Industry-specific impact assessment program: Onion

Impact assessment report for project *Managing soilborne diseases of onions* (VN13003)

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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 *VN13003: Managing of soilborne diseases in onions.* The project was funded by Hort Innovation over the period January 2014 to September 2016.

Methodology

The investment was first analysed qualitatively within a logical framework that included activities and outputs, outcomes, and impacts. Actual and/or potential impacts then were categorised into a triple bottom line framework. Principal impacts identified were then considered for valuation in monetary terms (quantitative assessment). 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 and a 5% reinvestment rate to estimate the modified internal rate of return (MIRR).

Results/key findings

The investment in VN13003 has increased onion industry understanding of onion stunt, other soilborne diseases and pests (e.g. pink root and nematodes). A best practice growing guide produced by the project summarises knowledge generated by VN13003 and relevant previous Hort Innovation investments. Adoption of NV13003 finding is expected to decrease both yield loss caused by onion stunt and production costs incurred by growers to manage its impacts.

Investment Criteria

Total funding from all sources for the project was $0.99 million (present value terms). The investment produced estimated total expected benefits of $2.48 million (present value terms). This gave a net present value of $1.49 million, an estimated benefit-cost ratio of 2.51 to 1, an internal rate of return of 19.5% and a modified internal rate of return of 7.8%.

Conclusions

A positive return has been assessed for this project. Three impacts identified were not valued, the impacts were considered uncertain and indirect compared with the impact valued. Consequently, the investment criteria provided by the valuation may be underestimates of the actual performance of the investment.

Keywords

Impact assessment, cost-benefit analysis, onion industry, soilborne disease, onion stunt, *Rhizoctonia solani* AG8, pink root, nematodes, best practice guide.

Introduction

All research, development, and extension (RD&E) and marketing levy investments undertaken by Horticulture Innovation Australia Limited (Hort Innovation) are guided and aligned to specific investment outcomes, defined through a Strategic Investment Plan (SIP). The SIP guides investment of the levy to achieve each industry's vision. The current industry SIPs apply for the financial years 2016/17 – 2020/21.

In accordance with the Organisational Evaluation Framework, Hort innovation has the obligation to evaluate the performance of its investment undertaken on behalf of industry.

This impact assessment program addresses this requirement through conducting a series of industry-specific ex-post independent impact assessments of the almond (AL), banana (BA), citrus (CT) and onion (VN) RD&E investment funds.

Twenty-nine RD&E investments (projects) were selected through a stratified, random sampling process. The industry samples were as follows:

- Nine AL projects were chosen worth $5.84 million (nominal Hort Innovation investment) from an overall population of 21 projects worth an estimated $10.78 million,
- Eight BA projects worth $3.02 million (nominal Hort Innovation investment) from an overall population of 22 projects worth approximately $16.72 million,
- Eight CT projects worth $5.4 million (nominal Hort Innovation investment) from a total population of 35 projects worth $15.78 million, and
- Four VN projects worth $2.4 million (nominal Hort Innovation investment) from an overall population of 8 projects worth $3.89 million.

The project population for each industry included projects where a final deliverable had been submitted in the five-year period from 1 July 2014 to 30 June 2019.

The projects for each industry sample were chosen such that the investments represented (1) at least 10% of the total Hort Innovation RD&E investment expenditure for each industry, and (2) the SIP outcomes (proportionally) for each industry.

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 onion industry is a mature industry with stable production. It is the fourth largest vegetable crop produced in Australia and the second largest vegetable category exported. Onions are grown across most Australian states, but South Australia (48%), Tasmania (23%), and Queensland (10%) produce most of the crop. Major growing areas include upper South Australia, the Adelaide Plains, the north-west region of Tasmania and the Lockyer Valley of Queensland. Brown onions account for 79% of production, red onions 19%, white onions 1% and shallots/spring onions less than 1% (Hort Innovation 2020).

In the five years ending 30 June 2019, Australia produced an average 247,423 tonnes of onions valued at $164.8 million (Table 1).

Table 1: Australian Onion Production and Value 2014/15 to 2018/19

Year Ended 30 June	Onion and Shallot Production (tonnes)	Onion and Shallot GVP ($m)
2015	231,465	136.0
2016	260,674	157.7
2017	237,635	174.2
2018	249,145	164.8
2019	258,195	191.2
Average	247,423	164.8

Source: Australian Horticulture Statistics Handbook 2017/18 and 2018/19

The onion industry has a statutory levy in place for RD&E, marketing, biosecurity, and residue testing programs. The RD&E levy is used for onion research, development, and extension activities across a range of disciplines targeting both on-farm and supply chain sectors in accordance with industry priorities.

Onion RD&E levy investment is guided by the Onion industry's SIP. The current SIP has been developed by levy payers and addresses the Australian onion industry's needs from 2017 to 2021. Strategies and priorities in the SIP have been driven by a set of four desired outcomes (Hort Innovation 2017):

1. Increased domestic consumption
2. Growth in export markets
3. Improved farm productivity
4. An informed and engaged industry.

Rationale

Onion stunt caused by *Rhizoctonia solani* AG8 is a widespread root disease of onion crops in South Australia, Tasmania, and Western Australia. In areas where stunt is present it can affect up to 80% of the crop. Despite years of research, onion stunt continues to be an issue causing yield loss and the production of bulbs that are below target size at harvest. Growers faced with yield loss caused by onion stunt, incur additional input costs (chemical, fertiliser, and irrigation) in an attempt to mitigate the impact.

This project aimed to build on the results of VN11000 (an examination of the incidence of onion stunting and stunt management strategies including nurse and rotation crops) to further develop management strategies that use cultural practices related to disease prediction, management of nurse crops and rotation crops to reduce disease incidence.

Disease prediction to manage soilborne disease is performed by analysing the amount of soil inoculum. This information is then used to forecast disease incidence so that growers can alter their production methods to reduce crop loss. The most difficult part of disease prediction is taking a representative soil sample and modelling the amount of inoculum to predict disease incidence. This project was to compare soil sampling methods so that the optimum means of obtaining an accurate measure of disease is identified. This was then related to estimated yield loss to provide a prediction of the "risk" of yield loss related to the level of pre-planting inoculum. The project was to also serve as a platform for the delivery of testing for a range of other diseases such as pink root (caused by *Phoma terrestris* and *Fusarium* spp.) and nematodes (including *Paratrichodorus minor, Pratylenchus neglectus* and *Setophoma terrrestris*).

The use of a nurse crop (typically barley or wheat) is critical in onion production in sandy soils to reduce stand loss due to windblast. However, management of the nurse crop is critical in the productivity of the onion crop. The project completed trials to generate information on the management of nurse crops to improve onion health.

Rotation crops sown before onions may reduce disease inoculum. A trial completed as part of VN11000 showed that a rotation that includes canola can reduce soilborne disease inoculum and improve onion growth. However, canola can result in the development of pest problems and the creation of unacceptable trash loads. This project was to expand on VN1000 findings and explore further rotation options including summer cover and green manure crops.

The current project (VN13003) built on results from a suite of Hort Innovation investments including VN05001, VN07007, VN08004, VN10000, VN10005, and MT09045.

Project Details

Summary

Project Code: VN13003
Title: Managing soilborne diseases of onions
Research Organisation: South Australian Research and Development Institute (SARDI)
Project Leader: Barbara Hall and Michael Rettke
Period of Funding: January 2014 to September 2016

Objectives

The objectives of this project were to:

- Validate the accuracy of a predictive test for onion stunt.
- Determine the best practice for managing nurse crops.
- Evaluate the use of rotation and cover crops leading into onion production to reduce disease inoculum and promote onion growth.
- Provide a summary document on the best practices for the control of onion stunt that has been generated from research performed to date.

Logical Framework

Table 2 provides a detailed description of the project in a logical framework.

Table 2: Logical Framework for Project VN13003

Activities	Major project activities included: • Re-examination and analysis of soil samples and soil test results completed as part of previous Hort Innovation projects to determine the most effective sampling techniques for detecting *R. solani* AG8 in onion soils. • Review of previous research and generation of new data to develop a statistical model that relates the levels of observed stunting with potential yield loss. Sampling was undertaken across paddocks. Stunted seedlings were defined as having a height <60% of nearby unaffected plants and a root disease incidence of >10%. The relationship between stunting incidence and yield was validated by taking bulb weights in sections of the paddock that were identified as stunted or non-stunted. • Assessment of the amount of *R. solani* AG8 soilborne inoculum was assessed before sowing in 43 paddocks over two seasons across the South Australian Mallee. Onion crops were assessed for disease incidence and productivity. • Once formulated, the validity of statistical models linking inoculum levels to yield loss were cross checked with those developed in the United States (US) where *R. Solani* AG8 is also problematic. • Controlled environment trials tested nurse crop sowing densities and nurse crop types sown with and without onions. The trials were designed to investigate ways of reducing the nurse crops potential to host *R. solani* AG8 and infection of onion seedlings. • Rotation trials were set up at two sites and continued for the length of the project. Rotations were representative of those used in the SA Mallee including cereal, sorghum, or brassica green manure crops followed by fallow and soil conservation and then an onion crop. The relationship between the inoculum soil test and crop growth was determined and provided input into the development of the predictive model. The rotation crops and onion crops were assessed for growth and disease level. • Grower practices on reducing onion stunt were evaluated across 18 paddocks. Effectiveness in managing *R. solani* inoculum levels by intensive cultivation and deep ripping, choice of cereal used as nurse crop and timing of nurse crop removal were compared.

	• Grower practices on reducing onion stunt were evaluated across 18 paddocks. Effectiveness in managing *R. solani* inoculum levels by intensive cultivation and deep ripping, choice of cereal used as nurse crop and timing of nurse crop removal were compared. • Samples submitted by growers and from research sites were also analysed to determine if other soilborne diseases exist in these sites and are contributing to poor growth and yield loss. • An exchange of ideas and research outcomes occurred between SARDI and US researchers working at Washington State University on onions and stunt caused by *R. solani* AG8. • Scientific presentations were prepared and published in relevant conference proceedings. • Development of a best practice guide for onion stunt for growers. The guide drew on knowledge garnered from this study as well as previous Hort Innovation research. The guide was to be a living document that is updated as new information becomes available. • Communication of guide information via farmer talks and articles in grower magazines.
Outputs	The important outputs of the project were: • An improved understanding of predictive testing as a means of managing onion stunt in Australia. • A model that can be used to predict onion stunt in Australian onion crops and that can also be applied as a platform to develop predictive testing for other diseases. • Strategies to incorporate nematode (*Pratylenchus neglectus*) and pink root (*Setophoma terrestris)* control in an integrated program of soilborne pest and disease management. • A nurse crop management plan to reduce the development of disease in onions and maintain onion yield. • An onion rotation crop plan to reduce yield loss from soilborne diseases. • A cultural practice plan that included cultivation and deep ripping of areas inoculated with *R. solani* AG8. • Knowledge required to deliver a testing service to enable onion growers to identify the risk of onion stunt before planting so they can implement appropriate management strategies to reduce losses. • A best practice guide for onion stunt available at https://www.horticulture.com.au/globalassets/hort-innovation/resource-assets/vn13003---best-practice-guide-for-onion-stunt.pdf
Outcomes	• Reduction in the incidence of stunt (*R. solani* AG8), other soilborne diseases, nematode (*Pratylenchus neglectus*) and pink root (*Setophoma terrestris)* in Australian onion crops. • Reduction in the incidence of reduced yield in Australian onion crops (*P. neglectus*).
Impacts	• Economic – reduction in yield loss caused by onion stunt, other soilborne diseases, nematode and pink root. • Economic - reduction in the cost of production inputs (chemical, fertiliser, and irrigation) used in an attempt to offset yield loss caused by onion stunt, other soilborne diseases, nematode and pink root. • Environment – less chemical in the farm environment with a reduction in chemical application for the control of onion stunt, other soilborne diseases, nematode and pink root. • Capacity – researchers and growers with additional skills in managing and offsetting the impacts of onion stunt, other soilborne diseases, nematode and pink root. • Social – future contribution to improved regional community wellbeing with more profitable and sustainable onion growers.

Project Investment

Nominal Investment

Table 3 shows the annual investment made in Project VN13003. The project included contributions from both Hort Innovation and SARDI.

Table 3: Annual Investment in Project VN13003 (nominal $)

Year ended 30 June	HORT INNOVATION ($)	SARDI ($)	TOTAL ($)
2014	97,833	27,617	125,450
2015	190,699	53,831	244,530
2016	110,693	31,247	141,940
2017	99,806	28,174	127,980
Total	**499,031**	**140,869**	**639,900**

Source: VN13003 Variation Agreement, August 2016

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, the investment costs of all parties were expressed in 2019/20 dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2020). No additional costs of extension were included; the project was focused on the production and dissemination of extension materials including a best practice guide for the management of onion stunt.

Impacts

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

Table 4: Triple Bottom Line Categories of Principal Impacts from Project VN13003

Economic	• Reduction in yield loss caused by onion stunt, other soilborne diseases, nematode and pink root. • Reduction in the cost of production inputs (chemical, fertiliser, and irrigation) used in an attempt to offset yield loss caused by onion stunt, other soilborne diseases, nematode and pink root.
Environmental	• Less chemical in the farm environment with a reduction in chemical application for the control of onion stunt, other soilborne diseases, nematode and pink root.
Social	• Researchers and growers with additional skills in managing and offsetting the impacts of onion stunt, other soilborne diseases, nematode and pink root. • Future contribution to improved regional community wellbeing with more profitable and sustainable onion and shallot growers.

Public versus Private Impacts

Impacts from investment in VN13003 will be mainly private and realised by onion growers through avoided yield loss and saved input costs.

Distribution of Private Impacts

Economic benefits from avoided yield loss and saved input costs will be shared along the supply chain with transporters, wholesalers, exporters, retailers, and consumers all benefiting. There may be some negative impacts on input suppliers (chemical, fertiliser, irrigation) if less of these products are purchased to mitigate the impacts of onion stunt. The share of benefit realised by each link in the supply chain will depend on both short- and long-term supply and demand elasticities in domestic and export onion markets.

Impacts on Other Australian Industries

Methods and models developed in this project will also be relevant to other horticultural and broadacre industries that are challenged by soilborne root disease.

Impacts Overseas

Onion stunt caused by *R. solani* AG8 has resulted in substantial yield loss in onion crops in the Columbia region of the US. It is likely to also be a problem in other onion growing countries. Additional knowledge generated through this project, and published in the peer-reviewed literature, will be relevant to overseas onion industries. Better yielding Australian crops with lower input costs will also allow Australia to export high quality, competitively priced onions to overseas markets. The Australian onion industry is an established fresh onion exporter.

Match with National Priorities

The Australian Government's Science and Research Priorities and Rural RD&E priorities are reproduced in Table 5. The project outcomes and related impacts will contribute to all four Rural RD&E Priorities as well as Science and Research Priorities 1, and 2.

Table 5: Australian Government Research Priorities

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

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

Alignment with the Onion Strategic Investment Plan 2017-2021

The strategic outcomes and strategies of the onion industry are outlined in the Onion Industry's Strategic Investment Plan 2017-2021[1] (Hort Innovation, 2017). Project VN13003 commenced prior to the industry's current SIP. Nevertheless, the project aligns with Outcome 3 'reduced costs and improved returns to growers through improvements in business and production skills', Strategy 2 'continue with a prioritised R&D program to manage pest and disease challenges and threats with a focus on soil health and IPM'.

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 were valued – reduction in yield loss caused by onion stunt/root lesion nematodes and reduction in the cost of production inputs.

Impacts Not Valued

Not all of the impacts identified in Table 4 could be valued in the assessment. The environmental impact and two social impacts identified but not valued were:

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

- Less chemical in the farm environment with a reduction in chemical application for the control of onion stunt and root lesion nematodes.
- Researchers and growers with additional skills in managing and offsetting the impacts of onion stunt, other soilborne diseases, nematode and pink root.
- Future contribution to improved regional community wellbeing with more profitable and sustainable onion growers.

These potential impacts were not valued due to an absence of data that would allow the development of credible assumptions.

Valuation of Impact 1: reduction in yield loss caused by onion stunt, other soilborne diseases, nematode and pink root.

The VN13003 investment has generated and communicated additional knowledge on the management of onion stunt, other soilborne diseases, nematode and pink root. Growers who adopt this knowledge can reasonably expect to reduce yield loss caused by *R. solani* AG8 (the principal source of lost income). The VN13003 project proposal prepared by SARDI suggests yield loss caused by onion stunt is 5 t/ha and 1,700 ha of onion production is impacted by *R. solani* AG8. This impact assessment assumes a yield loss of 2.5 t/ha given the use of onion stunt mitigation measures (chemical, fertiliser, irrigation), and that subsequent cost savings (Valuation of Impact 2) have also been assumed.

Valuation of Impact 2: reduction in the cost of production inputs.

Onion grower adoption of VN13003 outputs, including the onion stunt best practice guide, is also likely to result in production cost savings (chemical, fertiliser, irrigation). The VN13003 project proposal prepared by SARDI suggests cost savings of 15% on total variable costs of $20,225/ha.

Attribution

The best practice guide for onion stunt (Hort Innovation 2017a) drew on work from VN05001, VN07007, VN08004, VN11000, VN10005, and MT09045 as well as the current project (VN13003). The project agreement notes "knowledge gained from these (past) projects underpin the research being undertaken in this project and will contribute to its success". Consequently, a modest attribution of 20% is attributed to this project (VN13003).

Counterfactual

The scenario assumed if the investment had not been made is that it is 50% likely that some other project would have addressed gaps in knowledge in relation to the management of onion stunt.

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: reduction in yield loss caused by onion stunt and root lesion nematodes		
Yield loss avoided with VN13003 recommendations in place and use of yield loss mitigating measures (chemical, fertiliser, irrigation).	2.5 t/ha	5 t/ha suggested in the SARDI proposal for the project. Estimate halved after allowing for onion stunt mitigation measures.
Farmgate profit on avoided yield loss.	$155/tonne.	Onion price of $459/tonne and costs of production of $304/tonne (ABARES data on AUSVEG website,https://ausveg.com.au/resources/economics-statistics/australian-vegetable-production-statistics/#pricecost
Impact 2: reduction in the cost of production inputs		
Onion production cost saving with treatment	$3,033.75/ha.	Onion production costs of $20,225/ha with a 15% saving in production cost (chemical, fertiliser,

using recommendations documented in the VN13003 generated best practice guide.		irrigation) with adoption of best practice VN13003 recommendations – SARDI project proposal data.
Assumptions common to valuation of both impacts		
Area of stunt affected onion production.	1,700 ha.	VN13003 project documentation.
Share of stunt affected onion production treated using recommendations documented in the best practice guide.	75%.	Consultant estimate that recognises that some onion growers will stay with current management practices and mitigating measures.
Year of first impact.	2017/18	One year after project completion in 2016/17.
Year of final impact.	2029/30	Best practice recommendations replaced with new approaches and knowledge generated by future research.
Probability of VN13003 generating valuable outputs.	90%	Project has produced and communicated best practice guide. Commercial inoculum testing service still needs to be established.
Probability of VN13003 outcomes generating assumed impacts.	90%	There is some risk that best practice recommendations will not produce anticipated benefits across all Australian onion growing areas.

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 (2016/17) 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 (80%).

Table 7: Investment Criteria for Total Investment in Project VN13003

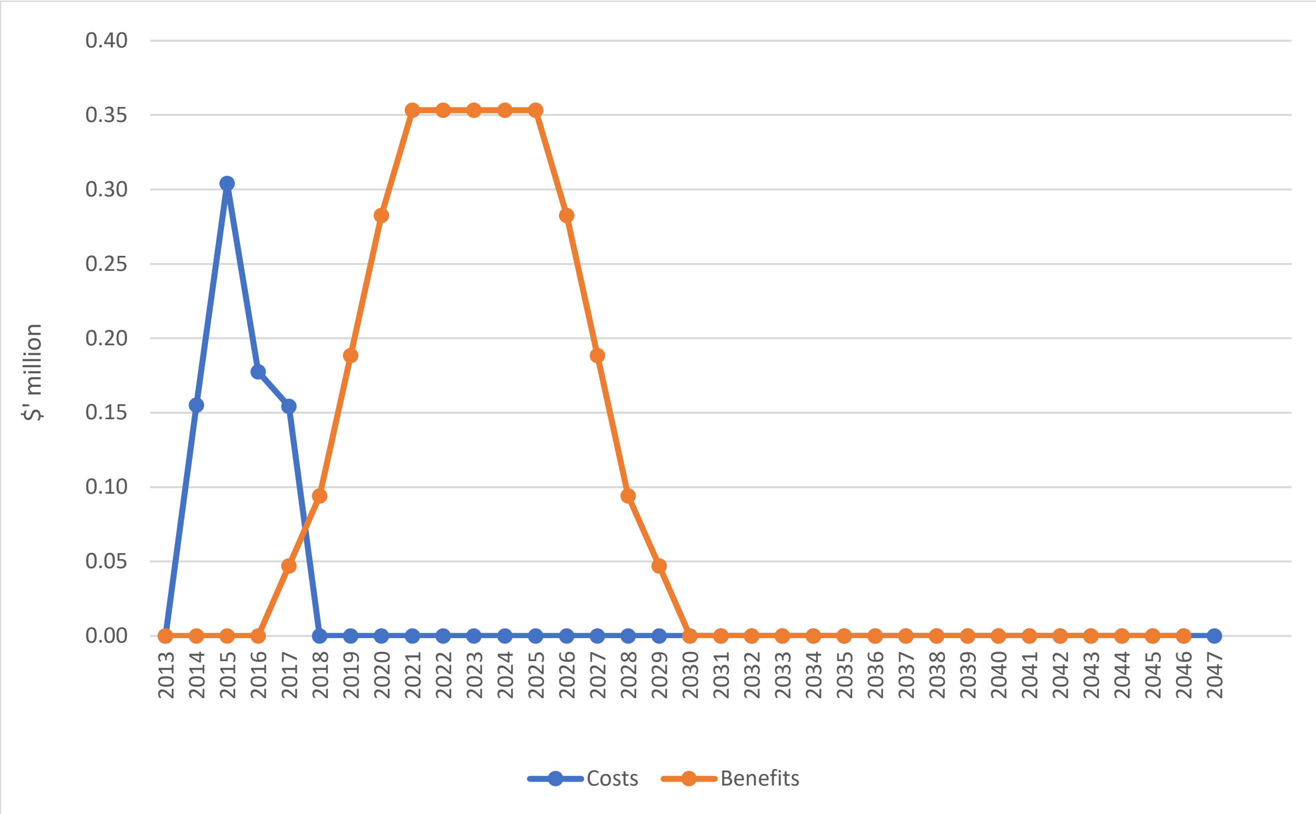
Investment Criteria	**Years after Last Year of Investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present Value of Benefits ($m)	0.00	0.93	2.27	2.48	2.48	2.48	2.48
Present Value of Costs ($m)	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Net Present Value ($m)	-0.99	-0.06	1.28	1.49	1.49	1.49	1.49
Benefit-Cost Ratio	0.00	0.94	2.29	2.51	2.51	2.51	2.51
Internal Rate of Return (%)	negative	0.0	18.6	19.5	19.5	19.5	19.5
MIRR (%)	negative	1.2	12.7	10.7	9.3	8.4	7.8

Table 8: Investment Criteria for Hort Innovation Investment in Project VN13003

Investment Criteria	**Years after Last Year of Investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present Value of Benefits ($m)	0.00	0.75	1.82	2.00	2.00	2.00	2.00
Present Value of Costs ($m)	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Net Present Value ($m)	-0.80	-0.05	1.03	1.20	1.20	1.20	1.20
Benefit-Cost Ratio	0.00	0.94	2.29	2.51	2.51	2.51	2.51
Internal Rate of Return (%)	negative	0.0	18.6	19.5	19.5	19.5	19.5
MIRR (%)	negative	1.2	12.7	10.7	9.3	8.4	7.8

The annual undiscounted benefit and cost cash flows for the total investment for the duration of the VN13003 investment plus 30 years from the last year of investment are shown in Figure 2.

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

	Contribution to PBV ($m)	Share of benefits (%)
Reduction in yield loss caused by onion stunt and root lesion nematodes	0.28	11.3
Reduction in the cost of production inputs	2.20	88.7
Total	2.48	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 presents the results. The results show low sensitivity to the discount rate.

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

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present Value of Benefits ($m)	2.99	2.48	2.11
Present Value of Costs ($m)	0.79	0.99	1.23
Net Present Value ($m)	2.20	1.49	0.88
Benefit-cost ratio	3.78	2.51	1.72

A sensitivity analysis was then undertaken on onion yield loss avoided with adoption of VN13003 recommendations. Results are provided in Table 11. The quantum of yield loss avoided has little impact on the investment criteria.

Table 11: Sensitivity to Onion Yield Loss Avoided
(Total investment, 30 years)

Investment Criteria	Onion Yield loss Avoided with VN13003		
	0.5 t/ha	2.5 t/ha (base)	5 t/ha
Present Value of Benefits ($m)	2.26	2.48	2.76
Present Value of Costs ($m)	0.99	0.99	0.99
Net Present Value ($m)	1.27	1.49	1.77
Benefit-cost ratio	2.28	2.51	2.79

A final sensitivity analysis tested the onion growing area impacted by onion stunt. The results (Table 12) show that the investment criteria remain positive with a halving of the assumed area affected by onion stunt.

Table 12: Sensitivity to Onion Growing Area Affected by Stunt
(Total investment, 30 years)

Investment Criteria	Area Affected by Onion Stunt		
	850 ha	1,700 ha (base)	3,400 ha
Present Value of Benefits ($m)	1.24	2.48	4.97
Present Value of Costs ($m)	0.99	0.99	0.99
Net Present Value ($m)	0.25	1.49	3.98
Benefit-cost ratio	1.25	2.51	5.02

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
High	Medium-high

Coverage of benefits valued was assessed as High – two key economic impacts were valued. Confidence in assumptions was rated as Medium-high, critical data was sourced from SARDI documents, some key assumptions were made by the analyst.

Conclusion

The investment in VN13003 has increased onion industry understanding of onion stunt, other soilborne diseases such as pink root and pests such as nematodes. A best practice growing guide produced by the project summarises knowledge generated by VN13003 and relevant previous Hort Innovation investments. Adoption of NV13003 finding is expected to decrease both yield loss caused by onion stunt and production costs incurred by growers to manage its impacts.

Total funding from all sources for the project was $0.99 million (present value terms). The investment produced estimated total expected benefits of $2.48 million (present value terms). This gave a net present value of $1.49 million, an estimated benefit-cost ratio of 2.51 to 1, an internal rate of return of 19.5% and a modified internal rate of return of 7.8%.

As three impacts identified were not valued, the investment criteria estimated by the evaluation may be underestimates 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

AL	Almond
BA	Banana
CRRDC	Council of Research and Development Corporations
CT	Citrus
DAWR	Department of Agriculture and Water Resources (Australian Government)
GDP	Gross Domestic Product
GVP	Gross Value of Production
IPM	Integrated Pest Management
IRR	Internal Rate of Return
MIRR	Modified Internal Rate of Return
OCS	Office of Chief Scientist Queensland
PVB	Present Value of Benefits
RD&E	Research, Development and Extension
SARDI	South Australia Research and Development Institute
US	United States
VN	Onion