and benefits of an investment to a base year using a stated discount rate.
Internal rate of return:	The discount rate at which an investment has a net present value of zero, i.e. where present value of benefits = present value of costs.
Investment criteria:	Measures of the economic worth of an investment such as Net Present Value, Benefit-Cost Ratio, and Internal Rate of Return.
Modified internal rate of return:	The internal rate of return of an investment that is modified so that the cash inflows from an investment are re-invested at the rate of the cost of capital (the re-investment rate).
Net present value:	The discounted value of the benefits of an investment less the discounted value of the costs, i.e. present value of benefits - present value of costs.
Present value of benefits:	The discounted value of benefits.
Present value of costs:	The discounted value of investment costs.

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Abbreviations

CRRDC	Council of Research and Development Corporations
DAWR	Department of Agriculture and Water Resources (Australian Government)
GDP	Gross Domestic Product
GVP	Gross Value of Production
IRR	Internal Rate of Return
MIRR	Modified Internal Rate of Return
OCS	Office of Chief Scientist Queensland
PVB	Present Value of Benefits
R&D	Research and Development
RD&E	Research, Development and Extension
RKN	Root Knot Nematode
RLN	Root Lesion Nematode
SARDI	South Australian Research and Development Institute
SIAP	Strategic Investment Advisory Panel
SIP	Strategic Investment Plan