Hort Innovation

Final Report

# Fund Impact Assessment 2020/21 for cherry, vegetables and small tropicals: Evaluation of VG15021

**Project leader:**

George Revell

**Delivery partner:**

Ag Econ

**Project code:**

MT21013

**Project:**

Fund Impact Assessment 2020/21 for cherry, vegetables and small tropicals (MT21013)

**Disclaimer:**



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Level 7
141 Walker Street
North Sydney NSW 2060

Telephone: (02) 8295 2300

www.horticulture.com.au

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# Executive summary

## What the report is about

This report presents the results of an impact assessment of a Horticulture Innovation Australia Limited (Hort Innovation) investment in *VG15021 Sowing success through transformational technologies.* The project was funded by Hort Innovation over the period November 2015 to August 2020.

## 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 2021-22 dollar terms and were discounted to the year 2021-22 using a real (inflation-adjusted), risk free, pre-tax discount rate of 5% to estimate the investment criteria.

## Key findings

VG15021 brought together transformational precision technologies that had been developed over 5 years of Hort Innovation-funded research and over 10 years of non-Hort Innovation funded research from multiple University R&D programs. The specific technology mechanisms explored were:

1) a plant growth regulator (PGR1) to enhance crop resilience to environmental variability, especially at establishment.

2) a precision delivery technology that delivers compounds to crops exactly when and where they are needed and at the right dose, in particular to enable the cost-effective delivery of the PGR1 being explored.

VG15021 contributed to increased industry research knowledge and capacity in PGRs and precision applicators and demonstrated the potential economic benefit at a farm level. PGR1 demonstrated crop resilience and establishment, and the precision micro-dosing prototype was able to deliver commercial PGRs to plants with higher accuracy and at lower cost than existing techniques.

As part of the project, a commercialisation strategy was developed and reviewed. By project completion the early stage commercialisation process had begun; however, there was still not enough data to substantiate defendable claims in a patent application. Of the two mechanisms being explored, the precision micro-dosing prototype was considered to have had a better than average potential to be patentable and commercialised once additional data collection was attained. As part of the commercialisation strategy, however, industry consultation across 17 separate businesses was undertaken and this concluded that the technology required further R&D before it would be at a level of commercialisation. Feedback also indicated that the plant micro-dosing prototype may not have been versatile enough for commercial application. Overall, at project completion it was estimated (in the project M&E plan) that additional an investment of between $12 million to $100 million would be required over a period of 15 years before viable commercialisation (and therefore adoption and impact) could be achieved. To date there had been no investment commitment for ongoing funding in this area. Given the current lack of funding commitment or investment priority for this area, and the significant uncertainty relating to the total cost before a viable commercial product (and therefore adoption and impact) is achieved, there was insufficient confidence to quantify any impacts for this project.

It is important to note that early-stage research has recognized higher levels of risk compared to later stage RD&E and commercialisation, so that successful outcomes are not always achieved. However, any finding are still valuable in informing future investments. In this light, while no project impacts were able to be valued for this project the additional knowledge and research capability generated from the investment has the potential to support future impacts in this or related research areas.

## Investment criteria

Total funding from all sources for the project was $2.19 million (2021-22 equivalent value). Impact metrics could not be calculated as the identified benefits were not able to be quantified.

## Keywords

Impact assessment, cost-benefit analysis, Vegetable; transformational, plant growth regulator (PGR)

## Introduction

Evaluating the impacts of levy investments is important to demonstrate to levy payers, Government and other industry stakeholders the economic, social and environmental outcomes of investment for industry, as well as being an important step to inform the ongoing investment agenda.

The importance of ex-post evaluation was recognised through the Horticulture Innovation Australia Limited (Hort Innovation) independent review of performance completed in 2017, and was incorporated into the Organisational Evaluation Framework.

Reflecting its commitment to continuous improvement in the delivery of levy funded research, development and extension (RD&E), Hort Innovation required a series of impact assessments to be carried out on a representative sample of investments across a cohort of Funds in its RD&E portfolio. The assessments were required to meet the following Hort Innovation evaluation reporting requirements:

- Reporting against the Hort Innovation's Strategic Plan and the Evaluation Framework associated with Hort Innovation's Statutory Funding Agreement with the Commonwealth Government.
- Reporting against strategic priorities set out in the Strategic Investment Plan for each Hort Innovation industry fund.
- Annual Reporting to Hort Innovation stakeholders.
- Reporting to the Council of Rural Research and Development Corporations (CRRDC).

As part of its commitment to meeting these reporting requirements, Ag Econ was commissioned to deliver the *Fund Impact assessment 2020/21: Cherry, Sweetpotato, Vegetables, Small Tropicals (MT21013)*. This program consisted of a once-off impact assessment series of randomly selected Hort Innovation RD&E investments (projects) within each of the nominated Funds.

The project *VG15021 Sowing success through transformational technologies* was randomly selected as one of the nine investments in the 2020-21 sample for the Vegetable Fund. This report presents the analysis and findings of the VG15034 cluster impact assessment.

## General method

The 2020-21 population for the Vegetable Fund was defined as an RD&E investment where a final deliverable had been submitted in the five year period from 1 July 2016 to 30 June 2021. This generated an initial population of 315 Hort Innovation investments, worth an estimated $88.7 million (nominal Hort Innovation investment). Projects in the Frontiers Fund, those of less than $80,000 Hort Innovation investment, multi industry projects where the Vegetable Fund was less than 50% of total Hort Innovation investment, enabler projects that don't directly support a 2017-2021 Vegetable Strategic Investment Plan (SIP) Outcome, and projects that have had a previous impact assessment completed were removed from the sample. A total of 90 projects with a combined value of $54.8 million satisfied these criteria and formed the eligible population. The eligible population was then stratified according to the 2017-2021 Vegetable SIP outcomes, and four project value clusters based on the distribution of project value within the population ($80,000-$265,000; $265,000-$440,000; $440,000-$695,000; $695,000-$8,680,000). A random sample of 9 projects was selected worth a total of $5.86 million (nominal Hort Innovation investment), equal to 10.7% of the eligible RD&E population (in nominal terms).

The impact assessment followed 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 included both qualitative and quantitative descriptions that are in accord with the impact assessment guidelines of the CRRDC (CRRDC, 2018).

The evaluation process involved reviewing project contracts, milestones, and other documents; interviewing stakeholders including Hort Innovation staff, project delivery partners, growers and other industry stakeholders where appropriate (see Acknowledgements); and collating additional industry and economic data where necessary. Through this process, the project activities, outputs, outcomes, and impacts were identified and briefly described; and the principal economic, environmental, and social impacts were summarised in a triple bottom line framework.

Some, but not all, of the impacts identified were valued in monetary terms. Where impacts were valued, the impact assessment used 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. As not all impacts were valued, the investment criteria reported potentially represents an underestimate of the performance of that investment.

# Background and rationale

## Industry background

The national vegetable levy is payable on all vegetable crops excluding potatoes, onions, mushrooms, sweetpotatoes, asparagus, garlic, ginger, herbs (except fresh shallots and parsley) and tomatoes. The levy is payable on vegetables that are produced in Australia and either sold by the producer or used by the producer in the production of other goods. Producers pay levies to the Department of Agriculture, Fisheries and Forestry (DAFF), which is responsible for the collection, administration and disbursement of levies and charges on behalf of Australian agricultural industries. Hort Innovation manages the vegetable levy funds which are directed to R&D investments.

The Australian levy paying vegetable industry has approximately 1,700 growers across Australia (Hort Innovation 2022a), with a 5-year average (to 2020-21) production value of $2.5 billion, growing at a trend 6.19% and a volume trend of 1.77% per annum (Hort Innovation 2022b). The majority of leviable vegetables are supplied to the domestic market, with approximately 10% exported at a total value of $170 million in 2020-21 growing at an average 1.19% per annum from 2016-17. Leviable vegetables are grown across Australia, however Queensland accounts for the highest share (32%), followed by Victoria (24%), Western Australia (16%), New South Wales (8%), South Australia (9%) and Tasmania (8%) in 2020-21.

## Rationale

The project objective of VG15021 was to significantly boost the profitability of the Australian vegetable industry through (a) higher profits via enhanced crop establishment, growth and/or yield, (b) reduced costs via enhanced resource efficiency or (c) reduced risk via enhanced crop resilience to environmental variability.

VG15021 built on the work of over 5 years of Hort Innovation-funded research (HG10025, MT13058, MT13042) and over 10 years of non-Hort Innovation funded research through multiple University R&D programs. The project aimed to refine the technologies via on-the-ground development within commercial grower systems and by creating new products that fit their operational requirements.

The specific technology mechanisms explored were:

1) a plant growth regulator (PGR1) that can enhance crop resilience to environmental variability, especially at establishment, and

2) a precision delivery technology that delivers compounds to crops exactly when and where they are needed and at the right dose, in particular to enable the cost-effective delivery of the PGR1 being explored.

### *Alignment with the Vegetable Strategic Investment Plan 2017-2021*

The vegetable levy investments are guided by a Strategic Investment Plan (SIP). With a focus on pest management to improved productivity, the VG15034 cluster was closely aligned with Outcome 3: *Improved farm productivity*, Strategy 3.8 *Increase use of advanced technologies to improve farm productivity and/or cut input costs for growers*.

### *Alignment with national priorities*

The Australian Government's National RD&E priorities (2015a) and Science and Research Priorities (2015b) are reproduced in Table 1. The VG15021 cluster outcomes and related impacts contributed to RD&E Priority 4, and to Science and Research Priority 1.

**Table 1. National Agricultural Innovation Priorities and Science and Research Priorities**

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

# Project details

## Summary

**Table 2. Project details**

| | |
|---|---|
| **Project code** | VG15021 |
| **Title** | Sowing success through transformational technologies |
| **Research organization** | The University of Queensland |
| **Project leader** | Dr Jitka Kochanek |
| **Funding period** | Nov 2015 to Jun 2021 |

## Logical framework

A logical framework is shown in Table 3 to highlight the connection between the project activities, outputs, outcomes, and impact.

**Table 3. Project logical framework**

| | |
|---|---|
| Activities | Research activities were conducted to investigate 1) a plant growth regulator (PGR1) that could enhance crop resilience to environmental variability, especially at establishment, and 2) a precision delivery technology that delivers compounds to crops exactly when and where they are needed and at the right dose, in particular to enable the cost-effective delivery of the PGR1 being explored.<br>• Grower/industry technology exchange (grower interviews)<br>• On-farm grower consultations across SE Qld and central NSW with 12 growers & industry affiliates<br>• On-farm grower trials (crop establishment, resilience and yield)<br>• Ongoing crop screenings and studies to validate compound effectiveness.<br>• Technology development which was multi-phased (I-III) being informed by each of the stages of crop trials and screenings.<br>• Phase I, II & III technology prototypes<br>• Ongoing grower trial testing of technology prototypes including laboratory, glasshouse and plot trials.<br>• Prototype units trialed alongside primed seedlings to determine effects of technologies on crop growth rates, bolting rates (premature flowering) and yield indices<br>• Grower field days completed<br>• Industry steering committee engaged (working as a project reference group)<br>• Grower strategic planning days<br>• Economic evaluation of technologies<br>• A commercialisation strategy completed by UniQuest (UQs commercialisation company).<br>• Discussions with commercial companies as potential R&D partners. |
| Outputs | • Technology prototypes I, II & III leading to the development of a precision application prototype |

| | |
|---|---|
| | • Two papers published in peer reviewed scientific journals<br>• An invited industry magazine publication completed<br>• The chief investigator (Dr Jitka Kochanek) spoke at The World Science Festival, Science Chats at The Edge & in a live-streaming UQ Science Radio interview.<br>• National and international reputation: In late 2019 the team won the CSIRO ON Prime accelerator program for best innovation, team pitch and overall commitment.<br>• Non-confidential aspects of project aims and technology potential were communicated to industry via on-farm meetings and a field day. Growers exhibited unanimous support for potential project outcomes.<br>• Bulletins completed for publication in the Hort Innovation and/or Vegetables Australia magazine. |
| Outcomes | • The development and proof of concept of a working precision micro-dosing prototype for the application of PGR's that fit the operational requirements of growers.<br>• Validation of PGR1's ability to enhance crop resilience to environmental variability, especially at establishment, with project trial results including:<br>○ 16% heavier broccoli heads relative to untreated plants<br>○ 42% of premium capsicum seedlings versus 10% for the control<br>○ Twice the number of capsicum seedlings emergence at one week after sowing and 26% taller plants at two weeks post emergence.<br>○ Stronger capsicum plants with better structure and faster fruit formation in extreme heat and drought conditions.<br>○ Suppressed disease via an upregulation of internal plant defense genes.<br>• Early stage commercialisation was commenced. Further post-project commercialisation funding requirements were estimated at $50k-$2m over a 2-2.5 year timeline to complete early stage commercialisation, with potentially $10-$100m over 5-15 years for full commercialisation.<br>• Variables were identified that require further research specifically to generate data sets that would bolster a patent application and give it sufficient breadth to make it commercially worthwhile.<br>• Research capacity and industry development with project lead Dr Jitka Kochanek from UQ supervising four PhD, four Masters, five Honours and 13 undergraduate research student projects. |
| Impacts | • [Economic and social] – Increased industry research knowledge, skills and evidence relating to plant growth regulators and precision application technology, supporting industry capacity for ongoing R&D into this area, with the potential for future industry impact.<br>• [Social] – Building horticulture research and academic capacity in Australia with a national and international reputation. |

# Project costs

## Nominal investment

**Table 4. Project nominal investment**

| Year end 30 June | Hort Innovation ($) | The University of Queensland ($) | Total ($) |
|---|---|---|---|
| 2016 | 249,000 | 188,081 | 585,074 |
| 2017 | 199,000 | 150,314 | 445,181 |
| 2018 | 100,018 | 75,548 | 222,705 |
| 2019 | 91,051 | 68,755 | 195,344 |
| 2020 | 964 | 728 | 2,013 |
| 2021 | 159,600 | 120,553 | 327,209 |
| **Total** | **799,633** | **604,000** | **197,429** |

### Program management costs

R&D costs should also include the administrative and overhead costs associated with managing and supporting the project. The Hort Innovation overhead and administrative costs were calculated for each project funding year based on the data presented in the *Statement of Comprehensive Income* in the *Hort Innovation Annual Report* for the relevant year. Where the overhead and administrative costs were equal to the total expenses, less the research and development and marketing expenses. The overhead and administrative costs were then calculated as a proportion of combined project expenses (RD&E and marketing), averaging 16.7% for the VG15021 funding period (2016-2021). This figure was then applied to the nominal Hort Innovation investment shown in Table 3.

### Real Investment costs

The investment costs of all parties were expressed in 2021-22 dollar terms (the closest financial year to the year of analysis) using the Implicit Price Deflator for Gross Domestic Product (ABS, 2022).

### Extension costs

There were no additional costs associated with VG15021 for project extension. Results were communicated as part of the project. Communication and extension were activities conducted within the project, so the project expenditure is assumed to be inclusive of extension costs.

## Project impact valuation

- No impacts were valued for VG15021. Discussions with stakeholders and a review of project resources indicated that further R&D and commercialisation investment estimated at over $12 million to $100 million would be required over a period of 15 years before viable commercialisation (and therefore adoption and impact) could be achieved. To date there had been no investment commitment for ongoing funding in this area. Given the current lack of funding commitment or investment priority for this area, and the significant uncertainty relating to the total cost before a viable commercial product (and therefore adoption and impact) is achieved, there would be little confidence in the impact valuation results at this point.

### Impacts not valued

The impacts from VG15021 identified but not quantified were:

- [Economic and social] – Increased industry research knowledge, skills and evidence relating to plant growth regulators and precision application technology, supporting industry capacity for ongoing R&D into this area, with the potential for future industry impact.
- [Social] – Building horticulture research and academic capacity in Australia with a national and international reputation.

### Public versus private impacts

The potential impacts identified from the investment are predominantly public benefits in the form of capacity built.

### Impacts on other Australian industries

The project activities and results were aimed at the vegetable industry but research capacity may have some limited influence for other users of PGR's such as the Nursery Industry.

### Impacts overseas

This research was focused on the Australian vegetable industry and limited overseas impact from this project is expected.

## Results

All costs were discounted to 2021-22 using a real discount rate of 5%. 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

Table 6 shows the impact metrics estimated for different periods of benefit for the total investment. Hort Innovation was the only funding organisation for this project.

**Table 6. Impact metrics for the total investment in VG15021**

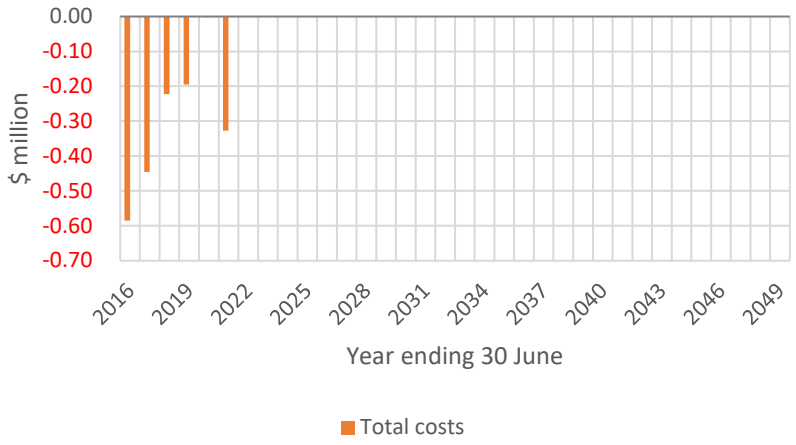
| Impact metric | Years after last year of investment | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 5 | 10 | 15 | 20 | 25 | 30 |
| PVC ($m) | 2.19 | 2.19 | 2.19 | 2.19 | 2.19 | 2.19 | 2.19 |
| PVB ($m) | NA | NA | NA | NA | NA | NA | NA |
| NPV ($m) | -2.19 | -2.19 | -2.19 | -2.19 | -2.19 | -2.19 | -2.19 |
| BCR | NA | NA | NA | NA | NA | NA | NA |
| IRR | NA | NA | NA | NA | NA | NA | NA |
| MIRR | NA | NA | NA | NA | NA | NA | NA |

**Table 6. Impact metrics for the Hort Innovation investment in VG15021**

| Impact metric | Years after last year of investment | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 5 | 10 | 15 | 20 | 25 | 30 |
| PVC ($m) | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 |
| PVB ($m) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NPV ($m) | -1.33 | -1.33 | -1.33 | -1.33 | -1.33 | -1.33 | -1.33 |
| BCR | NA | NA | NA | NA | NA | NA | NA |
| IRR | NA | NA | NA | NA | NA | NA | NA |
| MIRR | NA | NA | NA | NA | NA | NA | NA |

Figure 1 shows the annual undiscounted benefit and cost cash flows for the total investment of VG15021. Cash flows are shown for the duration of the investment plus 30 years from the last year of investment.

**Figure 1. Annual cash flow of undiscounted total benefits and total investment costs**




## Discussion and conclusions

VG15021 brought together transformational precision technologies that had been developed over 5 years of Hort Innovation-funded research and over 10 years of non-Hort Innovation funded research from multiple University R&D programs. The specific technology mechanisms explored were:

1) a plant growth regulator (PGR1) to enhance crop resilience to environmental variability, especially at establishment.

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As part of the project, a commercialisation strategy was developed and reviewed. By project completion the early stage commercialisation process had begun; however, there was still not enough data to substantiate defendable claims in a patent application. Of the two mechanisms being explored, the precision micro-dosing prototype was considered to have had a better than average potential to be patentable and commercialised once additional data collection was attained. As part of the commercialisation strategy, however, industry consultation across 17 separate businesses was undertaken and this concluded that the technology required further R&D before it would be at a level of commercialisation. Feedback also indicated that the plant micro-dosing prototype may not have been versatile enough for commercial application. Overall, at project completion it was estimated (in the project M&E plan) that additional an investment of between $12 million to $100 million would be required over a period of 15 years before viable commercialisation (and therefore adoption and impact) could be achieved. To date there had been no investment commitment for ongoing funding in this area. Given the current lack of funding commitment or investment priority for this area, and the significant uncertainty relating to the total cost before a viable commercial product (and therefore adoption and impact) is achieved, there was insufficient confidence to quantify any impacts for this project.

It is important to note that early-stage research has recognized higher levels of risk compared to later stage RD&E and commercialisation, so that successful outcomes are not always achieved. However, any finding are still valuable in informing future investments. In this light, while no project impacts were able to be valued for this project the additional knowledge and research capability generated from the investment has the potential to support future impacts in this or related research areas.

## Acknowledgements

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## 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. |
| 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. |

## Abbreviations

CRRDC Council of Rural Research and Development Corporations

DAFF Department of Agriculture, Fisheries and Forestry (Australian Government)

GDP Gross Domestic Product

GVP Gross Value of Production

IRR Internal Rate of Return

MIRR Modified Internal Rate of Return

PVB Present Value of Benefits

PVC Present Value of Costs

RD&E Research, Development and Extension

SIP Strategic Investment Plan

*Ends.*