Impact assessment of the investment:

Tools and interventions for increasing children's vegetable intake (VG16064)

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Hort Innovation

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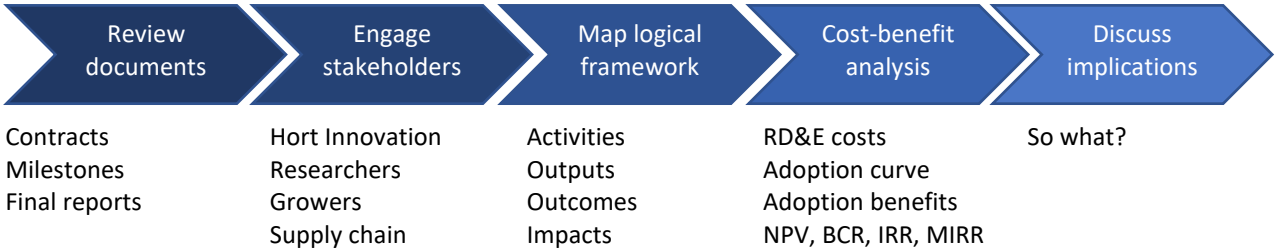
Executive summary

What the report is about

Ag Econ conducted independent analysis determine the economic, social, and environmental impact resulting from delivery of the vegetable project *Tools and interventions for increasing children's vegetable intake (VG16064)*. The project was funded by Hort Innovation over the period December 2017 to November 2022 using the vegetable research and development levy and contributions from the Australian Government. The project was delivered by the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

The analysis applied a five step analytical process to understand the impact pathway and collect supporting data.



Research background

From 2018 to 2023, Horticulture Innovation engaged CSIRO to progress the findings and recommendations of earlier projects VG13090 and VG15005 and deliver the project *Tools and interventions for increasing children's vegetable knowledge VG16064* (VegKIT). The project aimed to support an integrated program of R&D activities targeted at influencing vegetable consumption behaviour across multiple settings including Best Practice Guides, and pilot studies of interventions in long-daycare and primary school settings.

Key findings

The nominal investment cost of $4.75 million was adjusted for inflation (ABS, 2024) and discounted (using a 5% real discount rate) to a 2023-24 present value (PV) of costs equal to $6.30 million.

The analysis conducted a detailed evaluation of the VG16064 impact pathway through a logical framework, and a review of the available data. From this process it was identified that there were too many uncertainties relating to the continued rollout and uptake of the Best Practice Guides and the long-daycare initiatives to confidently estimate an impact. In contrast, the pilot study interventions in the primary school setting have been continued with the follow on project MT22006 that seeks to undertake large scale trials and a national rollout. This ongoing investment commitment provides confidence in the potential for uptake and impact. The impact of the primary school initiative was modelled with consideration to farmgate economic impacts from increased vegetable demand, and broader social impacts from increased vegetable consumption resulting in reduced incidence of diet related diseases and associated national healthcare costs.

The analysis estimated total expected benefits of $16.64 million (2023-24 present value (PV) using a 5% discount rate) accruing between 2024 and 2053, with social benefits (reduced healthcare costs) accounting for 60% and farmgate economic benefits accounting for 40%.

When compared to the total funding of $6.30 million (2023-24 PV) between 2017 and 2023, the results showed a positive RD&E impact with a net present value (NPV) of $10.34 million, an estimated benefit-cost ratio (BCR) of 2.64 to 1, an internal rate of return of 11% and a modified internal rate of return of 8%. Of note, industry benefits of $6.67 million were above the full cost of research ($6.30 million) in the baseline results.

Sensitivity analysis tested the results for uncertainty around the underlying variables, which was particularly important given the long-term future projections conducted in the analysis. Across 1000 simulations of the model the sensitivity analysis gave an impact (BCR) range of between 0.03:1 and 3.42:1 with 80% of results generating a positive impact. This gave a moderate to high level of confidence of a positive impact being generated. The results were most sensitive to the achieved rate of per-person consumption change achieved through the initiative, which accounted for 72% of the modelling variation, and also the rate of initiative rollout and cohort reach, which accounted for 8% of modelling variation. Collecting improved data on both of these variables (such as through MT22006) would improve the accuracy of any future impact assessments.

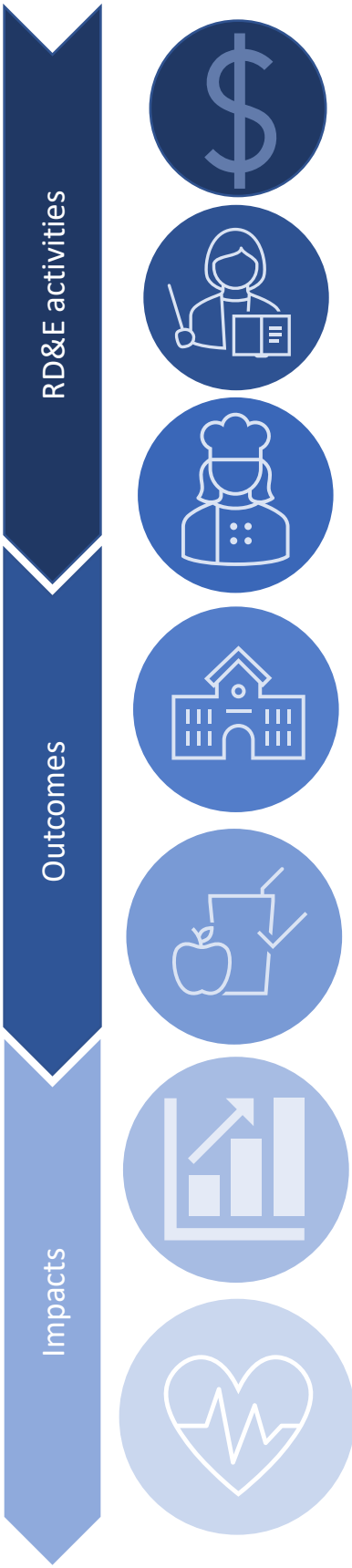
The key findings of the VG16064 impact assessment are summarized in Figure 1 below.

Keywords

Impact assessment; cost-benefit analysis; vegetable; consumption, demand-creation, primary school

Figure 1. Summary of impact assessment findings

VG16064 VegKit



Total RD&E costs:

- $4.75 million (nominal value)
- 92% R&D levy and Government matching, and 8% CSIRO in-kind.

Research activities:

- Review global initiatives to develop best practice guidelines for interventions across multiple settings, and dietary advice for maternal, infant and early years
- Develop national on-line registry of initiatives to increase vegetable intake and VegKIT website
- Continue the Vegetable Intake Strategic Alliance (VISA) of cross-sector stakeholders (commenced in VG15005)
- Undertake randomized controlled trials of interventions in long-daycare and primary school settings.
- Develop new vegetable products around sensory properties that are regarded as 'desirable' for children.

Outcomes:

- VegKIT pilot trials proved that children can be trained to like vegetables, with the program increasing vegetable consumption in both long day-care and primary school settings.
- The VegKIT best practice guides provided consolidated guidance to increase children's vegetable consumption through a range of settings, but a survey conducted in VG22005 noted uptake of these resources has been limited.
- The VISA was discontinued in 2023, being superseded by the Fruit and Vegetable Consortium (FVC).

Industry adoption:

- Of all research areas, only the primary school initiative has demonstrated a high likelihood of adoption, with large scale trials and national rollout planned through MT22006. Long term uptake was estimated at between 30% and 50% of the target primary school audience.

Industry economic impacts:

- Increased demand for vegetables supporting growth in industry production.

Socio-economic impacts:

- Increased consumption of vegetables reducing the incidence of diet related diseases such as Type-2 diabetes, coronary heart disease, stroke, and cancer.

Total attributable benefits and impact:

- Present value (PV @ 5% discount) RD&E costs of $6.30 million.
- PV estimated benefits of $16.64 million (60% social benefits, 40% industry economic benefits).
- Net PV (NPV) of $10.34 million.
- Benefit cost Ratio (BCR) of 2.64:1 with a 90% confidence of a BCR between 0.25:1 and 2.08:1

Introduction

Evaluating the impacts of levy investments is important to demonstrate the economic, social and environmental benefits realised through investment to levy payers, Government and other industry stakeholders. Understanding impact is also an important step to inform the ongoing investment agenda.

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 annually on a representative sample of investments of its RD&E portfolio. Commencing with MT18011 in 2017-18, the impact assessment program consisted of an annual impact assessment of up to 15 randomly selected Hort Innovation RD&E investments (projects) each year. In line with this ongoing program, Ag Econ was commissioned to deliver the *Horticulture Impact Assessment Program 2020-21 to 2022-23* (MT21015).

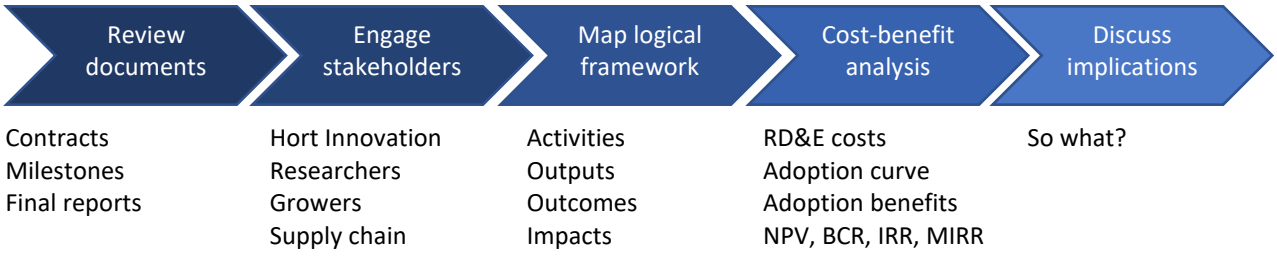
Novel Topical Vegetable, Cotton Virus and Whitefly Protection (VG16037) was randomly selected in the 2021-22 sample. This report presents the analysis and findings of the project impact assessment.

The report structure starts with the general method of analysis used, followed by the RD&E background and an outline of the impact pathway in a logical framework, then describes the approach used to quantify the identified costs and benefits including any data gaps and limitations to the analysis, presents the results including from the sensitivity analysis, and finally discusses any implications for stakeholders.

General method

The impact assessment built on the impact assessment guidelines of the CRRDC (CRRDC, 2018) and included both qualitative and quantitative analysis. The general method that informed the impact assessment approach is as follows:

1. Review project documentation including project plan, milestone reports, outputs and final report.
2. Discuss the project delivery, adoption and benefits with the Hort Innovation project manager, project researcher/consultant, growers and other relevant stakeholders (see *Stakeholder consultation*).
3. Through a logical framework, qualitatively map the project's impact pathway, including activities, outputs, and outcomes to identify the principal economic, environmental, and social impacts realised through the project
4. Collect available data to quantify the impact pathway and estimate the attributable impacts using cost-benefit analysis (over a maximum 30 years with a 5% discount rate), and then sensitivity test the results to changes in key parameters.
5. Discuss the implications for stakeholders.



The analysis identified and quantified (where possible) the direct and spillover impacts arising from the RD&E. The results did not incorporate the distributional effect of changes to economic equilibrium (supply and demand relationships) which was beyond the scope of the MT21015 impact assessment program. A more detailed discussion of the method can be found in the *MT21015 2023-24 Summary Report* on Hort Innovation project page Horticulture Impact Assessment Program 2020/21 to 2022/23 (MT21015).

Project background

The Vegetable industry Strategic Investment Plan (SIP) 2012 (VG10115) had recommended an increased focus of R&D levy investments into Consumer Alignment (Demand Creation), with a key performance metric of increased Vegetable Consumption beyond domestic population growth. Beyond the vegetable industry benefits, increased vegetable consumption was also linked with positive health outcomes with benefits for individuals (wellbeing) and society at large (healthcare costs and productivity).

In response to this strategic need, Hort Innovation commissioned the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to delivery the projects: VG13090 *A Strategy to Address Consumption of Vegetables in Children* and VG15005 *Implementation Plan for Increasing Children's Vegetable Intake*. These project identified six priority research areas to increase vegetable consumption among children:

1. Develop best-practice guidelines to increase vegetable consumption.
2. Create a national online register of initiatives to increase vegetable consumption.
3. Develop and coordinate the VISA.
4. Update current dietary advice for maternal, infant and early years, using evidence-based knowledge of flavour exposure and food preference development, to improve vegetable acceptance.
5. Execute initiatives in the community (for long day-care settings) .
6. Develop supply chain initiatives (industry innovations) and interventions in early primary school settings.

In 2017, the *Vegetable Strategic Investment Plan 2017*-2021 (Hort Innovation 2017) again prioritised RD&E investments to increase vegetable demand. As a result, Horticulture Innovation engaged CSIRO to progress the findings and recommendations of VG13090 and VG15005 and deliver the project *Tools and interventions for increasing children's vegetable knowledge* VG16064 (VegKIT). The project aimed to support an integrated program of R&D activities targeted at influencing vegetable consumption behaviour across multiple settings.

VG16037 aligned with the Vegetable SIP 2022-2026 through:

- Outcome 2: Demand creation. Strategy 4. Support vegetable product differentiation and initiate stakeholder education initiatives (e.g. health benefits).

VegKIT was funded through vegetable industry research and development (R&D) levies with contributions from the Australian Government.

Project details

VG16064 provided funding to CSIRO from 2017 to 2022 (Table 1).

Table 1. Project details

Project code	VG16064
Title	Tools and interventions for increasing children's vegetable knowledge
Research organization(s)	The Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Project leader	Dr David Cox (CSIRO)
Funding period	December 2017 to November 2022
Objective	To deliver an integrated program of research and development activities to increase children's intakes and acceptance of vegetables, with the long term planned impact of increasing children's intake by more than half a serve of vegetables per day.

Logical framework

The impact pathway linking the project's activities and outputs, and their assessed outcomes and impacts have been laid out in a logical framework (Table 2).

Table 2. Project logical framework detail

- As part of the integrated program of R&D, the VegKIT project included six activity areas:
  1. Develop best-practice guidelines to increase vegetable consumption. These consolidated research into global approaches to behavioural change for specific settings (maternal, long day-care, primary school, out of school hours care) including links to resources developed through other Hort Innovation initiatives (for example VG16018 Phenomenom and VG15067 Taste and Learn).

RD&E activities… (continued)

2. Create of a national online register of initiatives to increase vegetable consumption.
3. Develop and coordination of the Vegetable Intake Strategic Alliance (VISA).
4. Update existing dietary advice for maternal, infant and early years, using evidence-based knowledge of flavour exposure and food preference development, to improve vegetable acceptance.
5. Long day-care settings. Tested in 2 randomised controlled trials across a 12 weeks, 32 daycares, 1039 students, 237 teachers, and 39 cooks, to determine the relative effectiveness (individual and combined) for increasing children's vegetable intake in long day care, incorporating: cooks training and menu assessments, "Taste and Learn" curriculum for teachers (VG13089, VG15067, and online training.
6. Develop supply chain initiatives (industry innovations) and interventions in early Primary school settings.
   - **Primary school canteen initiatives**. Seven strategies tested in randomised controlled trials involving 4302 students across 16 (8 intervention and 8 control) schools
   - **New vegetable products.** Based on a review of the key properties that influence children's acceptance of vegetables, CSIRO developed a sensory model that can be used in the creation of vegetable-based products for children. Using this model, CSIRO developed a set of new 'vegetable based product concepts' built around the sensory properties that are regarded as 'desirable' for children.

- The development and delivery of VegKIT leveraged previous vegetable consumption resources and interventions, including Hort Innovation projects VG13089, VG15067, VG13090, VG15005, VG12078, VG14060, VG16026, and VG16049.
- The Guidelines provided a consolidated reference point for target audiences to identify resources relevant to specific settings (e.g. long day care, primary school, policy). The Guidelines drew on a wide range of existing resources including other Hort Innovation investments such as Taste & Learn (VG13089 and VG15067), and Phenomenom (VG16018).
- VG16065 coordinated with VG15067 (also delivered by CSIRO) to investigate the effectiveness of combining the long day care initiative with the classroom based Taste and Learn intervention.

RD&E outputs

- The VegKIT resources were used to deliver a broad program of resources to support vegetable consumption behavioural change across a broad cohort of children (2 to 12 years) and settings (at home, long day-care, primary school, out of school hours care) by engaging parents, carers, educators, researchers, supply chain, and policy makers. All resources were published at www.vegkit.com.au.
  - Best practice guidelines to increase vegetable intake,
  - A national on-line registry of initiatives to increase vegetable intake and VegKIT website
  - A Vegetable Intake Strategic Alliance (VISA) of cross-sector stakeholders.
  - Dietary advice for maternal, infant and early years.
  - Community initiatives for long day-care settings.
  - Supply chain initiatives including industry innovations and initiatives for early primary school settings.
    - New 'vegetable based product concepts' freely available for commercial adoption, including two concepts (rainbow dippers, and vegetable based ice blocks) at prototype stage.

Outcomes

- **Best-practice guidelines and early years advice statements**. The VegKIT resources were actively promoted during project delivery, with engagement levels measured through different channels (social media, e-DM, traditional media), website and resource access (9,811 downloads as of October 2022). These best practice resources weren't specifically monitored to evaluate their effectiveness at driving behaviour change. In 2022, Hort Innovation initiated the vegetable levy project *Evidence-based education program to support increased vegetable consumption in children* (VG22005), delivered by Nutrition Australia, to refine and promote the resources on the VegKIT website. Survey's conducted in VG22005 found that awareness of the VegKIT resources had been low following VG16064, and they were not being used regularly due to their length and time demands. VG22005 will run for 12 months to the end of 2024. There was no identified plan for ongoing maintenance of the VegKIT resources beyond VG22005.
- **National online register of initiatives**. The register was able to attract submissions of just 24 initiatives. Stakeholders noted that engagement was potentially limited due to a lack of incentive for submission, and a lack of time/resources for smaller community initiatives. There was no information identified to determine the ongoing use and outcomes of the national online register of initiatives. There was a small amount of funding allocated through VG22005 to drive further uptake of the registry.
- **The VISA**. The VISA was discontinued in 2023. The Fruit and Vegetable Consortium (FVC) (established 2020) effectively took over from the VISA as the consolidated voice leading the development, promotion and coordination of a long-term strategy to increase fruit and vegetable consumption.
- **Long day-care initiatives**. The randomised controlled trial showed that a combination of CSIRO's Taste and Learn™ for Early Years curriculum package and Educator's Training on the mealtime environment was the best way to increase children's vegetable intake:
  - Children at 3x more veggies (from 12g/day to 38g/day) with no significant change in food waste.
  - 81% of teachers would recommend the curriculum to other educators.

  The long day-care pilot was not taken any further beyond the resources developed in VG16064.
- **Primary school initiatives**. Seven school canteen strategies were tested in randomised controlled trials involving 4302 students across 16 (8 intervention and 8 control) schools, with a 75% increase vegetable sales and no adverse effect on vegetable waste. The change in vegetable consumption per person was not specifically measured. In 2022, Hort Innovation initiated the multi-industry levy project *Education and tools for canteen managers to increase vegetables in primary school canteens and vegetable consumption by children (MT22006)*. The MT22006 delivery partner, Healthy Kids Association, was directly involved in co-designing the VG16064 school canteen pilot program and incorporated the findings and recommendations of VG16064 into MT22006 for further refinement, evaluation and extension. The project will conduct a national rollout of the original NSW pilot program with a goal of 200 intervention schools and 200 control schools over two school terms in 2015. The target outcomes for MT22006 are for 30% of national primary schools to use the resources, resulting in a more than 20% increase in sales of intervention canteen menu items containing vegetables. Stakeholders are positive for the long-term prospects for the canteen intervention given the positive feedback from the VG16064 pilot program, the partnership with state-based canteen associations, and the partnership with a commercial provider of the ready-to-eat meal kits. However, stakeholders also noted the need for the canteen program to be integrated with other interventions to maximise long term success through a layered approach with multiple touch points including classroom based intervention, early learning settings, and policy settings.

- The VegKIT trials in both long day-care and primary school settings proved that children can be trained to like vegetables, with the program increasing vegetable consumption. In addition to the success in increasing consumption, the initiatives were deemed to be scalable. As pilot initiatives, the direct impact was limited, with long-term impacts dependent on their further expansion and implementation in large scale trials, and ultimately as part of a broader strategic program. Long term impacts from increased vegetable consumption include:
  - [Economic] Increased demand for vegetables, supporting an increase in both supply volume and also the price of vegetables.
  - [Social] Improved health and wellbeing resulting from an increase in vegetable intake (Angelino et al, 2019, Mujcic et al, 2016, Aune et al 2017, Stanaway et al 2022).
  - [Socio-economic] Increased contribution of the vegetable industry as a source of employment and economic stimulant to regional communities (The CIE 2023).

Project costs

The project was funded by Hort Innovation, using the vegetable research and development levies and contributions from the Australian Government, with additional funding from research partner CSIRO (Table 3). Overhead costs were added to the direct project cost to capture the full value of the RD&E investment.

Nominal investment

Table 3. Project nominal investment

Year end 30 June	Hort Innovation (VG levy and Gov't matching)	Hort Innovation overheads[1] ($)	Other funding ($)[2]	Total nominal cost ($)
2018	340,000	66,188	34,123	440,312
2019	548,800	91,285	55,079	695,164
2020	490,000	85,172	49,177	624,350
2021	739,600	110,730	74,228	924,558
2022	665,600	99,723	66,801	832,124
2023	970,800	160,738	97,432	1,228,969
Total	**3,754,800**	**613,837**	**376,840**	**4,745,477**

1. The overhead and administrative costs were calculated from the Financial Operating Statement of the Vegetable Fund Annual Reports, averaging 17% for the VG16064 funding period (2018-2023).
2. Other funds from CSIRO included in-kind for salaries of key staff, branding, and M&E. These were provided in the contract as a lump sum, so have been apportioned yearly based on Hort Innovation cash costs.

Present Value of investment

The nominal total investment cost of $4.75 million identified in Table 3 was adjusted for inflation (ABS, 2024) into a real investment of $5.39 million (2023-24 equivalent values). This was then further adjusted to reflect the time value of money using a real discount rate of 5% (CRRDC 2018), generating a present value (PV) of costs equal to $6.30 million (2023-24 PV). The results were sensitivity tested changes in the discount rate between 2.5% and 7.5%.

Project impacts

The impact pathways identified in Table 2 were evaluated against available data to determine if their impact could be quantified with a suitable level of confidence.

Impact pathway and available data

The primary school canteen program provided the clearest pathway to impact (though the national rollout in MT22006) as well as reasonable data on behaviour change. In contrast, while the long-daycare initiative showed reasonable data on behaviour change, there was no plan for scaled up rollout of the VG16064 pilot trials. For the online Best Practice resources there was both a lack of stakeholder awareness to date (identified through VG22005) and a lack of data measuring the outcomes of the Best Practices once adopted by stakeholders (either through VG16064 or through VG22005). Similarly, there was no data collected relating to improved industry research decision making or outcomes as a result of the VISA.

Impacts valued and valuation framework

Given the above, the impact assessment focussed on the primary school intervention.

A model was developed incorporating population and vegetable consumption changes over time. Projected population data for the primary school age group (6-12 years) was taken from ABS 3222 *Population Projections, Australia* (2023). Baseline national vegetable consumption was taken from ABS National Health Surveys (2012-2023), and consumption change as a result of the intervention was informed by the VG16064 results combined with the VG23005 review of consumption change in different settings (CSIRO, 2024). Together, these data sources provided the foundation for estimating national baseline vegetable consumption (the "without investment" scenario) and changes in national vegetable consumption over time as a result of the primary school intervention piloted in VG16064 (the "with investment" scenario). Comparing the "without investment" consumption and the "with investment" scenario generates the net vegetable consumption change resulting from the primary school intervention.

Having established the level of consumption change, the model valued economic and social benefits:

- [Economic] Increased demand for vegetables, supporting an increase in both supply volume and also the price of vegetables.
- [Social] Improved health and wellbeing resulting from an increase in vegetable intake (Angelino et al, 2019, Mujcic et al, 2016, Aune et al 2017, Stanaway et al 2022).

Finally, the attribution of the total identified impact to VG16064 was considered. As a pilot initiative, the direct impact of VG16064 was limited to 8 NSW schools, with long-term impacts dependent on further intervention expansion and implementation in large scale trials and national rollout, which is being delivered through MT22006. As such only a portion of the total end benefit is attributable to VG16064, which was based on the cost share of VG16064 relative to the total program of investment that delivered VG16064: particularly VG13090 (Strategy), VG15005 (Plan), VG16064 (Pilot), MT22006 (Scale-up), followed by a short period of declining ongoing investment to provide refinement and support (see *Appendix B. Total Program costs*).

Impacts unable to be valued

For the primary school intervention, the following impacts were unable to be valued.

- [Social] The contribution of the vegetable industry as a source of employment and economic stimulant to regional communities has been highlighted in previous Hort Innovation research (The CIE 2023). Increased vegetable demand, with associated increases in vegetable industry production, prices and profitability would generate flow on benefits to the regional communities in which the industry operates. While this analysis quantified the direct impacts for vegetable industry production and value, the flow-on effects require additional analysis using economic models that capture regional and national linkages, which are beyond the scope of the R&D impact assessment program (CRRDC 2018).

In addition, for reasons outlined above, the lack of certainty in the impact pathway combined with a lack of data, meant that the impacts of other research areas of VG16064 (best practice guidelines, the long-daycare intervention pilot and the VISA) could not be quantified with any confidence.

Data and assumptions

The required data relating to the impact pathway was collected from the project documents and other relevant resources (Table 4). Where available, actual data was applied to the relevant years, with estimates applied for any data gaps and projections into the future based on analytical techniques (for example correlations and trend analysis), or stakeholder estimates, or both. A data range was incorporated to reflect underlying risk and uncertainty. This was particularly relevant where estimates were needed due to data gaps, and where projections were made into the future. These ranges were then analysed through sensitivity testing (see *Results*).

Table 4. Summary of data and assumptions for impact valuation

Variable	Value	Source & comment
General data and assumptions		
Discount rate	5% (± 50%)	CRRDC Guidelines (2018)
Target population	2.3 million (ages 6-12 years)	Total focus cohort of ages 6-12 years. Population data from ABS 3101 and 3222 (2023).
Target reach by year (by year of investment)	Low: 18% 2027; 25% 2030; 30% 2040 Medium: 30% 2027; 42% 2030; 50% 2040 High: 10% 2027; 57% 2030; 70% 2040	MT22006 identified a target rollout of 30% of population reach by the end of the program. This was incorporated into the baseline with moderate growth thereafter to a 50% maximum. A low and high scenario were included in sensitivity analysis with slower or faster rollout to achieve maximum reach of 30% and 70% respectively.
Baseline national vegetable consumption	2.52 serves / person / day (national) 1.96 serves / person / day (ages 6-18)	ABS National Health Survey (2023). See *Appendix A. Health impact assumptions*.
Maximum setting consumption change (serves/person/day)	Low: +0.00 Medium: +0.12 High: +0.42	VG23005 Rapid Review of consumption change in different settings (CSIRO, 2024) including data from 18 reviews of primary school setting interventions ranging from +0 serves (0% of the target cohort baseline) to +0.42 serves (22% of the baseline, consistent with the MT22006 target) and an average of +0.12 serves (6% of the baseline). An average vegetable serve size of 75 grams was applied.
Timeline of setting consumption change (by year of first exposure)	1-3 years of exposure to max consumption change (midpoint 2 years)	No data was identified to quantify the change in consumption over time. An assumed change over 1 year (high), 2 years (moderate), and 3 years (low) was applied in discussion with stakeholders.
Farmgate vegetable price	$2.06/kg (± 5%)	No data was available for specific vegetables likely to make up the increased consumption. In agreement with stakeholders, prices for 33 vegetable categories (Hort Innovation 2024) were weighted by fresh supply volume share (proxy for consumption share assuming equal wastage) to identify the weighted average price of consumed vegetables. Prices were adjusted for CPI to FY2024 from which a 5-year average price of $2.06/kg was identified, with a standard deviation of 5% used in sensitivity testing.
Vegetable consumption and health	See Appendix A.	The relationship between vegetable consumption and disease risk was identified for four diseases. Combined with data on risk prevalence by age and disease expenditure in Australia, this data provided a mechanism to measure the health expenditure impact resulting from changes in vegetable consumption. See *Appendix A. Health impact assumptions*.
Impact attributable to VG16064	66%	The modelling framework calculated the total benefit resulting from the primary school interventions. However, VG16064 was one project in a series of investments that has contributed (and continues to contribute) to achieving this impact. As such, the attributable benefits considered the cost share of VG13090 relative to all other investments in the program. See *Appendix B. Total Program costs*.

Results

The analysis identified PV costs (PVC) of $6.30 million (2023-24 PV) between 2017-18 and 2022-23, and estimated PV benefits (PVB) of $16.64 million (2023-24 PV) accruing between 2024 and 2053 (Table 5). When combined, these costs and benefits generate a net present value (NPV) of $10.34 million, an estimated benefit-cost ratio (BCR) of 2.64 to 1, an internal rate of return (IRR) of 11% and a modified internal rate of return (MIRR) of 8%.

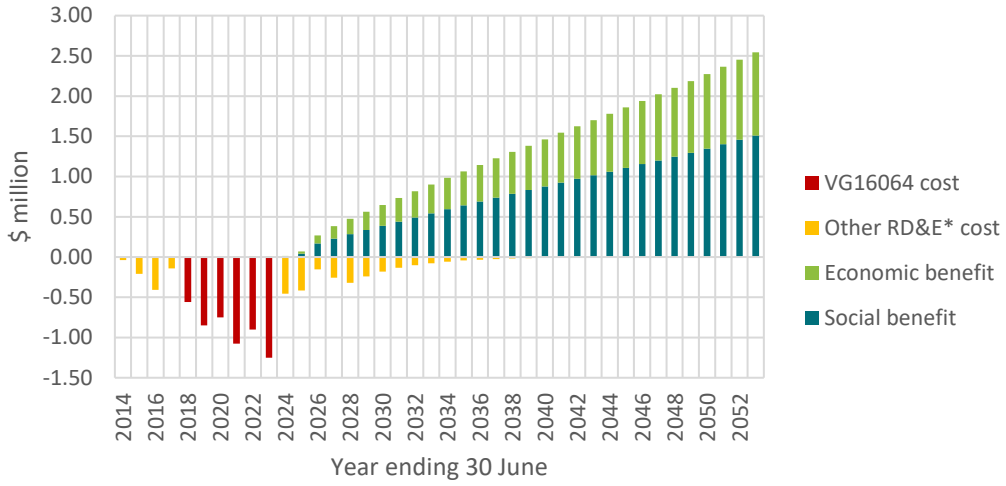
Economic benefits were estimated at $6.67 million (40% of total benefits and) and social benefits from reduced healthcare costs were estimated at $9.97 million (60% of total).

Table 5. Impact metrics for the total investment in project VG16064

Impact metric	Years after last year of investment						
	0	5	10	15	20	25	30
PVC ($m)	6.30	6.30	6.30	6.30	6.30	6.30	6.30
PVB ($m)	0.01	1.06	3.64	6.81	10.17	13.48	16.64
NPV ($m)	-6.29	-5.24	-2.66	0.51	3.87	7.18	10.34
BCR	0.00	0.17	0.58	1.08	1.61	2.14	2.64
IRR	#NUM!	-22%	-1%	6%	9%	10%	11%
MIRR	-100.0%	-12%	1%	5%	7%	8%	8%

Figure 2 shows the annual undiscounted benefit and cost cash flows attributed to VG16064.

Figure 2. Annual cash flow of undiscounted total benefits and total investment costs



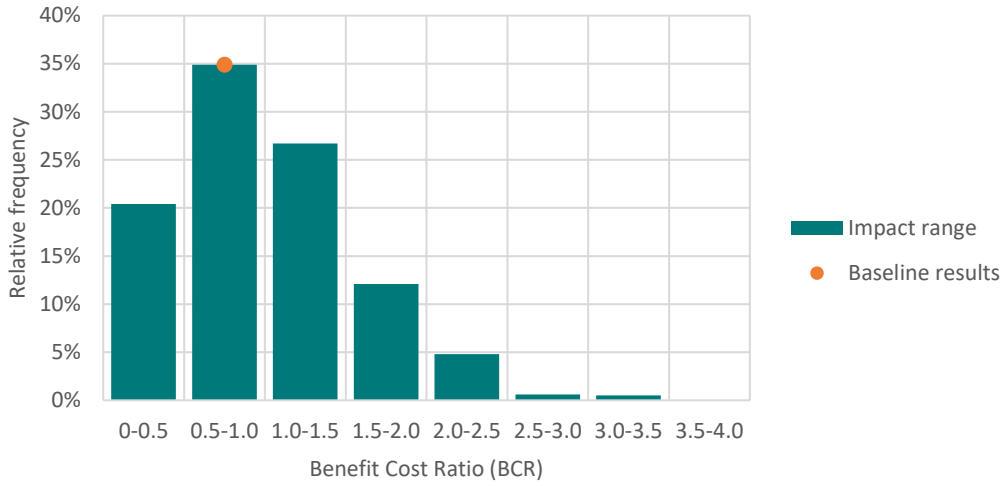
***** See *Appendix B. Total Program costs* for a total cost breakdown

Sensitivity analysis

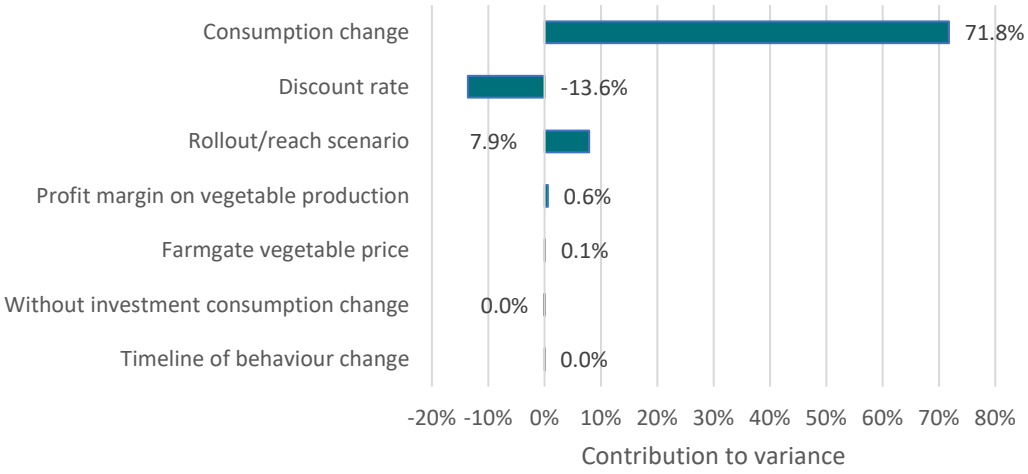
Given the risk and uncertainty associated with a number of underlying modelling variables, the potential model variation was estimated and drivers of variation identified. The sensitivity testing used @Risk stochastic modelling to incorporate the combined effect of changing all variables across their full ranges over 1000 simulations. This process showed:

- **Impact variation (Figure 3)**. Compared to the baseline BCR or 2.64:1, the 1000 simulation showed a potential BCR range of between 0.03:1 and 3.42:1, with 90% of results falling between 0.25:1 and 2.08:1 (i.e. excluding the low probability tails), and a simulation average of 0.99:1 (below the baseline results and a marginally negative impact). Of the 1000 simulations, 80% had a BCR greater than 1:1 (benefits greater than RD&E costs), giving a moderate to high level of confidence that the investment will generate a positive impact.

Figure 3. Impact variation in results over 1000 simulations



- **Contribution to variance (Figure 4)**. Contribution to variance is a measure of how much a variable contributes to the total variance of an output. Contribution to variance also shows whether a variable is positively or negatively correlated with impact. A negative contribution to variance, with bar extending to the left, indicates that this input has a negative effect on BCR: increasing this input will decrease the impact. The size of consumption change achieved by the intervention showed the largest contribution to variation, with a positive correlation with investment impact. A minimum consumption change of +0.05 serves (for the baseline rollout scenario with maximum 50% target reach) was required to achieve a positive impact. The discount rate had the second highest contribution to variance reflecting the long timeline of the benefits, but with a negative correlation with investment impact. The breakeven discount rate is reflected in the IRR (11%), or the MIRR (8%) if we assume that generated cashflows are reinvested at the risk-free discount rate. The rollout/reach inputs showed the third highest contribution to variation, with a positive correlation with investment impact. Keeping all else equal, a minimum target reach of 18% (below the tested range) was required to achieve a positive impact. Figure 4. Contribution to variance



Implications and learnings

The analysis identified a clear pathway to impact for VG16064. Drawing on the strategy and planning work completed in early investments (VG13090 and VG15005) the VegKIT delivered a multi-faceted approach to addressing vegetable behaviour change barriers for a range of cohorts, culminating in the development of best practice resources and recommendations that have been endorsed by stakeholder groups. These resources provide a strong foundation to guide the delivery of interventions targeting behavioural change barriers. In particular, VegKIT pilot trials proved that children can be trained to like vegetables, with the program increasing vegetable consumption in both long day-care and primary school settings. In

addition to the success in increasing consumption, the initiatives were deemed to be scalable. As pilot initiatives, the direct impact was limited, with long-term impacts dependent on their further expansion and implementation in large scale trials. To date, the necessary expanded trials and scale up has only been undertaken for primary school interventions, which commenced in 2024 with MT22006. Beyond the primary school interventions, the VegKIT resources provided guidance to increase children's vegetable consumption through a range of settings, but as identified in VG22005, the uptake of these resources has been limited.

Given the commitment to scale up the primary school setting, this investment area showed a clear pathway to impact, which was also supported by available data and was therefore quantified in the impact assessment.

The modelling results showed a baseline impact (BCR) of 2.64:1, with 40% of benefits were economic benefits in the form of increased farmgate value from increased vegetable demand. The remaining. 60% of the benefit being social benefits in the form of improved health outcomes and reduced health expenditure. This highlights the broader "spillover" benefits of vegetable demand creation beyond the private economic benefits captured by the vegetable industry.

Sensitivity testing showed a potential impact range of between 0.03:1 and 3.42:1, with 90% of results falling between 0.25:1 and 2.08:1 giving a moderate to high level of confidence that the investment will generate a positive impact. The variation was driven primarily by the wide potential consumption change (serves per person per day) that could be achieved in the primary school setting for which studies show a wide level of variation and therefore uncertainty for this program. Refining these estimates as part of future research (such as MT22006) would provide a more accurate estimate of investment impact.

It is important to note that the goal of childhood intervention is to engender a lifelong increase in vegetable consumption. However, as the length of the impact assessment is for 30 years (in line with CRRDC 2018 guidelines), the modelling only accounts for benefits up to a maximum age of 42 years. As a result, assuming the changes in vegetable consumption are retained over the course of a lifetime, there are additional benefits that would be generated above those captured in this model. This is particularly true for health benefits given the risks of the identified diseases increase rapidly with age.

Stakeholder consultation

Where possible, Ag Econ sought to engage multiple stakeholders across key areas of the logical framework and impact pathway to augment existing information and data sources, and reduce any uncertainty or bias from individual stakeholders. All stakeholders were engaged through telephone or online meetings, with follow up emails as necessary. Consultation followed a semi-structured approach in line with broad topics relating to the impact pathway and associated data requirements. Table 6 outlines the stakeholders consulted as part of this impact assessment and the topics on which they were consulted.

Table 6. Stakeholder consultation by theme

Stakeholder details		Consultation topics						
Stakeholder and organisation	**Stakeholder type**	**Related research**	**Research inputs**	**Research outputs**	**Research immediate outcomes**	**Follow on research**	**Stakeholder adoption**	**Impact areas and data**
Astrid Poelman, CSIRO, Public Health & Wellbeing	RD&E practitioner VG13090, VG15005, VG16064.	✓	✓	✓	✓	✓	✓	✓
Gilly Hendrie, CSIRO, Public Health & Wellbeing	RD&E practitioner VG13090, VG16064.	✓	✓	✓	✓	✓	✓	✓
Shadia Djakovic, Healthy Kids, Senior Project Manager: Schools & Community	RD&E practitioner VG16064, MT22006	✓	✓	✓	✓	✓	✓	✓

Glossary of economic terms

Benefit-cost ratio (BCR)	The ratio of the present value of investment benefits to the present value of investment costs.
Cost-benefit analysis (CBA)	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.
Direct Effects	Impacts generated for the funding industry as a result of adoption of the RD&E outputs and recommendations, typically farm level outcomes relating to productivity and risk.
Discounting and Present Values	The process of relating the costs and benefits of an investment to a base year to reflect the time value of money or opportunity cost of RD&E investment. The analysis applies a real discount rate of 5% in line with CRRDC Guidelines (CRRDC 2018) with results sensitivity tested at discount rates of 2.5% and 7.5%.
Economic Equilibrium	Due to a market's underlying supply and demand curves, changes in supply will have an impact on price and vice-versa. The Economic Equilibrium is the point at which market supply and price are balanced. Estimating the magnitude of market response to changes in supply or demand is a complex and demanding task that is considered beyond the scope of most CRRDC Impact Assessments (CRRDC 2018).
Gross Margin (GM)	The difference between revenue and cost of goods sold, applied on a per hectare basis and excluding fixed or overhead costs such as labour and interest payments.
Internal rate of return (IRR)	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 (MIRR)	The internal rate of return of an investment that is modified so that the cash inflows generated from an investment are re-invested at the rate of the cost of capital (in this case the discount rate).
Net present value (NPV)	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.
Nominal and real values	Nominal values reflect the actual values in a given year (e.g. contracted RD&E expenses). These are converted to real (inflation adjusted) values to make them comparable across time.
Spillover Effects	Impacts generated for stakeholders who did not fund the RD&E, including other agricultural industries, consumers, communities, and the environment.

Abbreviations

CSIRO The Commonwealth Scientific and Industrial Research Organisation

RD&E Research, Development and Extension

SIP Strategic Investment Plan

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Appendix A. Health impact assumptions

1. Key diseases impacted by vegetable consumption. Drawing on data presented by Aune et al (2017) and Stanaway et al (2022) the implications of changes in vegetable consumption were quantified for five disease: three cardiovascular diseases (CVD) including Coronary Heart Disease (CHD), Stroke, and other CVD; all cancers combined; and Type 2 diabetes.
2. Incidence of the key diseases in the Australian population (Figure 5) were taken from AIHW (2023a-d) and applied to setting population data (ABS 2023) to generate a baseline time series of disease incidence in Australia (assuming fixed vegetable consumption).
3. Disease risk reduction through vegetable consumption (Figure 6) was taken from Aune et al (2017) and Stanaway et al (2022). This was combined with the projected vegetable consumption (ABS 2012-2023) (Figure 7) to generate the annual disease incidence.
4. The final disease incidence was used to index the 2019-20 healthcare costs (AIHW 2021) for the five identified diseases (Figure 8), generating a time series of healthcare costs.
5. Steps 3 and 4 were completed for both the baseline (without VG16064) vegetable consumption, and the changed vegetable consumption resulting from VG16064 (and follow on investments). The difference between the two scenarios represented the reduction in disease risk and associated health-care costs.

Figure 5 Incidence of diseases in the Australian population

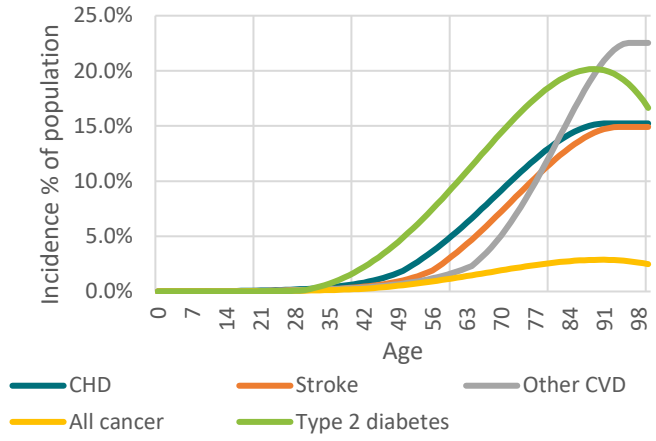


Figure 6 Changes in relative disease risk

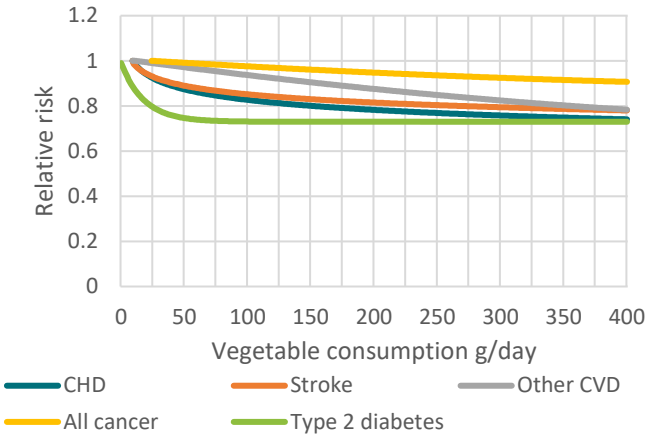


Figure 7 Baseline projections of national vegetable consumption

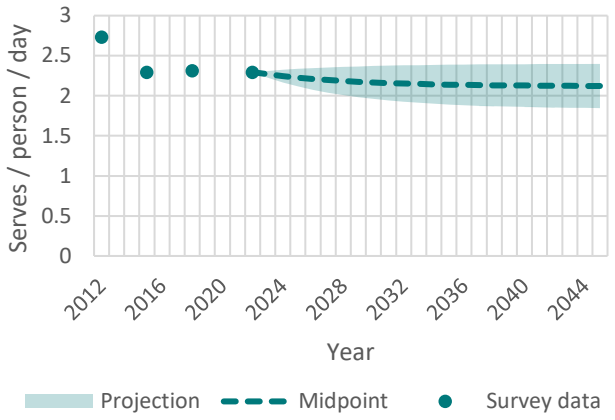
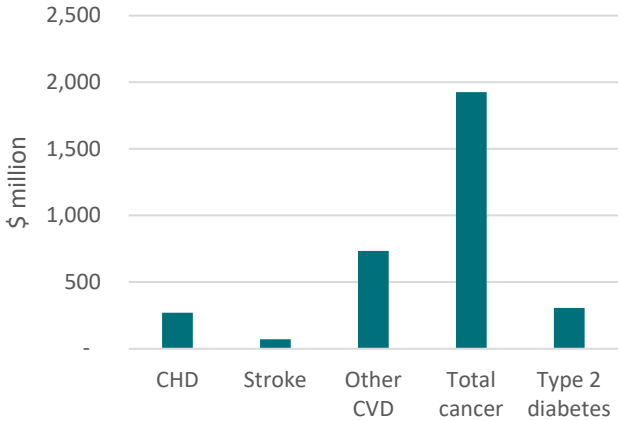


Figure 8 Total health expenditure (2019-20)



Appendix B. Total Program costs

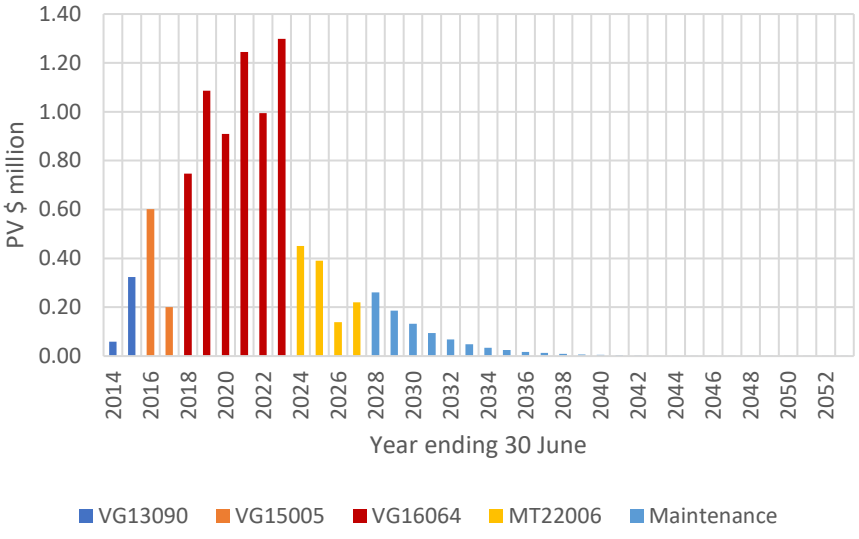
Five investment stages were identified as part of the program to deliver a national rollout of the primary school interventions. The cost share of VG16064 (in present value (PV) terms) was used to attribute a share of the total program benefits to the project (Table 6 and Figure 9).

- **Strategy**. VG13090 *A Strategy to Address Consumption of Vegetables in Children*
- **Planning**. VG15005 *Implementation Plan for Increasing Children's Vegetable Intake*
- **Pilot trials**. VG16064 *Tools and interventions for increasing children's vegetable intake* (sampled project)
- **Large scale trials and national rollout**. MT22006 *Education and tools for canteen managers to increase vegetables in primary school canteens and vegetable consumption by children*
- **Maintenance.** Costs to provide support and refinements of the program resources in the initial years of national rollout (after MT22006) tapering off over time.

Table 7. Total program cost by investment stage

Investment stage	Total PVC ($m)	% Total PVC	Years	Annual PVC
VG13090	0.38	4%	2	0.19
VG15005	0.80	8%	2	0.40
VG16064	6.30	66%	6	1.05
MT22006	1.21	13%	4	0.30
Maintenance	0.92	10%	26	0.04
Total program	9.61	100%		

Figure 9. Total program cost by investment stage



Ends.